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Effective from academic session 2023-24

Graduate Attributes

Graduate attributes are the qualities, skills, and knowledge that a student is expected to have acquired upon completing a specific degree program. In the context of a Bachelor of Science (B.Sc) in Environmental Science (EVS), the graduate attributes would encompass a range of competencies related to environmental science and sustainability. These attributes generally reflect the program's educational goals and the skills required for a successful career in the field. Here are some common graduate attributes for a B.Sc in Environmental Science:

1. **Environmental Knowledge:** Graduates should have a solid understanding of key concepts, principles, and theories related to environmental science, including ecology, biodiversity, conservation, climate change, pollution, and sustainability.
2. **Critical Thinking:** Graduates should be able to analyze complex environmental issues, evaluate evidence, and make informed decisions. They should be capable of critically assessing the impacts of human activities on the environment and proposing effective solutions.
3. **Research Skills:** Graduates should be equipped with research methodologies used in environmental science, including data collection, analysis, interpretation, and presentation. They should be able to design and conduct research projects related to environmental issues.
4. **Interdisciplinary Approach:** Environmental science is inherently interdisciplinary. Graduates should be skilled at integrating knowledge from various fields, such as biology, chemistry, geology, and social sciences, to understand and address complex environmental challenges.
5. **Sustainability Awareness:** Graduates should possess a strong awareness of sustainability principles and their application in various contexts, such as resource management, urban planning, and policy development.
6. **Communication Skills:** Effective communication is crucial for conveying complex environmental concepts to different audiences. Graduates should be able to communicate scientific information clearly, both in writing and through oral presentations.
7. **Problem-Solving:** Graduates should be adept at identifying and solving environmental problems. This includes designing and implementing strategies to mitigate environmental impacts and adapt to changing conditions.
8. **Ethical Considerations:** An understanding of ethical issues related to environmental decision-making and the responsible use of natural resources is important for graduates. This includes considerations of environmental justice, equity, and the well-being of future generations.

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Semester-I

Major Paper Code: BENVS-101	**SEM-I**
Paper Name: EARTH & ENVIRONMENTAL SYSTEM	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Lecture hour: 45	**End semester exam: 70**
Tutorial hour: 30	**Continuous Assessment: 30**
Practical hour: 0	**Mode of Exam: Offline**
Total hour: 75	
Credit: 5	

Course Objective:

1. Develop a basic understanding of environmental issues, challenges, and the importance of conservation and sustainable practices.
2. Acquire knowledge of fundamental scientific principles in areas such as biology, chemistry, physics, and geology, which are essential for studying environmental systems.
3. Learn about the principles and techniques for managing natural resources, ecosystems, and environmental pollution.
4. Understand the importance of biodiversity and explore strategies for its conservation and preservation.
5. Study the science behind climate change, its causes, impacts, and mitigation strategies.
6. Examine various types of pollution (air, water, soil) and explore methods to control and reduce pollution levels.
7. Explore the concept of sustainable development and how to achieve a balance between economic, social, and environmental objectives.
8. Gain insight into environmental policies, regulations, and international agreements concerning environmental protection.
9. Learn how to assess the potential environmental impacts of development projects and proposals.
10. Study renewable energy sources and their role in sustainable energy production and consumption.
11. Understand the challenges of waste disposal and recycling, and explore waste management strategies.
12. Discuss ethical considerations and values related to environmental issues and decision-making.

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Course Outcome:

1. **Knowledge of Environmental Concepts:** Graduates will have a comprehensive understanding of various environmental concepts, including ecosystems, biodiversity, natural resources, climate change, pollution, and sustainability.
2. **Scientific Skills:** Students will acquire scientific skills such as data collection, analysis, interpretation, and laboratory techniques relevant to environmental science.
3. **Environmental Problem-Solving:** Graduates will be able to identify, analyze, and propose solutions to environmental issues and challenges, both locally and globally.
4. **Environmental Policy and Regulation:** Students will gain knowledge about environmental laws, policies, and regulations that govern environmental protection and management.
5. **Sustainable Practices:** Graduates will be familiar with sustainable practices and principles that promote the conservation of natural resources and sustainable development.

Detailed Syllabus:

Module-1 (10hrs)

Origin of earth. Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere. Concept of minerals and rocks. Formation of igneous and metamorphic rocks. Controls on formation of landforms - tectonic including plate tectonic and climatic. Concept of steady state and equilibrium, Energy budget of the earth. Earth's thermal environment and seasons. Coriolis force, pressure gradient force, frictional force, geo-strophic wind field, gradient wind. Climates of India, western disturbances, Indian monsoon, droughts, *El Nino*, *La Nina*. Concept of residence time and rates of natural cycles. Geophysical fields.

Module-2 (10hrs)

Weathering including weathering reactions, erosion, transportation and deposition of sediments. Soil forming minerals and process of soil formation, Identification and characterization of clay minerals, Soil physical and chemical properties, soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls.

Module-3 (10hrs)

Geochemical classification of elements, abundance of elements in bulk earth, crust, hydrosphere and biosphere. Partitioning of elements during surficial geologic processes, Geochemical recycling of elements. Paleoclimate.

Module-4(10hrs)

Distribution of water in earth, hydrology and hydrogeology, major basins and groundwater provinces of India, Darcy's law and its validity, groundwater fluctuations, hydraulic conductivity, groundwater tracers, land subsidence, effects of excessive use of groundwater, groundwater

quality. Pollution of groundwater resources, Ghyben-Herzberg relation between fresh-saline water.

Module-5 (5hrs)

Natural Hazards: Catastrophic geological hazards - floods, landslides, earthquakes, volcanism, avalanche, tsunami and cloud bursts. Prediction of hazards and mitigation of their impacts.

Tutorial (30hrs)

Suggested books:

1. *Briedge, J,. Demicco, R. 2008. Earth Surface Processes, Landforms and Sediment deposits. Cambridge University Press.*
2. *Duff, P. M. D., & Duff, D. (Eds.). 1993. Holmes' Principles of Physical Geology. Taylor & Francis.*
3. *Gupta, A. K., Anderson, D. M., & Overpeck, J. T. 2003. Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. Nature 421: 354-357.*
4. *Gupta, A. K., Anderson, D. M., Pandey, D. N., & Singhvi, A. K. 2006. Adaptation and human migration, and evidence of agriculture coincident with changes in the Indian summer monsoon during the Holocene. Current Science 90: 1082-1090.*
5. *Keller, E.A. 2011. Introduction to Environmental Geology (5th edition). Pearson Prentice Hall.*

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Major Paper Code: BENVS-102	**SEM-I**
Paper Name: ENVIRONMENTAL RESOURCES AND ENERGY SCIENCE	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Lecture hour: 45	**End semester exam: 70**
Tutorial hour:30	**Continuous Assessment: 30**
Practical hour:	**Practical/Seasonal internal continuous evaluation:**
Total hour: 75	**Practical/Seasonal external examination:**
Credit: 5	**Mode of Exam: Offline**

Course Objective:

1. Develop a basic understanding of environmental issues, challenges, and the importance of conservation and sustainable practices.
2. Acquire knowledge of fundamental scientific principles in areas such as biology, chemistry, physics, and geology, which are essential for studying environmental systems.
3. Learn about the principles and techniques for managing natural resources, ecosystems, and environmental pollution.
4. Understand the importance of biodiversity and explore strategies for its conservation and preservation.
5. Study the science behind climate change, its causes, impacts, and mitigation strategies.

Course Outcome:

1.Knowledge of Environmental Concepts: Graduates will have a comprehensive understanding of various environmental concepts, including ecosystems, biodiversity, natural resources, climate change, pollution, and sustainability.
2. Scientific Skills: Students will acquire scientific skills such as data collection, analysis, interpretation, and laboratory techniques relevant to environmental science.
3. Environmental Problem-Solving: Graduates will be able to identify, analyze, and propose solutions to environmental issues and challenges, both locally and globally.
4. Environmental Policy and Regulation: Students will gain knowledge about environmental laws, policies, and regulations that govern environmental protection and management.
5. Sustainable Practices: Graduates will be familiar with sustainable practices and principles that promote the conservation of natural resources and sustainable development.

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Module-1 (10hrs)

Concept of renewable, non-renewable, conventional and nonconventional Energy resources; Energy and heat budget of the earth; Global energy use Pattern, energy use and prospects in India; Energy security.

Module-2 (10hrs)

Sun as source of energy; solar radiation and its spectral characteristics. Fossil fuels: classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas. Shale oil, Coal bed Methane, Gas hydrates. Gross-calorific value and net-calorific value.

Module-3 (10hrs)

Principles of generation of hydro-power, tidal energy, ocean thermal energy conversion, wind power, geothermal energy, solar energy (solar collectors, photo-voltaic modules, solar ponds).Nuclear energy - fission and fusion, Nuclear fuels, Nuclear reactor – principles and types.

Module-4 (10hrs)

Bioenergy: methods to produce energy from biomass. Bio-mass characteristics; Different methods of extracting energy from bio-mass,
their use, prospects and problems; Concept and use of bio-fuel and environmental impacts.

Module-5 (5hrs)

Environmental implications of energy use; energy use pattern in India and the world, emissions of CO2 in developed and developing countries including India, radiative forcing and global warming. Impacts of large scale exploitation of solar, wind, hydro and nuclear energy sources.

Suggested books:

1. M.Dayal (6th Esd:). 1997. Renewable Energy: Environment and Development. Konark Pub. Pvt. Ltd.
2. S. Vandana. 2002. Alternative Energy. APH Publishing Corporation.
3. S. K. Agarwal. 2003. Nuclear Energy: Principles Practice and Prospects. APH Publishing Corporation.
4. P. Chaturvedi. 1995. Bio-Energy Resources. Concept Publications.
5. V S. Mahajan. 1991. National Energy: policy, crisis and growth. Ashish Publishing House.
6. R.K.Rajput, Non-Conventional Energy Resources, S.Chand Publication.

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Semester-II

Major Paper Code: BENVS-201 & BENVS-291	**SEM-II**
Paper Name: PHYSICS & CHEMISTRY OF ENVIRONMENT	**Maximum Marks: 100+100**
Teaching Scheme	**Examination Scheme**
Lecture hour: 45	**End semester exam: 70**
Tutorial hour: 0	**Continuous Assessment: 30**
Practical hour: 30	**Practical/Seasonal internal continuous evaluation: 40**
Total hour: 75	**Practical/Seasonal external examination: 60**
Credit: 5	**Mode of Exam: Offline**

Course Objective:

1. Develop a basic understanding of environmental issues, challenges, and the importance of conservation and sustainable practices.
2. Acquire knowledge of fundamental scientific principles in areas such as biology, chemistry, physics, and geology, which are essential for studying environmental systems.
3. Learn about the principles and techniques for managing natural resources, ecosystems, and environmental pollution.
4. Understand the importance of biodiversity and explore strategies for its conservation and preservation.
5. Study the science behind climate change, its causes, impacts, and mitigation strategies.
6. Examine various types of pollution (air, water, soil) and explore methods to control and reduce pollution levels.
7. Explore the concept of sustainable development and how to achieve a balance between economic, social, and environmental objectives.

Course Outcome:

1.Knowledge of Environmental Concepts: Graduates will have a comprehensive understanding of various environmental concepts, including ecosystems, biodiversity, natural resources, climate change, pollution, and sustainability.
2. Scientific Skills: Students will acquire scientific skills such as data collection, analysis, interpretation, and laboratory techniques relevant to environmental science.
3. Environmental Problem-Solving: Graduates will be able to identify, analyze, and propose solutions to environmental issues and challenges, both locally and globally.

4. Environmental Policy and Regulation: Students will gain knowledge about environmental laws, policies, and regulations that govern environmental protection and management.
5. Sustainable Practices: Graduates will be familiar with sustainable practices and principles that promote the conservation of natural resources and sustainable development.

Detailed Syllabus:

Module-1 (10hrs)

Laws of thermodynamics, heat transfer processes, mass and energy transfer across various interfaces, material balance. Meteorological parameters - pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, radiation and wind velocity, adiabatic lapse rate, environmental lapse rate. Wind roses.

Module-2 (10hrs)

Fundamentals of Environmental Chemistry: Classification of elements, Stoichiometry, Gibbs' energy, chemical potential, chemical kinetics, chemical equilibria, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes.

Module-3 (10hrs)

Composition of air. Particles, ions and radicals in the atmosphere. Chemical speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog.

Module-4 (10hrs)

Hydrological cycle. Water as a universal solvent. Concept of DO, BOD and COD. Sedimentation, coagulation, flocculation, filtration, pH and Redox potential (Eh).
Inorganic and organic components of soils. Biogeochemical cycles – nitrogen, carbon, phosphorus and sulphur. Toxic chemicals: Pesticides and their classification and effects. Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O3, PAN, VOC and POP. Carcinogens in the air.

Module-5 (5hrs)

Principles of analytical methods: Titrimetry, Gravimetry, Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flame photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS), Electrophoresis, XRF, XRD, NMR, FTIR, GC-MS, SEM, TEM.

Practical
Major Paper Code: BENVS-291

Credit: 2

1. Determination of DO.

2. Determination of BOD and COD.

3. Alkalinity and Buffering Capacity of Water.

4. pH determination of different water.

5. Determination of Hardness of water.

6. Determination of Salinity of water

7. Determination of Sulphate in water.

Suggested Books:

1. Environmental Chemistry with Green Chemistry, Asim K Das, Books and Allied (P) Ltd., 2010
2. Geomorphology & Environment, Editors Savindra Singh, H S Sharma and Sunil K De, ACB Publications, 2004.
3. Green Chemistry (PB): Nova; Luque

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Major Paper Code: BENVS-202 & 292	**SEM-II**
Paper Name: ENVIRONMENTAL SUSTAINIBILITY CONCEPT AND CONCERN	**Maximum Marks: 100**
Teaching Scheme	**Examination Scheme**
Lecture hour: 45	**End semester exam: 70**
Tutorial hour: 30	**Continuous Assessment: 30**
Practical hour: 0	**Mode of Exam: Offline**
Total hour: 75	
Credit: 5	

Course Objective:

1. Develop a basic understanding of environmental issues, challenges, and the importance of conservation and sustainable practices.
2. Acquire knowledge of fundamental scientific principles in areas such as biology, chemistry, physics, and geology, which are essential for studying environmental systems.
3. Learn about the principles and techniques for managing natural resources, ecosystems, and environmental pollution.
4. Understand the importance of biodiversity and explore strategies for its conservation and preservation.
5. Study the science behind climate change, its causes, impacts, and mitigation strategies.
6. Examine various types of pollution (air, water, soil) and explore methods to control and reduce pollution levels.
7. Explore the concept of sustainable development and how to achieve a balance between economic, social, and environmental objectives.

Course Outcome:

1.Knowledge of Environmental Concepts: Graduates will have a comprehensive understanding of various environmental concepts, including ecosystems, biodiversity, natural resources, climate change, pollution, and sustainability.
2. Scientific Skills: Students will acquire scientific skills such as data collection, analysis, interpretation, and laboratory techniques relevant to environmental science.
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Detailed Syllabus:

Module-1 (10hrs)

Strategies and debates on Sustainable Development, Concept of sustainable agriculture, concept of sustainability science: different approach towards sustainable development and its different constituents; sustainability of society, resources and framework; sustainable energy strategy; principles of energy conservation; Indian renewable energy programme.

Module-2 (10hrs)

Introduction to Sustainable Development: Glimpse into History and Current practices - Broad introduction to SD - its importance, need, impact and implications; definition coined; evolution of SD perspectives (MDGs AND SDGs) over the years; recent debates; 1987 Brundtland Commission and outcome; later UN summits (Rio summit, etc.) and outcome.

Module-3 (10hrs)

Ecosystem & Sustainability: Fundamentals of ecology - types of ecosystems & interrelationships, factors influencing sustainability of ecosystems, ecosystem restoration - developmental needs. Introduction to sustainability & its factors, requirements for sustainability: food security and agriculture, renewable resources - water and energy, non-renewable resources, factors and trade-offs, sustainability conflicts, a conceptual framework for linking sustainability and sustainable development.

Module-4 (10hrs)

Dimensions to Sustainable Development - society, environment, culture and economy; current challenges - natural, political, socio-economic imbalance; sustainable development initiatives and policies of various countries: global, regional, national, local; needs of present and future generation - political, economic, environmental.

Module-5 (5hrs)

Critical Perspectives on Sustainable Development: Resource management and implications on sustainable development - implications for valuation, risk assessment; integrated decision-making processes: requirements of information, information flow, data analytics, learning from historical data, multicriteria decisions, multi-level decisions, participatory decisions ; translating impact chains to information flows - impact of governance and policies.

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Major Paper Code: BENVS-292

Credit: 2

1. Strategies of Agricultural Sustainability.

2. Sustainable energy strategy.

3. Renewable resources - water and energy, non-renewable resources, factors and trade-offs, sustainability conflicts.

4. Sustainable development initiatives and policies of various countries.

5. Resource management and implications on sustainable development - implications for valuation, risk assessment.

Suggested Books:

1. Franco, I.B. and Tracey, J. (2019), "Community capacity-building for sustainable development: Effectively striving towards achieving local community sustainability targets", International Journal of Sustainability in Higher Education, Vol. 20 No. 4, pp. 691-725

2. Our Common Journey: A Transition Toward Sustainability. National Academy Press, Washington D.C. Soubbotina, T. P. 2004.

3. Elliott, Jennifer. 2012. An Introduction to Sustainable Development. 4th Ed. Routledge, London.

4. Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. "An introduction to sustainable development." (2012).

5. Sachs, J. D. 2015. The Age of Sustainable Development. Columbia University Press, New York.

6. Soubbotina, Tatyana P. 2004. Beyond Economic Growth: An Introduction to Sustainable Development. WBI learning resources series. Washington DC ; World Bank. ○ Kerr, Julie. Introduction to energy and climate: Developing a sustainable environment. CRC Press, 2017.

7. Saito, Osamu. Sharing Ecosystem Services. Springer Singapore, 2020. ○ Nhamo, Godwell, and Vuyo Mjimba. Sustainable Development Goals and institutions of higher education. Springer, 2020.