

**Syllabus of
Integrated UG-PG in Environmental Sciences
from
(Semester I to VI)**



**Department of Environmental Sciences
Central University of Jharkhand
Cheri-Manatu, Ranchi-835222**

| Semester-I | | | | |
|----------------------|--------------------|---|--|---------------|
| Sl. No. | Course Code | Title of the Course | Course Type (MC/MNC/MDC/AEC/ SEC/VAC etc) | Credit |
| 1 | ENV011010 | Fundamentals of Environment | Major Course (MC) | 3 |
| 2 | ENV011030 | Working Principle of Laboratory Instruments- Lab | Major Course | 2 |
| 3 | ENV021010 | Introduction to Earth Processes (*To be offered for other departments as a minor) | Minor Course | 4 |
| 4 | DDD031010 | Offered by another/same department as per their respective group. | Multi-disciplinary course (MDC) | 3 |
| 5 | ENG011010 | English-1 | Ability Enhancement Course (AEC) | 2 |
| 6 | DDD051010 | Offered by another/same department | Skill Enhancement Course (SEC) | 3 |
| 7 | ENV061010 | Environmental Studies | Value added course (VAC) | 3 |
| Total Credits | | | | 20 |
| Semester-II | | | | |
| Sl. No. | Course Code | Title of the Course | Course Type (MC/MNC/MDC/AEC/ SEC/VAC etc) | Credit |
| 1. | ENV011020 | Environmental Pollution and Monitoring | Major Course | 3 |
| 2. | ENV011040 | Atmosphere and Air Pollution Monitoring- Lab | Major Course | 2 |
| 3. | ENV021020 | Introduction to Atmosphere and Climate Change | Minor | 4 |
| 4. | DDD031020 | Offered by another/same department as per their respective group. | Multi-disciplinary course (MDC) | 3 |
| 5. | HIN041020 | Hindi-1 | Ability Enhancement Course (AEC) | 2 |
| 6. | DDD051020 | Offered by another/same department | Skill Enhancement Course (SEC) | 3 |
| 7. | ANT061020 | Understanding India (UI) | Value added course (VAC) | 3 |

| Total Credits | | | | 20 |
|----------------------|--------------------|--|--|---------------|
| Semester-III | | | | |
| Sl. No. | Course Code | Title of the Course | Course Type (MC/MNC/MDC/AEC/ SEC/VAC etc) | Credit |
| 1 | ENV012010 | Environment and Ecology | Major Course | 3 |
| 2 | ENV011030 | Basics of Climatology and Meteorology | Major Course | 3 |
| 3 | ENV012050 | Ecology Lab | Major Course Practical | 2 |
| 4 | ENV022010 | Aerosols and Environment | Minor | 4 |
| 5 | DDD032010 | Offered by another/same department as per their respective group. | MDC | 3 |
| 6 | ENG042010 | English-2 | Ability Enhancement Course (AEC) | 2 |
| 7 | DDD052010 | Offered by another/same department | Skill Enhancement Course (SEC) | 3 |
| Total Credits | | | | 20 |
| Semester-IV | | | | |
| Sl. No. | Course Code | Title of the Course | Course Type (MC/MNC/MDC/AEC/ SEC/VAC etc) | Credit |
| 1 | ENV012020 | Environmental Microbiology and Biotechnology | Major Course | 3 |
| 2 | ENV012040 | Environmental Chemistry | Major Course | 3 |
| 3 | ENV012060 | Environmental Geology | Major Course | 3 |
| 4 | ENV012080 | Environmental Biotechnology-Lab | Major Course Practical | 2 |
| 5 | ENV012100 | Water Chemistry-Lab | Major Course Practical | 2 |
| 6 | ENV012120 | Seminar | Major Course | 1 |
| 7 | ENV022020 | Environmental Pollution and Management | Minor Course | 3 |
| 8 | ENV012040 | Environmental Pollution and Management-Lab | Minor Course Practical | 1 |
| 9 | HIN042020 | Hindi-2 | AEC | 2 |
| Total Credits | | | | 20 |
| Semester-V | | | | |
| Sl. No. | Course Code | Title of the Course | Course Type (MC/MNC/MDC/AEC/ SEC/VAC etc) | Credit |
| 1 | ENV013010 | Fundamentals of Remote Sensing and GIS | Major Course | 3 |
| 2 | ENV013030 | Water and Wastewater Treatment | Major Course | 3 |

| 3 | ENV013050 | Solid and Hazardous Waste Management | Major Course | 3 |
|----------------------|--------------------|--|--|---------------|
| 4 | ENV013070 | Biodiversity Conservation | Major Course | 2 |
| 5 | ENV013090 | Remote Sensing and GIS-Lab | Major Course Practical | 2 |
| 6 | ENV013110 | Industrial/ Field Visit | Major Course | 1 |
| 7 | ENV023010 | Environmental Physics and Chemistry | Minor Course | 3 |
| 8 | ENV013030 | Environmental Physics and Chemistry - Lab | Minor course-Practical | 1 |
| 9 | ENV053010 | Internship (of minimum six weeks) | SEC | 2 |
| Total Credits | | | | 20 |
| Semester-VI | | | | |
| Sl. No. | Course Code | Title of the Course | Course Type (MC/MNC/MDC/AEC/ SEC/VAC etc) | Credit |
| 1 | ENV013020 | Fundamentals of Soil Sciences | Major Course | 3 |
| 2 | ENV013040 | Fundamental of Environmental Statistics | Major Course | 3 |
| 3 | ENV013060 | Environmental Law and Legislation | Major Course | 3 |
| 4 | ENV013080 | Forestry and Wildlife Management | Major Course | 3 |
| 5 | ENV013100 | Soil Sciences Lab | Major Course Practical | 2 |
| 6 | ENV013120 | Mini Project (Theme-based Review and Review Paper Writing) | Major Course | 2 |
| 7 | ENV023020 | Global Environmental Issues | Major Course | 4 |
| Total Credits | | | | 20 |

FIRST SEMESTER

Fundamentals of Environment (ENV/011010)

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| 1) | Type of Course | Major Course (1 st sem) |
| 2) | Name of the Course | Fundamentals of Environment |
| 3) | Course Code: | ENV/011010 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | This course is designed to introduce the essential concepts of natural environment. It will help to understand the nature of environment, basics concept of earth's atmosphere, lithosphere, and hydrosphere and their function and importance. |
| 8) | Programme/course objective | <ul style="list-style-type: none">• To understand the basic concepts of environment and its components.• To know the different types of environment and their importance.• To develop an understanding of the environmental components (lithosphere, hydrosphere, atmosphere, biosphere) and their relationship with biosphere. |
| 9) | Course features and learning outcome | After completing this course successfully, students would acquire knowledge on the fundamental concepts of environment and its dynamic nature. Students would also have more familiar with structure and function of atmosphere, lithosphere and hydrosphere and their |

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| | | interaction with biosphere. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Introduction to Atmosphere |
| | | Concept and components of the environment, Concept of the atmosphere, Components of the atmosphere, Structure of the Atmosphere, Atmospheric stability, Atmospheric composition, Natural Greenhouse Effect, Temperature and Pressure Variation, Atmospheric Pressure and Density, Concept of Weather and Climate, Concept of Climate System, Natural Climate Variations, Natural Forcing of the Climate System, Natural Variability of Climate, Human-induced Climate Variations, Human Influence on the Climate System. |
| (ii) | Unit-II | Introduction to Lithosphere |
| | | Structure and composition, Layers of the lithosphere, Features of lithosphere: Plate Tectonics, Interaction with other spheres, Rock decomposition and rock weathering, Mineralisation and Humification, Soil Profile, Properties of Soil: Physical Properties, Chemical Properties, Soil Biota and Soil Fertility, Micro-organisms in Soil. |
| (iii) | Unit-III | Introduction to Hydrosphere |
| | | Concept of hydrosphere, Distribution and quantity of water across the globe, Lake water, groundwaters, ice, distribution and quantity of Earth's waters, Biogeochemical properties of the hydrosphere, Hydrological cycle, Importance of hydrosphere, Human impact on hydrosphere, Ocean acidification. |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • Santra, S.C. (2018) Environmental Science. New Central Book Agency (P) Ltd., Kolkata. • De, A. K. (2000) Environmental Chemistry, New Age International P. Ltd., New Delhi. • Rai, M. M. (2013) Principles of Soil Sciences; Mc. Millan Publishers India Ltd. • Sharma, P.D. (2018) Ecology and Environment. Rastogi Publications (13th Edition), Meerut. • Vogt, G. (2007) The Lithosphere Earth's Crust (Earth's Spheres). Twenty-First Century Books (CT). • Dynamics of the Atmosphere: A Course in Theoretical Meteorology, by Wilford Zdunkowski, Andreas Bott, Wilford Zdunkowski. 2003, Cambridge University Press | |

Working Principles of Laboratory Instruments (ENV/011030)

- Functioning of pH Meter
- Functioning of Conductivity Meter
- Functioning of TDS Meter
- Functioning of Sound Level Meter
- Functioning of Desiccator
- Functioning of Magnetic stirrer with hot plate
- Functioning of Electronic analytical weighing balance
- Functioning of Water bath
- Functioning of Air Quality Meter
- Functioning of Compound Light Microscope

Introduction to Earth Processes: (ENV021010)

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| 1) | Type of Course | Minor Course |
| 2) | Name of the Course | Introduction to Earth Processes |
| 3) | Course Code: | ENV/021010 |
| 4) | Total Credit: | 4 (Four) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | This is an undergraduate level course to introduce students to the basic concepts of Earth Science. The course gives an introduction to the dynamic planet Earth, explains the natural principles and processes that govern how its interior works and couples with the external system. In essence, this course provides a beginner's guide to planet Earth. Upon the completion of this course the student will have an understanding of the co-evolution of the Earth and life. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • To introduce the students to basics of the earth structure and its physical, chemical and biological characteristics. • To introduce the students to various earth processes those are operating inside the earth and their role in shaping and evolution of earth. • Introduction to different ocean movements and their importance |
| 9) | Course features and learning outcome | After completing this course successfully, students would acquire knowledge on origin of earth and how earth got evolved with time. Students will be able to differentiate different processes operating on earth surface. The course will polish the skill on different earth processes that can be further used for understanding and managing different environmental problems. |
| 10) | Who can attend the course | This course is suitable for students having a background of science at +2 level. |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Science |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | An introduction to Earth Sciences: |

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| | | Disciplines of Earth science; Earth system science and its role in global environmental management and sustainability. General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and Jovian planets. Meteorites and Asteroids. Origin of Atmosphere. |
| (ii) | Unit-II | Interior of the Earth |
| | | Primary differentiation and multilayer structure of Earth ,internal structure of the earth and discontinuities. Rocks and Minerals, Physical properties of minerals, Mohs Hardness Scale, Silicate Minerals. |
| (iii) | Unit-III | Plate tectonics |
| | | Concept and types of plate margins; Continental drift–evidences and causes; Sea floor spreading; Mid-oceanic ridge, trenches, transform faults; Island arc. |
| (iv) | Unit-IV | Ocean Movements |
| | | Wave, Tide and Currents, Ocean movements and Energy production alternate sources of energy. Physical and chemical properties of sea water and their spatial variations. Ocean currents, waves and tides, important current systems. |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • Press, F., and Siever, R., 2001, Understanding Earth (3rd Edition), Freeman and Co. Ltd. • Grotzinger, J., and Jordan, T., 2014, Understanding Earth (7th Edition), Freeman and Co. Ltd. • Tom Garrison 2009: Essentials of Oceanography, Fifth Edition ISBN-13: 978-0-495-55531-5,ISBN-10: 0-495-55531-2 • Mahapatra 2009: G.B 2011. Textbook Of Geology CBS publications, ISBN 8123900139; ISBN-13-9788123900131. • The Changing Earth: Exploring Geology and Evolution. 4th edition, Brooks/Cole Publishing Co; ISBN-10: 0495010200; ISBN-13: 978-0495010203 • Fluvial Processes in Geomorphology. Dover Publications, ISBN-10: 0486685888; ISBN-13: 978-0486685885 • Burbank D W and Anderson R S 2000. Tectonic Geomorphology. 1st edition Wiley-Blackwell, ISBN-10: 0632043865; ISBN-13: 978-0632043866 • Subramanian V. A Textbook in Environmental Science. Narosa Publishers, ISBN13:978-0849324086. • Valdiya K S. Environmental Geology, Indian Context. Tata McGraw-Hill Pub Co. ISBN 10: 0074519719 / 0-07-451971-9;ISBN 13: 9780074519714 | |

Environmental Studies (ENV/061010)

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| 1) | Type of Course | Value Added Course (VAC) |
| 2) | Name of the Course | Environmental Studies |
| 3) | Course Code: | ENV/061010 |
| 4) | Total Credit: | 3 (Three) |

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| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | This course is designed based on basic concepts of environment and related environmental issues. It will help to gather knowledge and achieve detailed understanding of environment, its components, and related environmental issues. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • To develop a scientific understanding of the Environment. • To develop an in-depth understanding of the biotic and abiotic components of the environment. • To develop an understanding of biodiversity, ecosystem, natural resources with their associated problems. • To develop an understanding of upto date knowledge of environmental issues, policies, and solutions. |
| 9) | Course features and learning outcome | After completing this course successfully, the students will develop a basic understanding of the environment. The students will be able to generate ideas related to biodiversity, ecosystem, natural resources with their associated problems. |
| 10) | Who can attend the course | This course is suitable for students of all science and social science background. |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated MA/M. Sc. in all science and social science subjects. |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Environment and Ecosystem |
| | | <ul style="list-style-type: none"> • Environment: concept and types; Environmental Studies: objectives, importance, multidisciplinary nature, and need for public awareness • Ecosystem: Concept, structure and function (Food chains and food webs, productivity, energy flow, and biogeochemical cycle) |
| (ii) | Unit-II | Natural Resources and Biodiversity |
| | | <ul style="list-style-type: none"> • Natural Resources: Concept, types (renewable and non-renewable resources); Details of forest, water, food, mineral, energy, and land resources and their associated problems. • Biodiversity: Concept, levels (genetic, species, ecosystem or community diversity), importance, threats, and conservation of |

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| | | biodiversity |
| (iii) | Unit-III | Environmental Pollution and Environmental Issues |
| | | <ul style="list-style-type: none"> • Environmental Pollution: concept, types (air, water, soil, and noise pollution), cause, effects and control measures. • Environmental and Social Issues: Climate change, global warming, acid rain, ozone layer depletion, population growth, environment and human health, child and women welfare, value education, sustainable development, rain-water harvesting, wasteland reclamation, environmental laws |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • Kaushik, A. & Kaushik, C. P., Perspectives in Environmental Studies, New Age International, New Delhi, 2006. • Bharucha, E., Textbook of Environmental Studies for undergraduate courses, Universities Press (India) Pvt. Ltd., 2019 • Sharma J. P., Comprehensive Environmental Studies (For Under Graduate Students) Laxmi Publication (P) Ltd. • Sharma P. D., Ecology and Environment, Rastogi Publication • Asthana D. K. & Asthana Meera, Environment: Problems and Solutions, S. Chand Publication • Dave D. & Katewa S. S., Textbook of Environmental Studies, Cengage Learning India Pvt. Ltd. | |

SECOND SEMESTER

Environmental Pollution and Monitoring (ENV011020)

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| 1) | Type of Course | Major Course |
| 2) | Name of the Course | Environmental Pollution and Monitoring |
| 3) | Course Code: | ENV011020 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | The course is designed to understand different pollutions and their impact on different spheres of earth like lithosphere, atmosphere, hydrosphere and biosphere. The course will also introduce different methods that are used for monitoring different types of pollutants. |

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| 8) | Programme/course objective | <ul style="list-style-type: none"> To introduce the students to different types of pollutants both natural and anthropogenic. To introduce the students to different standards those are used for monitoring different levels of pollution. Introduction to different methods that are used to control different types of pollution. Students will be introduced to different primary and secondary pollutants and their sources, point and dispersed. |
| 9) | Course features and learning outcome | After completing this course successfully, students would acquire knowledge on origin of different types of pollution and their impacts on different types of natural resources. They will be able to mitigate the problem of pollution at differ levels. They will get basic knowledge and a whole idea of environmental monitoring and its objectives. |
| 10) | Who can attend the course | This course is suitable for all the students of science background. |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Science |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Air Pollution |
| | | Introduction, Composition of air, Sources of air pollution, Classification and effect of air pollutants, Point source and non point source Meteorological factors and air pollution, Vehicular Pollution, Smog formation and effects, Monitoring and control of air pollution, Air quality standards; Acid Rain, Ozone layer depletion, Global warming. |
| (ii) | Unit-II | Water Pollution |
| | | Introduction, Types, Sources of Water Pollution; Classification and effect of Water Pollutants, Eutrophication, Biological Magnification, Industrial wastes and treatment processes, Water Purification, Water quality standard, Water quality monitoring, Prevention and control of water pollution, Thermal Pollution; Marine Pollution. |
| (iii) | Unit-III | Soil Pollution |
| | | Introduction, sources, effect and control of soil pollution, Soil quality monitoring, Industrial waste effluents and heavy metals, their interactions with soil components; Soil microorganisms and their functions, Different kinds of synthetic fertilizers (N, P & K) and their interactions with different components of soil. |

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| (iv) | Unit-IV | Noise Pollution |
| | | Sources of noise pollution, measurement of noise and indices, effect of meteorological parameters on noise propagation; Noise exposure levels and standards; Noise control and abatement measures, Impact of noise on human health. |
| (v) | Unit-V | Environmental Monitoring |
| | | Basic knowledge and a whole idea of environmental monitoring and its objectives, characteristics and techniques; main environmental standards, importance of quality assurance and quality control system. |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • Cunningham, W.P. and W.B. Saigo (2005) Environmental Science, McGraw Hill, New York. • Bell, J.N.B. (2002) Air Pollution and Plant Life, (II ed.), John Wiley and Sons, New Delhi. • Fellenberg, G. (1999) Chemistry of Pollution, John Wiley and Sons, New Delhi. • Tirvedi, R. K. and Geol, P. K. (2010) An Introduction to Air Pollution, (II Ed),DVS Publication, New Delhi. • De, A. K. (2000) Environmental Chemistry, New Age International P. Ltd., New Delhi. • Santra, S. C. (2001) Environmental Science, New Central Book Agencies, Pvt., Ltd. Kolkata | |

Atmosphere and Air Pollution Monitoring Lab (ENV/011040)

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| <ul style="list-style-type: none"> • Time Series Analysis of Air temperature • Monitoring wind speed and direction • Wind rose analysis • Real time wind dynamics • Determination of CO₂ concentration in air • Determination of O₂ concentration in air • Long range transport HYSPLIT model • Determination of CO concentration in air • Determination of temperature and humidity in air • Measurement of noise level in different environment • Measurement of PM_{2.5} and PM₁₀ in different environment • Monitoring of ambient SO_x and NO_x |
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Introduction to Atmosphere and Climate Change (ENV021020)

THIRD SEMESTER

Environment and Ecology (ENV/012010)

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| 1) | Type of Course | Major Course (3 rd sem) |
| 2) | Name of the Course | Environment and Ecology |
| 3) | Course Code: | ENV/012010 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | This course is designed based on basic concepts of environment and ecology. It will help to gather knowledge and achieve detailed understanding of environment, its components, and the interactions between the biotic and abiotic components of the environment. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • To develop a scientific understanding of the Environment and ecosystems. • To develop an understanding of the interactions between biotic and abiotic components. • To develop an understanding of various population interactions, population characteristics and ecosystem dynamics. • To develop an understanding of current knowledge of ecological footprints. |
| 9) | Course features and learning outcome | After completing this course successfully, the students will develop a basic understanding related to the environment and ecosystem. The students will be able to generate ideas related to population interaction, community characteristics and ecosystem dynamics. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Concepts of Environment and Ecology |

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| | | <ul style="list-style-type: none"> • Environment: concept and types; Environmental Sciences: Definition, objectives, importance, multidisciplinary nature, and need for public awareness • Ecology: concept and classification; Ecological factors: climatic, topographic, edaphic and biotic (population interactions); Ecological groups of plants and Ecological adaptations |
| (ii) | Unit-II | Population and Community Characteristics |
| | | <ul style="list-style-type: none"> • Population characteristics: Population size and density, dispersion, age structure, natality, mortality, life tables; population regulation • Methods of community study, Community characteristics: Analytical and synthetic characters |
| (iii) | Unit-III | Ecosystem Ecology |
| | | <ul style="list-style-type: none"> • Ecosystem: concept, structure, types, and function (Food chain and Food web, Productivity, Energy flow, Biogeochemical cycles, Homeostasis) • Ecological succession: types and general process |
| 14) | Text Book and References: | |
| <ul style="list-style-type: none"> • Odum E. P., Fundamentals of Ecology, Nataraj Publisher, Dehradun 1996 • Dash M. C., Fundamentals of Ecology, Tata McGraw Hill, 1994 • Shukla R. S. & Chandel P. S., A Text Book of Plant Ecology including Ethnobotany and Soil Science • Sharma J. P., Comprehensive Environmental Studies (For Under Graduate Students) Laxmi Publication (P) Ltd. • Sharma P. D., Ecology and Environment, Rastogi Publication • Asthana D. K. & Asthana Meera, Environment: Problems and Solutions, S. Chand Publication • Dave D. & Katewa S. S., Textbook of Environmental Studies, Cengage Learning India Pvt. Ltd. | | |

Ecology Lab (ENV/012050)

1. Field Ecology: Identification of Terrestrial Flora (Herbs, Shrubs, Trees)
2. Determine the minimum size of the quadrat by the Species Area Curve Method
3. Determine the minimum number of quadrats to be laid down in the field
4. Study of the community by quadrat method for determining frequency, density, abundance, dominance, and species dispersion pattern by A/F ratio
5. Study of the community by quadrats method for determining IVI, diversity index, the concentration of dominance, evenness index, species richness indices (Dmg & Dmn), and effective number of species
6. Study of different communities by quadrat method for determining the similarity indices

(Jaccard and Sorenson)

7. Study of the life-form and biological spectrum of the nearby vegetation of DEVS, CUJ
8. Phenological study of nearby vegetation of DEVS, CUJ campus
9. Study of grassland vegetation by line transect method
10. Study of forest vegetation by belt transect method
11. Determination of allelopathic effects of *Parthenium hysterophorus* on germination of Mung seeds
12. Determination of leaf area index of selected plant species
13. Determination of carbon content of leaf litter of selected plant species
14. Determination of primary productivity of herbaceous community by harvest method
15. Determination of moisture content and biomass of leaf litter of selected plant species

Basics of Climatology and Meteorology (ENV011030)

Aerosols and Environment (ENV022010)

FORTH SEMESTER

Environmental Microbiology and Biotechnology (ENV/ 012020)

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| 1) | Type of Course | Major Course (4 th sem) |
| 2) | Name of the Course | Environmental Microbiology and Biotechnology |
| 3) | Course Code: | ENV/ 012020 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview | This paper presents an objective view of the application of microbiological understanding and know-hows its application in the form of biotechnological instruments to tackling environmental problems. It starts with basic knowledge about microbes, molecular biology and later links to application-based processes and techniques. It aims to provide an idea of effective biotechnical management strategies of environmental problem. |
| 8) | Programme/course objective | <ul style="list-style-type: none">• To describe the types of microbes and their technological application for betterment of nature |

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| | | <p>and human beings</p> <ul style="list-style-type: none"> • To study and analyze the basics about microbiology, sterilization techniques and application of microbes in industry, medical sciences and environment. • To develop scientific views for application of recombinant technology in modern sciences. • To develop understanding about kinetics of microbes in fermentation technology. • To develop understanding on current application of bioremediation strategy and its limitation to tackle environmental Problems. |
| 9) | Course features and learning outcome | After completion of this course successfully, the students will develop critical thinking skills and will be able to explain the interrelationships between human development and role of microbiology and biotechnology to tackle current environmental and natural problems in Ecofriendly manner. The students will be able to generate new ideas for sustainable utilization of microbes to develop effective technology for environmental problems by reducing impacts of chemical substances. Different units will provide to students an understanding for types of Microbes kinetics of microbes, application of microbes in fermentation technology along with cleaner technology for environmental problems. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences. |
| 11) | Course Eligibility/Pre-requisite | 10+2 or equivalent |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Basics of Microbiology |
| | | Prokaryotic and eukaryotic microorganisms: Characteristics; Classification, Nutrition and Growth, Structures; Microbial Culture: pure culture techniques, Methods of sterilization, Culture Media: Bioreactor and its Types: Microbial kinetics; growth curve, growth pattern of microbes in bioreactors: Batch, fed-batch, and synchronous growth; Specific growth rate and doubling time; Monod's model, Enzymes and Enzyme kinetics. |
| (ii) | Unit-II | Basics of Biotechnology |
| | | Basic structure of DNA and RNA, concept of genetic materials, gene functions, concept of Replication, Transcription and Translation in |

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| | | prokaryotes. Protein: hierarchical structure, types of amino acids; Coding and non-coding sequences in genomes: Basic techniques in genetic engineering, Recombinant DNA Technology: origin and current status; steps of preparation; toolkit of enzymes for manipulation of DNA: restriction enzymes, other DNA modifying enzymes, cloning and expression vectors (plasmids, bacteriophage, phasmids, Cosmides etc.) Synthetic DNA, PCR Techniques, GEL electrophoresis, Blotting Techniques, DNA Fingerprinting, |
| (iii) | Unit-III | Cleaner Bioprocess |
| | | Role of microbiology and biotechnology in environmental Protection: Xenobiotics, biosurfactants, bio scrubbers, biobeds, and biofuel; Role of microorganisms in wastewater treatment and metal removal from soil and water: bioremediation; Bioindicator microorganism, biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, remediation of degraded ecosystems. |
| 14) | Text Book and References: | |
| (i) | Pelczar, Chan & Krieg, Microbiology by McGraw-Hill education, New Delhi. | |
| (ii) | Prescott, Harley & Klein, Microbiology, by McGraw-Hill education, New Delhi | |
| (iii) | Mahapatra P. K , A textbook of Microbiology, I.K. International Publishing House Pvt. Limited, 2013 | |
| (iv) | Agarwal S. K., Environmental Biotechnology, APH Publishing Corp., New Delhi. | |
| (v) | Dubey R.C., A Text Book of Biotechnology, S. Chand & Company Ltd., New Delhi. | |
| (vi) | R.P. Singh, Microbiology, Kalyani Publishers, Noida U.P | |
| (vii) | Singh B. D., Biotechnology, Kalyani Publishers, New Delhi. | |
| (viii) | P. D. Sharma- Environmental Microbiology. | |
| (ix) | Principles of Biochemistry, Lehninger, by Nelson and Cox. | |
| (x) | Rao A. S., Introduction to Microbiology. | |
| (xi) | Practical Book: Experiment in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja | |

Environmental Biotechnology-Lab (ENV/012080)

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| <ul style="list-style-type: none"> • Preparation of Agar Agar media for microbial culture from soil, water and air and their identification • Preparation of bacterial media: Nutrient agar and nutrient broth • Sub-culturing of bacterial culture. • Sterilization technique by autoclaving. • Preparation of fungal media (PDA) • Preparation of slants and pouring of Petri plates • Isolation of microorganisms by streak plate method. |
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- Isolation of microorganisms by pour plate method
- Bacteria staining (Gram Staining) by simple staining method (methylene blue/crystal violet) from curd
- Kinetic study of bacterial growth
- Kinetic study of Fungal growth.
- Glucose estimation by DNS methods

Environmental Chemistry (ENV/012040)

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| 1) | Type of Course | Major Course (4 th sem) |
| 2) | Name of the Course | Environmental Chemistry |
| 3) | Course Code: | ENV/012040 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | This course is basically design to understand the different chemical processes that happen in air, water and soil and their consequences on environment and human health. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • To understand the structure and composition of the atmosphere and emission of pollutants to the atmosphere. • To learn the physical and chemical properties of water and soil. • To acquire knowledge about the chemistry of toxic chemicals in environment and biochemical aspects of heavy metals. • To expertise practical knowledge in relation to quality parameters of water and soil. |
| 9) | Course features and learning outcome | After completion of the course, the students will be able to understand the details of chemistry related to air, water and soil, create awareness and responsibilities towards environment and apply their knowledge to solve the issues related to environmental pollution. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences |

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| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Fundamental of Environmental Chemistry |
| | | Acid base reactions and titration, Stoichiometry, Gibbs energy, Chemical potential, Chemical equilibrium, Solubility product, Solubility of gases in water, Thermodynamics, unsaturated and saturated hydrocarbon, radionuclide, Toxic chemicals in environment and their effect. |
| (ii) | Unit-II | Air Chemistry |
| | | Atmospheric structure, Chemical composition of air, Chemical processes for formation of inorganic and organic particulate matters, Chemical and photochemical reactions in atmosphere, Oxygen and ozone chemistry, Chemistry of air pollutants, Formation and effect of photochemical smog. |
| (iii) | Unit-III | Water and Soil Chemistry |
| | | Chemistry of water, Inorganic and organic compounds: Carbonates, Sulphates, Nitrates, Phosphates; Eutrophication, Concept of DO, BOD, COD, Water purification, Redox potential, Buffer in water system. Formation of soil, Inorganic and organic components of soil, Nutrient cycling in soil (nitrogen, phosphorus and potassium), Acid-base and ion exchange reactions in soil, Micronutrients and macronutrients in soil, soil pollution by addition of pesticides and fertilizers. |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • A. K. De, Environmental Chemistry, New Age International Limited Publishers • S. S. Dara and D.D. Mishra, A Text Book of Environmental Chemistry and Pollution Control, S Chand & Company Publishers • V. Subramanian, A Textbook of Environmental Chemistry, Dreamtech Press Publisher • P. D. Sharma, Ecology and Environment, Rastogi Publication • D. K. Asthana & M. Asthana, Environment: Problems and Solutions, S. Chand Publication • E. D. Enger & B. E. Smith, Environmental Science – A study of Inter relationships, 5th edition, W C B publication. • B. K. Sharma, Environmental Chemistry, Geol. Publ. House, Meerut • S. E. Manahan, Environmental Chemistry, Lewis Publishers, Florida, USA | |

Water Chemistry-Lab (ENV/012100)

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| <ul style="list-style-type: none"> • pH of water samples • Electrical Conductivity of water samples • Redox Potential of water samples • Estimation of Total Solid (TS) of water samples • Estimation of Total Dissolved Solid (TDS) of water samples • Estimation of Total Suspended Solid (TSS) of water samples • Estimation of Turbidity of water samples |
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- Estimation of Alkalinity/Acidity of water samples
- Estimation of Chloride of water samples
- Estimation of Hardness of water samples
- Estimation of Free CO₂ of water samples
- Estimation of Dissolved Oxygen (DO) of water samples
- Estimation of BOD of water samples
- Estimation of COD of water samples

Environmental Geology (ENV/012060)

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| 1) | Type of Course | Major Course (4 th sem) |
| 2) | Name of the Course | Environmental Geology |
| 3) | Course Code: | ENV/012060 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach course | Teachers from Dept. of Environmental Sciences |
| 7) | Overview | This course explores the complex interactions between the Earth's geologic processes and human activities. The course offers an understanding of geological principles and its influence on environmental issues, including natural hazards, resource management, mitigating the hazards, and land use planning. The contents of the paper will make the undergraduate students examine and analyze the role of geology in addressing contemporary environmental issues and to develop critical thinking to evaluate and mitigate environmental risks. |
| 8) | Programme/ course objective | <ul style="list-style-type: none"> • To understand the fundamentals of geology and its relation with environmental science. • To explore the relationships between human activities and geological hazards such as earthquakes, volcanoes, landslides, floods and drought. • To evaluate strategies for mitigating environmental risks and promoting environmental sustainability through geological approaches. • To develop scientific aptitude and environmental concerns effectively through lectures, presentations, and discussions. |

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| 9) | Course features | After completion of this course successfully, the students will develop an understanding of geological processes and their relevance to environmental issues, including natural hazards and resource management. Students will develop an appreciation for the interconnections between human activities and Earth's geological systems, fostering a sense of environmental stewardship and responsibility. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences |
| 11) | Course Eligibility/ Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Environmental Geosciences |
| | | Origin of earth. Primary geochemical differentiation and formation of core. Mantle, crust, atmosphere and hydrosphere. Concept of minerals and rocks. Major endogenic and exogenic processes, geological agents of changing environment viz. tectonics, magnetism, weathering, erosion, and deposition; common geological structure- bedding, fold, faults, cleavages, fractures, deposits and erodibility of rocks Coriolis force, pressure gradient force, frictional Force, geostrophic wind field, gradient wind. |
| (ii) | Unit-II | Natural Hazards and Disasters |
| | | Concepts of hazard, risk, vulnerability, & disaster Natural disasters- types, causes, impacts, forecasting and management (viz. earthquake, flood, drought, cyclone, tsunami, El Nino and La Nino, volcano, landslide), Man-made industrial accident like Bhopal gas tragedy |
| (iii) | Unit-III | Hydrogeology |
| | | Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water, Distribution of water in earth, major basins and groundwater provinces of India, Hydraulic conductivity, groundwater tracers, land subsidence, Effects of excessive use of groundwater, Rainwater harvesting and artificial recharge of groundwater |
| 12) | Text Book and References: | |

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| (i) | Hudson Travis. Living with Earth: An Introduction to Environmental Geology. PHI Learning |
| (ii) | Stephen Marshak. Essentials of Geology. WW Norton and Company |
| (iii) | K.S. Valdiya Environmental Geology: Ecology, Resource and Hazard Management. Mc Graw Hill Publisher |
| (iv) | Carla W. Montgomery. Mc Graw Hill Publisher |

Seminar (ENV/012120)

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| 1) | Type of Course | Major Course (4 th sem) |
| 2) | Name of the Course | Seminar |
| 3) | Course Code: | ENV012120 |
| 4) | Total Credit: | 1 (One) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | This course is designed based on the review based presentation related to the basic concepts of environment and Environmental Sciences. It will help to improve the presentation skills of students. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> To develop an in-depth understanding of the seminar presentation and acquire presentation skill. |
| 9) | Course features and learning outcome | After completing this course successfully, the students will develop skill to prepare and present good seminar presentation. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Seminar Presentation |
| | | <ul style="list-style-type: none"> Presentation skills, Types of presentation, Seminar presentation: Importance, how to make Effective Presentation, Important features of good seminar presentation Individual review-based scientific presentation |

Environmental Pollution and Management (ENV022020)

Environmental Pollution and Management Lab (ENV12040)

FIFTH SEMESTER

Fundamentals of Remote Sensing and GIS (ENV013010)

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| 1) | Type of Course | Major Course |
| 2) | Name of the Course | Fundamentals of Remote Sensing and GIS |
| 3) | Course Code: | ENV013010 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | To provide the basic knowledge of Remote Sensing and its application to address various environmental issues and management of natural resources |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • Basic understanding of Remote Sensing and its uses in environmental monitoring • It will make the student to understand the different processes and platforms of remote sensing and different elements of remote sensing • Microwave remote sensing and its different uses in environmental science • A basic understanding of different types of resolutions of satellite sensors • Application of remote sensing to address various environmental issues and management of natural resources |
| 9) | Course features and learning outcome | After completing this course successfully, students will gain knowledge on different methods that can be used for acquiring data remotely. The remotely sensed data can be further used in different fields of environmental science for environmental management and sustainability. |
| 10) | Who can attend the course | This course is suitable for the students of environmental sciences |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Science |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Introduction to Remote Sensing and GIS |
| | | The concept of remote sensing and GIS, Historical developments in the field of remote sensing, benefits of remote sensing over physical survey, |

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| | | Electromagnetic Radiation, Electromagnetic Spectrum, Interactions with the Atmosphere, different elements of remote sensing, , Use of remote sensing in environmental monitoring, Passive vs. Active Sensing. |
| (ii) | Unit-II | Sensors and Platforms |
| | | Different platforms used in remote sensing: Ground, air and space, different types of instruments used in remote sensing, Satellite Characteristics, Pixel Size and Scale, Different Resolutions , Cameras and Aerial Photography, Different Satellites, Other Sensors, Characteristics of Images |
| (iii) | Unit-III | Microwave Remote Sensing |
| | | Introduction to microwave remote sensing, its benefits in environmental monitoring, Radar Basic, Viewing Geometry & Spatial Resolution, Airborne vs Spaceborne Radars. |
| (iv) | Unit-IV | GIS and Image Analysis |
| | | Different components of GIS, Image Analysis: Visual interpretation of images, Elements of visual interpretation, Digital analysis of images. |
| (v) | Unit-V | Applications of Remote Sensing |
| | | Applications: Environmental Management, Agriculture, Glaciology, Forestry, Geology, Hydrology, Sea Ice, Land Cover, Oceans & Coastal |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • Lillesand & Keifer, (2011): Remote Sensing & Image Interpretation, John Wiley & Sons, ISBN: 9788126532230. • James B.Campbell,(2007): Introduction to Remote Sensing, Taylor & Francis, ISBN: 9780415416887. • J.R.Jensen, (2009): Remote Sensing of the Environment, Pearsons education Pub. ISBN: 9788131716809. • George Joseph, (2005): Fundamental of Remote Sensing, University Press, India, ISBN: 9788173715358. • Bruce Grubbs, (2005): Basic Essentials Using GPS, Falcon Press Publishing, ISBN: 9780762734214. | |

Remote Sensing and GIS-Lab (ENV013090)

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| <ul style="list-style-type: none"> • Basic Introduction of Toposheets • Delineating different features from Toposheets • Cross sectional profile of different types of contours • Different uses of GPS, Point line and Area Mapping • Change detection analysis using visual interpretation of images (Google Earth Images) • Acquisition of different types of images from different open sources • Acquisition of digital toposheets. |
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- Image digitization
- Georeferencing of Toposheets and Images
- Classification of images
- Change detection analysis
- Mass balance of glacier using remote sensing

Water and Waste Water Treatment (ENV/013030)

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| 1) | Type of Course | Major Course (5 th sem) |
| 2) | Name of the Course | Water and waste water treatment |
| 3) | Course Code: | ENV013030 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview | This paper presents an objective view of the role water quality and quantity in survival of human life. It starts with characteristics of water quality, water resources, standards of water quality and treatment methods of waste water. It aims to provide basic understanding about water quality, application of different treatment methods on the basis of typical characteristics of industrial and municipal waste water. |
| 8) | Programme/course objective | <p>To Gain the Knowledge on Water and its significance, importance of its quality and Standards for usage as per WHO/IS-10500 guidelines</p> <p>To understand about objectives of water treatment.</p> <p>To development understanding of cost effective and ecofriendly treatment techniques with respect to typical characteristics of waste water.</p> <p>To Understand the design and working principle of various treatment methods.</p> <p>Understand about the Purification process like, Sedimentation, Coagulation, Filtration, Disinfection, Fluoridation & De-fluoridation and softening</p> |

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| | | methodologies involved before supplying to Public. |
| 9) | Course features and learning outcome | After completion of this course successfully, the students will develop basic understanding of water sampling methods, its quality on the basis of standards, design and working principle of various treatment methods. The students will be able to treat municipal and industrial waste water and utilize treated waste water as Zero discharge policy of water. + |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences. |
| 11) | Course Eligibility/Pre-requisite | 10+2 or equivalent |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Water Quality and its standards |
| | | Water resources and its Importance, Necessity for conservation and development of water resources, water sampling methods, Water Quality: Definitions & Characteristics; Physical Water Quality parameters, Chemical Water Quality parameters, Biological Water Quality parameters, Comparison of various criteria: WHO, Bureau of Indian Standards, IS-10500. Effects of Industrial wastes on sewerage system and receiving water bodies; effects on soil. Objectives of wastewater treatment system, classification of sewerage systems. |
| (ii) | Unit-II | Waste water treatment and its effective utilization |
| | | Engineered systems for wastewater treatment and disposal, Unit processes in wastewater treatment, Characteristics of Municipal wastewater –Types and flows; Primary treatment: Screening, grit chambers, primary sedimentation; coagulation and flocculation, Secondary treatment: Trickling filters, Activated Sludge process, Ponds & Lagoons, Rotating Biological Contractor (RBCs); Disinfection of wastewater, Sludge disposal, Anaerobic digesters, Wastewater reclamation and reuse in industry; Effluent standards and receiving water quality standards; Different aspects and choices of various |

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| | | disposal alternatives. |
| (iii) | Unit-III | Industrial and rural waste water treatment Waste water treatment in major industries: Textile, Paper and Pulp, Steel, Sugar, Cement, coal mining sump water, Dairy, Fertilizer, Distillery, Petroleum Refinery, Designing of Effluent treatment plant, Rural wastewater systems – Septic tanks, two-pit latrines, Eco-toilet, soak pits. |
| 14) | Text Book and References: | |
| (i) | Mahajan S. P., “Pollution control in industries”, McGraw Hill Co. | |
| (ii) | Rao & Dutta, “Wastewater Treatment”, Oxford & IBH Publishers | |
| (iii) | Wark& Warner, “Air Pollution- origin and control” Harper and Collins | |
| (iv) | Peavy & Rowe “Environmental Engineering” McGraw Hill Co. | |
| (v) | Masters G.M. and Ela W.P. (2016), Introduction to Environmental Engineering and Science, Pearson Education, Inc. | |
| (vi) | Inc. Metcalf & Eddy (2002),Wastewater Engineering ,esueRdnatnemtaerT : noitacudElliHwarGcM | |
| (viii) | Wastewater Treatment Concepts and Design Approach, Karia G.L., and Christian R.A., (2001), Prentice Hall of India Pvt. Ltd., New Delhi. | |
| (ix) | Wastewater Treatment Concepts and Design Approach, Karia G.L., and Christian R.A., (2001), Prentice Hall of India Pvt. Ltd., New Delhi. | |

Solid and Hazardous Waste Management (ENV/013050)

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| 1) | Type of Course | Major Course (5 th sem) |
| 2) | Name of the Course | Solid and Hazardous Waste Management |
| 3) | Course Code: | ENV013050 |
| 4) | Total Credit: | 3(Three) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | TeachersfromDept.ofEnvironmentalSciences |
| 7) | Overview/ Course Description | Thiscourseprovidesacomprehensiveviewoftheunderstanding of solid and hazardous waste originating in the environment and tohandle and to utilize it as a resource. The contents of the paper will provides a structured framework to undergraduate students on theme of solid and hazardous waste management, covering fundamental principles of solid and hazardous waste |

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| | | and its management, regulatory aspects, sustainable practices, real-world applications, and future perspectives related to waste handling and management. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • To understand the nature and characteristics of solid and hazardous waste, including their sources, characteristics, and composition. • To explore the methods and technologies for the collection, transportation, treatment, and disposal of solid and hazardous wastes. • To examine the regulatory requirements and compliance mechanisms relevant to solid and hazardous waste management, including waste classification, labeling, and documentation. • To understand the benefits of implementing sustainable waste management strategies. • To learn the emerging trends, challenges, and opportunities in the field of solid and hazardous waste management, including advancements in technology, policy developments, and community engagement. • To develop a critical thinking skills through interactive discussions, group activities, and assignments focused on waste management scenarios and case studies. |
| 9) | Course features and learning outcome | After completion of this course successfully, the students will develop the concepts and principles of solid and hazardous waste management. The students will be able to present fundamental concepts, case studies, and regulatory aspects of solid and hazardous waste management. Students aided with hands-on activities will be able to reinforce theoretical knowledge and demonstrate waste management practices. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |

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| (i) | Unit I | Solid waste and management |
| | | <p>Solid Waste – types and sources. Solid waste: characteristics, generation rates, components, proximate and ultimate analyses of solid Wastes</p> <p>Solid waste collection and transportation; Concepts of waste reduction, recycling and reuse; Collection & Disposal method</p> <p>Solid waste processing and recovery; Composting, vermicomposting, and biomethanation of solid waste. Disposal of solid Wastes – sanitary land filling and its management, incineration of solid Waste</p> |
| (ii) | Unit-II | Hazardous waste and other solid waste management |
| | | <p>Hazardous waste – Types, characteristics and health impacts</p> <p>Hazardous Waste management: Treatment Methods – neutralization, oxidation Reduction, precipitation, solidification, stabilization, incineration and final Disposal, Fly ash: sources, composition and utilization; Plastic waste: sources, consequences and management; e-waste: classification, methods of handling and disposal</p> |
| (iii) | Unit-III | Regulatory aspects, emerging trends & practical training in solid waste management |
| | | <p>Solid Waste Management Rules, 2016; Hazardous and other Wastes (Management & Transboundary Movement) Rules, 2016</p> <p>Emerging trends in solid and hazardous waste management</p> <p>Practical training of solid waste management</p> |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • Bhatia SC. Solid and Hazardous Waste Management. Atlantic Publishers • Peavy HS, Rowe DR, Tchobanoglous G. Environmental Engineering. McGraw Hill Education (India) Private Limited • Rao MN and Sultana R. Solid and Hazardous Waste Management. BS Publications • Blackman Jr. WC. Basic Hazardous Waste Management. Lewis Publishers • Goel S. Advances in Solid and Hazardous Waste Management. Springer Publishers | |

Biodiversity Conservation (ENV/013070)

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| 1) | Type of Course | Major Course (5 th sem) |
| 2) | Name of the Course | Biodiversity Conservation |
| 3) | Course Code: | ENV/013070 |
| 4) | Total Credit: | 2 (Two) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |

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| 7) | Overview/ Course Description | This course is designed based on basic concepts of biodiversity with its importance. It will help to gather knowledge and achieve detailed understanding of biodiversity, its threats, and conservation. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • To get an overview of the biodiversity and its importance. • To develop an in-depth understanding of the conservation of biodiversity including protected area networks. • To develop an understanding of biodiversity at local and national level. • To develop an understanding of biodiversity-related issues. |
| 9) | Course features and learning outcome | After completing this course successfully, the students will develop a in-depth understanding of the biodiversity. The students will be able to generate ideas related to biodiversity-related issues, importance and their conservation. |
| 10) | Who can attend the course | This course is suitable for the students Environmental Sciences. |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences. |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Biodiversity and its Importance |
| | | <ul style="list-style-type: none"> • Biodiversity: concept, levels (genetic, species, community or Ecosystem diversity), values, and threats. Importance of local and national level biodiversity, India as a megabiodiversity nation, biodiversity hotspots |
| (ii) | Unit-II | Biodiversity Conservation |
| | | <ul style="list-style-type: none"> • In-situ and ex-situ conservation strategies: Protected Area Network, UNESCO-MAB Program, Cryopreservation, National & International efforts for the conservation of Biodiversity: Bonn Challenge, CBD, CITES, IUCN, Ramsar Convention. |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • Kaushik, A. & Kaushik, C. P., Perspectives in Environmental Studies, New Age International, New Delhi, 2006. • Bharucha, E., Textbook of Environmental Studies for undergraduate courses, Universities Press (India) Pvt. Ltd., 2019 • Sharma J. P., Comprehensive Environmental Studies (For Under Graduate Students) Laxmi | |

Publication (P) Ltd.

- Sharma P. D., Ecology and Environment, Rastogi Publication
- Singh, J. S., Singh, S. P. & Gupta, S. R., Ecology, Environmental Science & Conservation, S. Chand Publishing, 2019

Environmental Physics and Chemistry (ENV023010)

Environmental Physics and Chemistry Lab (ENV013030)

SIXTH SEMESTER

Fundamentals of Soil Sciences (ENV/013020)

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| 1) | Type of Course | Major Course (6 th Sem) |
| 2) | Name of the Course | Fundamentals of Soil Sciences |
| 3) | Course Code: | ENV/013020 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | This course is designed to gain the understanding of the theories and principles of soil science and conservation of soils as natural bodies, as media for plant growth, and as components of the larger ecosystem. It will provide a basic concept of all the aspects of soil science including; genesis and composition, physical, chemical, and biological properties; soil conservation, soil fertility and productivity and management practices. |
| 8) | Programme/course objective | <ul style="list-style-type: none">• To impart knowledge to the students on basic concepts of origin, classification, and distribution of soils.• To develop an understanding and knowledge of the basic and applied physical, chemical, and biological properties of soil.• To understand the relationship between soil and crops growth.• To develop an understanding of the management and conservation of soils. |

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| 9) | Course features and learning outcome | At the end of this course, students will be enriched with the knowledge of soil physical, chemical and biological properties and their important to plant growth and environmental quality. The knowledge gained from the course will work as building block to pursue many research in future. Furthermore, lab based hands-on training will be provided for analysis of soil quality parameters to strength the knowledge. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Soil Genesis and Morphology |
| | | Origin, Nature and Classification of Parent Materials: Rocks And Minerals; Processes of Soil Formation: Physical, Chemical and Biological Weathering, Pedogenesis: Humification, Mineralization, Eluviation And Illuviation, Factors Affecting Soil Formation, Soil Profile: Concept And Different Horizons, Morphological Characteristics of Soil Profile, Profile Development Processes, Soil components (air, water, organic and inorganic), Soil Physical Properties (texture, soil aggregates, structure, density, soil water relations), Soil Chemical Properties (soil colloids, ion exchange), Soil Classification and Major Soil Types of India with Special Reference To Jharkhand. |
| (ii) | Unit-II | Soil Nutrients and Fertility |
| | | Major, Minor and Trace Elements Essential for Plant Growth; Essential Plant Nutrients: Sources, Functions and Nutrient Deficiency Symptoms in Plants, Soil Microbes and its Role in Soil Fertility, Soil Organic Matter Decomposition, Nutrient Cycling in Soil, Immobilization and Mineralization, Forms and Availability of Soil Nutrients, Integrated Plant Nutrients Management, Fertilizer, Biofertilizer, Compost, Vermicompost, Soil Conditioners. |
| (iii) | Unit-III | Soil Erosion and Conservation |
| | | Soil Erosion: Types and Mechanism of Erosion, Factors Affecting Soil Erosions, Effects of Soil Erosion; Methods of Soil Conservation: Biological and Mechanical Soil Conservation. |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • Rai, M. M. (2013) Principles of Soil Sciences; Mc. Millan Publishers India Ltd. • Das, D. K. (2015) Introductory Soil Science; 4 th Edition, Kalyani Publishers, New Delhi. • Shukla, R.S. and Chandel, P.S. (2005) A Text Book of Plant Ecology including Ethnobotany and Soil Science | |

- Sehgal, J. (2015) A Text Book of Pedology – Concepts and Applications, Kalyani publishers, New Delhi.
- Weil, R.R. and Brady, N.C. (2017) The Nature and Properties of Soils, 15th edition, Pearson Education Limited, England.
- Biswas, T. D. and Mukherjee, S. K. (2017) Textbook of Soil Science, 2nd edition, McGraw Hill Education, India.
- Fundamentals of Soil Science (2012) Indian Society of Soil Science, IARI, New Delhi.

Soil Sciences Lab (ENV/013100)

- Soil texture analysis
- Soil profile analysis
- Determination of pH of Soil
- Determination of EC of Soil
- Determination of Moisture Content of soil
- Determination of Bulk Density & Porosity of Soil
- Determination of Water Holding Capacity of soil
- Determination of Water Filled Pore Space
- Determination of Soil Cation Exchange Capacity
- Determination of Soil Acidity/Alkalinity analysis
- Determination of Soil Organic Carbon
- Determination of Soil Organic Matter
- Determination of Nitrate
- Determination of Base Saturation
- Determination of Available Nitrogen
- Determination of Total Nitrogen in Soil
- Determination of Available Potassium
- Determination of Available Phosphorus
- Determination of Soil Respiration By Titration Method

Fundamentals of Environmental Statistics (ENV/013040)

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| 1) | Type of Course | Major Course (6 th sem) |
| 2) | Name of the Course | Fundamentals of Environmental Statistics |
| 3) | Course Code: | ENV/013040 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | This course is designed to provides the theory of statistical analysis and basic knowledge of the application of statistical methods and tools in biological and |

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| | | environmental science. The course will give an idea of scientific data collection and extract information from data for conducting research and their interpretation by using different statistical tools and models in the domain of environmental research. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • To introduce the basic knowledge of statistics with special reference to biological and environmental research problems • To learn about data analysis and data interpretation with the help of statistical tools and software • To provide experience in the correct use and interpretation of the various statistical methods for analysis of data • To develop technical skills to use statistical tools and software in environmental research |
| 9) | Course features and learning outcome | By the end of the course, the students are expected to gain basic knowledge about the role of statistics and statistical methods for analysing environmental data. This course will help the students to develop statistical expertise necessary for biological and environmental research and apply accordingly in experimentations. Furthermore, the students should develop skills to deal with modern statistical programmes and interpret datasets confidently. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Introduction to Basic Statistics |
| | | Introduction to statistical terms and symbols: Sample, Population, Data source, Data Collection, Data types, Data summarization, Variables, Attributes, Class and Class interval; Sample and sampling method; Methods of Statistical Data Representation |
| (ii) | Unit-II | Descriptive Statistics |
| | | Measures of Frequency; Measures of Central Tendency (Mean, Median and Mode), Means (Arithmetic, geometric and harmonic); Measures of Dispersion or Variation (Range, Variance, Standard Deviation, Standard Error, Coefficient of Variance); Measures of Partition (Quartiles, Quintiles, Deciles, Percentiles); Concept of Probability and probability distribution (normal, binomial, poisson); Moments, Skewness and Kurtosis |
| (iii) | Unit-III | Correlation, Regression and Tests of Significance |

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| | Correlation measurements (Simple Correlation, Rank Correlation and Partial correlation) and Regression analysis; Test of hypothesis; Level of significance; One and two tailed tests, Degrees of freedom; Analysis of variance (ANOVA): One way and two-way analysis of variance test; Chi-square test, F- test and t-test |
| 14) | Text Book and References: |
| | <ul style="list-style-type: none"> • Ayyub, B.M. and McCuen, R.H. (2011). Probability, Statistics and Reliability for Engineers and Scientists, CRC Press, Boca Raton, FL. • Helsel, D.R. and Hirsch, R.M. (1997). Statistical Methods in Water Resources, Elsevier Science Ltd., UK. • Hoshmand, A.R. (1997). Statistical Methods for Environmental and Agricultural Sciences, CRC Press, Boca Raton, FL. • Sharma, D.D. (2002). Geostatistics with application in earth science, Capital Pub. • Chiles, J.P. (1999). Geo-statistics: Modeling spatial uncertainty, Wiley Interscience Pub. • Gupta, S.C. and Kapoor, V. K. (2004). Fundamentals of Mathematical Statistics. Sultan Chand Pub. |

Environmental Law and Legislation (ENV/013060)

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| 1) | Type of Course | Major Course (6 th sem) |
| 2) | Name of the Course | Environmental Law and Legislation |
| 3) | Course Code: | ENV013060 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview | This paper presents an objective view of the role of environmental law and legislation in control of environmental degradation. It starts with history of environmental laws along with different convention and its output in formulation of environmental policy of nation. It aims to provide environmental policy at the initial stage of development project along with awareness of people about importance of nature for sustainability of human kind and maintenance of ecosystem stability. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • To describe the history of environmental law and need of environmental protection for betterment of nature and human beings in current scenario. • To study and analyze the baseline condition of natural resources along with biodiversity and its conservation strategies. • To develop scientific views for application of |

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| | | <p>environmental law at the initial stage of project to reduced environmental degradation by EIA as a tool.</p> <ul style="list-style-type: none"> • To develop different guidelines to control environmental pollutants emission by establishing standards of different pollutants. • To develop common consensus on global environmental issues and apply output of different convention and conferences organized by UN to achieve the target of sustainable development by updating environmental policy of the country. |
| 9) | Course features and learning outcome | After completion of this course successfully, the students will develop basic understanding of environmental acts, rules to tackle current environmental and natural problems in systematic manner. The students will be able to reduce the discharge of pollutants at different stages of project by preparing Environmental impacts assessment report and remediation plan at initial stage of the developmental project. Different units will provide to students an understanding for history of Environmental laws in India and international efforts to reduced environmental problems at global level. |
| 10) | Who can attend the course | This course is suitable for students of Environmental Sciences. |
| 11) | Course Eligibility/Pre-requisite | 10+2 or equivalent |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Basic Concepts in Environmental Law and legislation |
| | | Introduction to environmental laws in India; sustainable development; Constitutional provisions; National Environmental Policy; Constitutional Provisions (Article 21, 48A, 51A (g)) Role of Ministry of Environment & Forests, Environmental movement in India, Supreme Court Cases – Ratlam Municipality, Ganga Action Plan, Taj Trapezium, Delhi CNG etc. Role of International Environmental Agencies -UNEP, GEF, UNFCC and IPCC |
| (ii) | Unit-II | Objectives and Provisions of Acts, Rules and Regulations |
| | | Acts, rules and amendments thereof - Indian Forest Act 1927, Wildlife (Protection) Act 1972, Water (Prevention and Control of Pollution) Act 1974; Forest Conservation Act 1980, Air (Prevention and Control of Pollution) Act 1981; Environment (Protection) Act 1986, Biomedical Waste Management Rules, 2016; Hazardous Waste Management & Handling Rules, 2008); Coastal Regulation Zones (CRZ) Rules 1991. Public Liability Insurance Act, 1991. E-waste Management Rules 2016; |

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| | | Solid waste management rules, 2016 |
| (iii) | Unit-III | International Environmental Treaties and Conventions |
| | | Evolution and development of International Environmental laws with reference to Stockholm Conference on Human Environment, 1972, Ramsar Convention on Wetlands, 1971, Montreal Protocol, 1987, Basel Convention (1989, 1992), Earth Summit at Rio de Janeiro, 1992, Kyoto Protocol, 1997; Earth Summit at Johannesburg, 2002. UN Summit on Millennium Development Goals 2000, Copenhagen Summit 2009, CITES 1973, Convention on Biological Diversity 1992, Bonn Convention 1979, Vienna Convention 1985, UNCCD 1994, COP 21, 24, 25, Minamata Convention 2013, COP25, Basel Convention 1989 |
| 14) | Text Book and References: | |
| (i) | Shyam Divan and Armin Rosencranz (2005), <i>Environmental Law and Policy in India</i> , Oxford University Press, New Delhi. | |
| (ii) | Leelakrishnan. P (2008), <i>Environmental Law Case Book</i> , Lexis Nexis, Butterworths | |
| (iii) | Mohanty. S. K. (2011) <i>Environment and Pollution Law</i> , Universal Law Publishing Co. Pvt. Ltd. | |
| (iv) | Shastri S C (2008) <i>Environmental Law</i> , (2nd Edn.), Eastern Book Company, Lucknow | |
| (v) | Singh Gurdip (2004) <i>Environmental Law in India</i> , Mcmillan & Co. | |
| (vi) | Sahasranaman P. B. (2008) <i>Handbook of Environmental Law in India</i> , Oxford University Press (India) | |

Forestry and Wildlife Management (ENV/013080)

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| 1) | Type of Course | Major Course (6 th sem) |
| 2) | Name of the Course | Forestry and Wildlife Management |
| 3) | Course Code: | ENV/013080 |
| 4) | Total Credit: | 3 (Three) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | This course is designed based on basic concepts of Forestry and wildlife management. It will help to gather knowledge and achieve detailed understanding of forestry and wildlife related problems and their solutions. |

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| 8) | Programme/course objective | <ul style="list-style-type: none"> To get an overview of the forests, wildlife, and its importance. To develop an in-depth understanding of wildlife management and conservation. To develop an understanding of forestry and its significance To develop an understanding of forest and wild-life related issues. |
| 9) | Course features and learning outcome | After completing this course successfully, the students will develop an in-depth understanding of the biodiversity. The students will be able to generate ideas related to biodiversity-related issues, importance and their conservation. |
| 10) | Who can attend the course | This course is suitable for the students Environmental Sciences. |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Environmental Sciences. |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Forests and Forestry |
| | | <ul style="list-style-type: none"> Forests: Importance, crown differentiation, forest resources, forest types of India with special reference to Jharkhand, measurement of height and girth of trees, deforestation, role of plantation forestry in environmental conservation |
| (ii) | Unit-II | Social Forestry |
| | | <ul style="list-style-type: none"> Social forestry, Community participation in social forestry programme, Multipurpose tree species (MPTs) and Nitrogen fixing tree species (NFTs) and their importance and characteristics, Pattern of planting, calculation of number of plants (line, square, triangular and quincunx) |
| iii) | Unit-III | Wildlife: Importance and Conservation |
| | | <ul style="list-style-type: none"> Wildlife: importance, wildlife resources, threats to wildlife, poaching of wildlife, species endangerment, factors influencing the distribution pattern of wildlife, major habitats of wildlife, component of wildlife habitat, human-wildlife conflict, wildlife conservation, wildlife conservation and protection Act |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> Ghosh S. K. & Singh R. (2003) Social Forestry and Forest Management, Global vision publication, Delhi. Dwivedi A. P. (2003) A Text Book of Silviculture, Intl. Book Distributors, Dehradun. Jha, L. K. & Sen Sarma P. K. (2008) Forestry for the people, APH publishing corporation, New Delhi | |

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Global Environmental Issues (ENV023020)

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| 1) | Type of Course | Major Course |
| 2) | Name of the Course | Global Environmental Issues |
| 3) | Course Code: | ENV023020 |
| 4) | Total Credit: | 4 (Four) |
| 5) | Proposed by: | Departments of Environmental Sciences, Central University of Jharkhand |
| 6) | Who can teach this course | Teachers from Environmental Sciences |
| 7) | Overview/ Course Description | The course is designed to provide knowledge about different environmental issues which are a matter of concern for people across the national boundaries. Also, the solutions to these issues and required efforts at the international level. |
| 8) | Programme/course objective | <ul style="list-style-type: none"> • Defining and listing different global environmental issues • Understanding the science behind global warming and relating it with the phenomenon of global climate change; • To understand harmful effects of global warming and climate change • To understand the causes and effects of ozone layer depletion; • It will describe acid rain, its causes and its harmful effects, especially on agriculture, environment, materials and buildings; • Impact of the above global issues on human communities and environment. • Various international conventions and treaties related to above environmental issues |
| 9) | Course features and learning outcome | After completing this course successfully, students can identify different global environmental issues and will be able to look for sustainable methodologies to cope up with the prevailing environmental problems. |
| 10) | Who can attend the course | This course is suitable for the students of environmental sciences |
| 11) | Course Eligibility/Pre-requisite | Admitted in UG-PG integrated M. Sc. in Science |
| 12) | Course Duration: | One Semester |
| 13) | Course Structure | |
| (i) | Unit I | Introduction to Global Issues |

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| | | Overpopulation and resource depletion, Concept of sustainability, Carrying capacity of earth, Natural and anthropogenic events, Impact of unsustainable development on atmosphere, hydrosphere, lithosphere and biosphere. |
| (ii) | Unit-II | Global Warming and Climate Change |
| | | History of Climate Change, Milankovitch's theory of Climate Change, Energy budget, Greenhouse gases and their impacts, Ozone layer depletion, understanding global and regional climate change, Possible Impacts of global Climate Change. |
| (iii) | Unit-III | Acid rain |
| | | Different types of precipitation, pH of rain water and different gases that controls the pH, causes of acid rain- natural and anthropogenic, different impacts of acid rain on different environmental components, different control measures for mitigating acid rain. |
| (iv) | Unit-IV | Climate Change Mitigations |
| | | Mitigation and adaptation, the need of mitigation and adaptation in the era of climate change, adaptation and mitigation measures to climate impacts in India, role of individual, state and civil society to slow down climate change. |
| (v) | Unit-V | Global Environmental Concerns |
| | | United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon Fund (PCF), National Action Plan for Climate Change (NAPCC). |
| 14) | Text Book and References: | |
| | <ul style="list-style-type: none"> • Hardy, John T. Climate Change: Causes, Effects, Solutions. Wiley & Sons, USA. 2003. • Harris, F. Global Environmental Issues. Wiley & Sons, Inc., USA. 2004. • Adger, W.N. et al. 2007. "Assessment of adaptation practices, options, constraints and capacity, Climate Change 2007: Impacts, Adaptation and Vulnerability", contribution of Working Group IT to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, (eds.), Cambridge University Press, Cambridge, UK, 717-743. • Dutt, G. and Fabian, G. 2008. "Coping with climate change". Economic and Political Weekly, 4239-50. • Government of India. 2009. "National Action Plan on Climate Change" Ministry of Forest & Environment, Government of India. • Kapur, D. et al. 2009. "Climate change; India's Options", Economic and Political Weekly, vol. XLIV, 31, 34-42. • Brown, Lemay, and Buster. Chemistry: the Central Science, 7th ed. Upper Saddle River, NJ: Prentice Hall, 1997. p. 673-5. • Charola, A. "Acid Rain Effects on Stone Monuments," J. Chem. d. 64 (1987), p. 436-7. | |

- Firor, J. (1992) *The Changing Atmosphere*, New Haven, CT: Yale University Press.