

**M. G. S. UNIVERISTY, BIKANER**  
**SYLLABUS**  
**SCHEME OF EXAMINATION AND**  
**COURSES OF STUDY**

**MSC ENVIRONMENTAL SCIENCE**

**(2021-22)**

**(2022-23)**



**Maharaja Ganga Singh University**  
**Bikaner**

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### Background

Considering the curricular reforms as instrumental for desired learning outcomes, all academic Department of Maharaja Ganga Singh University made a rigorous attempt to revise the curriculum of postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP". The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

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

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

dispositions as specified for each course. The University has also developed consensus on adoption of Blended Learning with 10% component of online teaching and 90% face to face classes for each programme.

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

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Therefore, the curriculum may be reviewed annually so as to gradually include all relevant provisions of NEP-2020.

### **Programme Outcomes (PO)**

The PG Courses of Faculty of Science will be able:

| <b>PO</b> | <b>Description</b>   |
|-----------|--|
| PO1       | To acquaint students with recent knowledge and techniques in basic and applied sciences.   |
| PO2       | To develop understanding of biological and environmental basis of life.  |
| PO3       | To provide insight in to ethical implications of scientific research for environmental protection and good laboratory practices and bio safety.                      |
| PO4       | To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to sciences.                                     |
| PO5       | To understand application of biotic material in food security for human wellbeing and sustainable development.   |
| PO6       | To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of sciences for self reliance. |

### **Program Specific Outcomes (PSO)**

| <b>PSO</b>   | <b>Description</b>  |
|--------------|---|
| <b>PSO-1</b> | To contribute to Environmental Sustainability and wise use of Natural Resources for benefit of society through education and research on environment with a multidisciplinary and professional approach |
| <b>PSO-2</b> | To provide knowledge on Ecology, Biodiversity Conservation, Remediation and Restoration.  |
| <b>PSO-3</b> | To create awareness on Pollution, Climate Change, Ecotoxicology and their linkages to human health  |
| <b>PSO-4</b> | To educate students on Environmental Impact Assessment, Monitoring and Policy frameworks  |
| <b>PSO-5</b> | To give knowledge on concepts, tools and modern techniques for Environmental Analysis and Management  |

|              |   |
|--------------|---|
| <b>PSO-6</b> | To educate students on Natural Resource Management and Sustainable Development. |
|--------------|---|

### **Post Graduate Attributes**

The graduate attributes of our students shall be aligned with those of our University in terms of touching “the life of every student through inculcating virtues of empathy, ethics, efficiency, respect for diversity, prudence and creativity with compassion”. We wish to achieve this through rigorous teachings and research effort, which remains the basic tenet of our teaching-learning philosophy. The following are the University’s graduate attributes which we emphasize.

- In depth Domain Knowledge
- Interdisciplinary Perspective
- Competence for Research and Innovation
- Analytical Competence
- Critical Thinking
- Problem Solving Competence
- Decision Making
- Information Technology Skills
- Ability to Work Independently
- Capacity for Creativity
- Contribute to Societal Well-being & Sustainability

### Structure of Programme

#### Semester Ist: Four Core Compulsory, One Foundation Course, One Practical Course

|                 |   |                                    |
|-----------------|---|------------------------------------|
| FS-ENV-CF-100   | Environmental Science Foundation Course (Audit) | Elementary concepts of Environment |
| FS-ENV-CC-101   | Environmental Science Core Compulsory           | Environment and Ecology            |
| FS-ENV-CC-102   | Environmental Science Core Compulsory           | Environmental Geosciences          |
| FS-ENV-CC-103   | Environmental Science Core Compulsory           | Environmental Chemistry            |
| FS-ENV-CC – 104 | Environmental Science Core Compulsory           | Environmental Pollution            |
| FS-ENV-CP – 105 | Practical                                       |                                    |

#### Semester IInd: Four Core Compulsory, One Foundation Course, One Practical Course

|                 |                                       |                           |
|-----------------|---------------------------------------|---------------------------|
| FS-ENV-CF-200   | Foundation Course (Audit)             | Human Values              |
| FS-ENV-CC-201   | Environmental Science Core Compulsory | Environmental Monitoring  |
| FS-ENV-CC-202   | Environmental Science Core Compulsory | Desert Ecology            |
| FS-ENV-CC-203   | Environmental Science Core Compulsory | Environmental Legislation |
| FS-ENV-CC – 204 | Environmental Science Core Compulsory | Environmental Toxicology  |
| FS-ENV-CP – 205 | Practical                             |                           |

#### Semester IIIrd: Two Core Compulsory, One Core Elective, One Elective Open, One Practical Course

|                |                                       |  |
|----------------|---------------------------------------|--|
| FS-ENV-CC-301  | Environmental Science Core Compulsory | Environmental Technology   |
| FS-ENV-CC -302 | Environmental Science Core Compulsory | Environmental Impact Assessment-I  |
| FS-ENV-CE -303 | Environmental Science Core Elective   | FS-ENV-CE -303 (a) Population and Community Ecology<br><b>OR</b><br>FS-ENV-CE -303 (b) Biomes and Biogeography |
| FS-ENV-EO -304 | Environmental Science Elective Open   | FS-ENV-EO -304 (a) Climate Science<br><b>OR</b><br>FS-ENV-EO -304 (b) Disaster Management                      |
| FS-ENV-CP -305 | Practical                             |  |

#### Semester IVth: Two Core Compulsory, One Core Elective, One Elective Open, One Practical Course

|         |                                       |                             |
|---------|---------------------------------------|-----------------------------|
| FS-ENV- | Environmental Science Core Compulsory | Natural Resource Management |
|---------|---------------------------------------|-----------------------------|

|               |                                       |  |
|---------------|---------------------------------------|--|
| CC-401        |                                       |  |
| FS-ENV-CE-402 | Environmental Science Core Elective   | FS-ENV-CE 402 (a) Environmental Impact Assessment-II<br><b>OR</b><br>FS-ENV-CE 402 (b) Biodiversity and Conservation |
| FS-ENV-EO-403 | Environmental Science Elective Open   | FS-ENV-EO-403 (a) Environmental Issues, Awareness and Monitoring<br><b>OR</b><br>FS-ENV-EO-403 (b) Waste Management  |
| FS-ENV-CC-404 | Environmental Science Core Compulsory | Dissertation   |
| FS-ENV-CP-405 | Practical                             |  |

### Learning outcome Index of the courses

#### (i) Programme outcome (PO) and programme Specific Outcome(PSO)

|     | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 |
|-----|------|------|------|------|------|------|
| PO1 | ✓    | ✓    | ✓    | ✓    | ✓    | ✓    |
| PO2 |      | ✓    |      |      |      |      |
| PO3 |      |      |      |      | ✓    |      |
| PO4 | ✓    | ✓    |      | ✓    |      | ✓    |
| PO5 |      |      | ✓    | ✓    |      | ✓    |
| PO6 |      | ✓    |      |      | ✓    |      |

#### (ii) Programme Specific Outcome (PSO) and Core Courses

|      | ESCC 101 | ESCC 102 | ESCC 103 | ESCC 104 | ESCC 201 | ESCC 202 | ESCC 203 | ESCC 204 | ESCC 301 | ESCC 302 | ESCC 401 | ESCC 404 |
|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| PSO1 | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        | ✓        |
| PSO2 | ✓        | ✓        | ✓        |          |          | ✓        |          |          | ✓        |          | ✓        | ✓        |
| PSO3 |          | ✓        |          | ✓        |          |          |          | ✓        |          |          |          | ✓        |
| PSO4 |          |          |          |          | ✓        |          | ✓        |          |          | ✓        |          | ✓        |
| PSO5 |          |          | ✓        |          | ✓        |          |          |          | ✓        |          | ✓        | ✓        |
| PSO6 |          |          |          | ✓        | ✓        |          |          |          |          |          | ✓        | ✓        |

#### (iii) Programme Specific Outcome (PSO) and Elective Courses

|      | ESCE 303 A | ESCE 303 B | ESEO 304 A | ESEO 304 B | ESCE 402 A | ESCE 402 B | ESCO 403 A | ESEO 403 B |
|------|------------|------------|------------|------------|------------|------------|------------|------------|
| PSO1 | ✓          | ✓          | ✓          | ✓          | ✓          | ✓          | ✓          | ✓          |
| PSO2 | ✓          | ✓          |            |            |            | ✓          |            | ✓          |
| PSO3 |            |            | ✓          |            |            |            | ✓          |            |
| PSO4 |            |            |            |            | ✓          |            |            |            |
| PSO5 |            |            |            | ✓          | ✓          | ✓          | ✓          | ✓          |
| PSO6 |            |            |            | ✓          |            |            |            | ✓          |

### Semester Wise Credit Distribution as per CHOICE BASED CREDIT SYSTEM (CBCS)

| Paper Code | Paper Name | Course | Lecture | Tutorial | Practical | Total Credits | Maximum Marks  |                | Minimum Passing Marks |
|------------|------------|--------|---------|----------|-----------|---------------|----------------|----------------|-----------------------|
|            |            |        |         |          |           |               | Internal Marks | External Marks |                       |
|            |            |        |         |          |           |               |                |                |                       |

| <b>Semester-I</b>    |   |                   |   |   |           |                    |                    |                       |                       |
|----------------------|---|-------------------|---|---|-----------|--------------------|--------------------|-----------------------|-----------------------|
| <b>Theory Papers</b> |   |                   |   |   |           |                    |                    |                       |                       |
| ESCC-101             | Environment and Ecology                           | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCC-102             | Environmental Geosciences                         | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCC-103             | Environmental Chemistry                           | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCC-104             | Environmental Pollution                           | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESFC-01              | Elementary Concept in Environment                 | Foundation Course | 2 | 2 | 1         | 5                  |                    |                       |                       |
|                      |   |                   |   |   |           |                    | 40                 | 160                   |                       |
|                      |   |                   |   |   |           |                    | Total Theory Marks | 200                   | 72<br>(36% aggregate) |
| <b>Practical</b>     |   |                   |   |   |           |                    |                    |                       |                       |
| Practical            |   | Core Compulsory   |   |   |           | 25                 | 75                 | 36<br>(36% aggregate) |                       |
| <b>Total Credits</b> |   |                   |   |   | <b>25</b> | <b>Grand Total</b> | <b>300</b>         |                       |                       |
| <b>Semester-II</b>   |   |                   |   |   |           |                    |                    |                       |                       |
| <b>Theory Papers</b> |   |                   |   |   |           |                    |                    |                       |                       |
| ESCC -201            | Environmental Monitoring                          | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCC-202             | Desert Ecology                                    | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCC-203             | Environmental Legislation                         | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCC-204             | Environmental Toxicology                          | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| FC-02                | Human Values                                      | Foundation Course | 2 | 2 | 1         | 5                  |                    |                       |                       |
|                      |   |                   |   |   |           |                    | 40                 | 160                   |                       |
|                      |   |                   |   |   |           |                    | Total Theory Marks | 200                   | 72<br>(36% aggregate) |
| <b>Practical</b>     |   |                   |   |   |           |                    |                    |                       |                       |
| Practical            |   | Core Compulsory   |   |   |           | 25                 | 75                 | 36<br>(36% aggregate) |                       |
| <b>Total Credits</b> |   |                   |   |   | <b>25</b> | <b>Grand Total</b> | <b>300</b>         |                       |                       |
| <b>Semester-III</b>  |   |                   |   |   |           |                    |                    |                       |                       |
| <b>Theory Papers</b> |   |                   |   |   |           |                    |                    |                       |                       |
| ESCC-301             | Environmental Technology                          | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCC-302             | Environmental Impact Assessment-I                 | Core Compulsory   | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCE-303             | (A) Population and Community Ecology<br><b>OR</b> | Core Elective     | 3 | 1 | 1         | 5                  | 10                 | 40                    | 13 (25 %)             |

|                      |  |                 |   |   |    |                    |                    |                       |                       |
|----------------------|--|-----------------|---|---|----|--------------------|--------------------|-----------------------|-----------------------|
|                      | (B) Biomes and Biogeography  |                 |   |   |    |                    |                    |                       |                       |
| ESEO-304             | (A) Climate Science<br><b>OR</b><br>(B) Disaster Management                              | Elective Open   | 3 | 1 | 1  | 5                  | 10                 | 40                    | 13 (25 %)             |
|                      |  |                 |   |   |    |                    | 40                 | 160                   |                       |
|                      |  |                 |   |   |    |                    | Total Theory Marks | 200                   | 72<br>(36% aggregate) |
| <b>Practical</b>     |  |                 |   |   |    |                    |                    |                       |                       |
| Practical            |  | Core Compulsory |   |   |    | 25                 | 75                 | 36<br>(36% aggregate) |                       |
| <b>Total Credits</b> |  |                 |   |   | 20 | <b>Grand Total</b> | <b>300</b>         |                       |                       |
| <b>Semester-IV</b>   |  |                 |   |   |    |                    |                    |                       |                       |
| ESCC-401             | Natural Resource Management  | Core Compulsory | 3 | 1 | 1  | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCE-402             | (A) Environmental Impact Assessment-II<br><b>OR</b><br>(B) Biodiversity and Conservation | Core Elective   | 3 | 1 | 1  | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESEO-403             | (A) Environmental Issues, Awareness and Monitoring<br><b>OR</b><br>(B) Waste Management  | Elective Open   | 3 | 1 | 1  | 5                  | 10                 | 40                    | 13 (25 %)             |
| ESCC-404             | Dissertation   | Core Compulsory | 0 | 4 | 1  | 5                  | 20                 | 80                    | 36 (25 %)             |
|                      |  |                 |   |   |    |                    | 40                 | 160                   |                       |
|                      |  |                 |   |   |    |                    | Total Theory Marks | 200                   | 72<br>(36% aggregate) |
| <b>Practical</b>     |  |                 |   |   |    |                    |                    |                       |                       |
| Practical            |  | Core Compulsory |   |   |    | 25                 | 75                 | 36<br>(36% aggregate) |                       |
| <b>Total Credits</b> |  |                 |   |   | 20 | <b>Grand Total</b> | <b>300</b>         |                       |                       |

**M.Sc. First Semester**

FS-ENV-CF-100  
 FS-ENV-CC-101  
 FS-ENV-CC-102  
 FS-ENV-CC-103  
 FS-ENV-CC – 104

Elementary Concept in Environment  
 Environmental Ecology  
 Environmental Geoscience  
 Environmental Chemistry  
 Environmental Pollution

FS-ENV-CP – 105

Practical



**Course Title: Elementary Concepts in Environment**

**Course Code: FS-ENV-CF-100**

**Course Objectives:** To disseminate knowledge to students about environment as a fundamental core issue in present time.

**Course Description:** Acquaintance with basic concept of earth environment with interdisciplinary approach.

**Course Outcome:** Sensitize the students towards environmental concerns issues and impact at local and global level.

**UNIT I**

Introduction to the interdisciplinary nature of environmental science and fundamental issues in environmental science, including climate change, pollution, sustainability.

Overview of critical Earth systems and their interrelationships: Aquatic, terrestrial and atmospheric systems. Earth's structure, composition, surface features. Earth's processes.

**UNIT II**

Four main motions of the Earth (rotation, revolution, precession and galactic rotation), Gaia theory of the Earth.

Earth's atmosphere and climate: Climate, Ice ages, Greenhouse effect, Global warming and climate change.

**UNIT III**

Introduction to the Earth's physical systems: Weathering and soil formation.

Biosphere: Biodiversity and conservation of terrestrial systems.

Introduction to water resources and marine resources.

**Suggested Reading:**

- Cunningham, W.P., Cunningham, M.A. & Saigo, B. (2004) Environmental Science, a Global Concern. (8th edition). McGraw-Hill (Boston)
- Montgomery, C. (2005) Environmental Geology. McGraw-Hill.
- Nebel, BJ & Wright, R. (2004) Environmental Science: Toward a Sustainable Future. Prentice-Hall.
- Park, C. (2001) The Environment: Principles and Applications. Routledge
- Tyler Miller G. (2005) Living in the Environment: Principles, Connections, and Solutions. Belmont, Calif.: Brooks/Cole (14th International student edition)
- Wright, R.T. (2005) Environmental Science - toward a Sustainable Future. (9th International Edition), Pearson Education International, Prentice Hall Publishers.

**Course Title: Environment and Ecology**

**Course Code: FS-ENV-CC-101.**

**Course Objectives:** To attain the fundamental knowledge of ecology and environment with conceptual framework in holistic manner.

**Course Description:** Basic attributes about principles of ecology, environment and their interrelationship with nature as an essential component.

**Course Outcome:**

**CO1:** Develop foundation on principles of Environmental Science and concept of structure and function of different compartments of the Environment.

**CO2:** Gain scientific perspective of the issues confronting our present day environment.

**CO3:** Enable to analyze the national and global environmental issues relating to atmosphere, water, soil and land use, biodiversity, and natural resources (global warming, climate change, mineral extraction and energy resources, environmental impact assessment and environmental audit).

**Unit I**

Earth, man and environment. Environmental factors: Atmosphere, Hydrosphere, Lithosphere and Biosphere, and their interrelationships. Holistic concept, environmental complex, tolerances, ecological amplitude, limiting and inhibiting effects. Climatic factors: Pressure, temperature, RH, precipitation, radiation, wind. Edaphic factors: physical, chemical and biological characteristics.

**Unit II**

Ecology- Definition, principles, and scope. Human ecology and settlement. ECOSystems: Structure and functions. Abiotic and Biotic components, Energy flows, Food chains, Food web, Ecological pyramids. ECOSystem types- Aquatic (freshwater, marine) and terrestrial (grassland, forest) eCOsystems. Concept of Population and Community. Ecotones and their importance.

**Unit III**

Biogeochemical cycles and regulation, pools and fluxes, basic cycles: hydrologic, carbon, oxygen, nitrogen, phosphorus and sulphur cycles; Nutrient cycling in forest and aquatic eCOsystems.

**Suggested Readings:**

1. Basic ecology - E. P. Odum
2. Ecology and field biology - R.L. Smith
3. Ecology - P.D. Sharma
4. Fundamentals of ecology -E.P. Odum
5. Principles of ecology – Rickleff
6. Environmental Science – The natural environment and human impact (1998): A. R. W.
7. Jackson and J. M. Jackson, Longman
8. Environmental Science (2001) : S. C. Santra, New Central Book Agency (P) Ltd
9. Introduction to Environmental Science and Engineering (2nd Ed.) (2004): G. M. Masters, Pearson Education Pvt. Ltd.
10. Environmental Science (6th ed) (1997): Jr. G. T. Miller, Wadsworth Pub. Co.
11. Fundamentals of Environmental Science: G. S. Dhaliwal, G. S. Sangha and P. K. Raina, Kalyani Publication
12. General Climatology: Critchfield H. J.
13. Introduction to Weather and Climate : Trewartha

**Course Title: Environmental Geoscience****Course Code: FS-ENV-CC-102**

**Course Objectives:** To get acquaintance about domain knowledge in environmental geology with perspective of current environmental problems.

**Course Description:** It inculcates various ideas and concepts about earth interior environment as close system with various earth processes and geological process. It also emphasize on various natural hazards, calamities, occurs in nature with subject to their rationale management.

**Course Outcome:**

**CO1:** Lay foundation on basic geologic knowledge to maximize the utilization of all natural resources and minimize their degradation.

**CO2:** Empower with geological methods to minimize the destructive potential of natural processes and to sustain a healthy biosphere on earth.

**CO3:** Train on methods to identify common minerals & major rock types in hand specimens and under petrological microscope, and tools to analyze geomorphologic basis of land use and interpret plate tectonics and hazard zonation maps.

**Unit I**

The earth systems and Biosphere: Conservation of matter in various geospheres- lithosphere, hydrosphere atmosphere and biosphere. Energy budget of the earth. Earth's thermal environment and seasons. General relationship between landscape, biomes and climate. Climates of India. Indian Monsoon. El Nino. Droughts. Tropical cyclones and Western Disturbances.

**Unit II**

Earth's Processes and Geological Hazards: Earth's processes; concept of residence, time and rates of natural cycle. Catastrophic geological hazards. Study of floods, landslides, earthquakes, volcanism and avalanche. Prediction and perception of the hazards and adjustments to hazardous activities, Plate tectonics.

**Unit III**

Environmental Geochemistry: Concept of major, trace and REE. Classification of trace elements. Mobility of trace elements. Geochemical cycles. Biogeochemical factors in environmental health. Human use, trace elements and health. Possible effects of imbalance of some trace elements. Interface between climate and techniques geoindicators.

**Suggested Readings:**

1. Environmental geology- Edward A. Keller
2. Physical geology - C.W. Montgomery.
3. Geology of India - National book trust series.

**Course Title: Environmental Chemistry****Course Code: FS-ENV-CC-103**

**Course Objectives:** It elaborate that how the chemical reactions are responsible for governing the various nature cycles in the environment with respect to their positive and negative effects.

**Course Description:** It provides fundamental knowledge of chemical aspects in environment and various chemical reactions which are working as natural bulwark and also having concern with the anthropogenic activities held responsible for pollution in chemical manner.

**Course Outcome:**

**CO1:** Develop understanding on the chemistry of the lithosphere. Hydrosphere and atmosphere.

**CO2:** Gain understanding on the chemistry of various anthropogenic pollutants and basic analytical techniques.

**CO3:** Trains on chemical analysis of water and waste water, and the scientific principle of tools and techniques used for chemical analysis.

**Unit I**

**Fundamentals of Environmental Chemistry:** Stoichiometry, Gibbs' energy, Chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.

**Unit II**

**Chemical composition of Air:** Classification of elements, chemical speciation. Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermochemical and photochemical reactions in the atmosphere. Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical smog.

**Unit III**

**Water Chemistry:** Chemistry of water, concept of DO, BOD, COD, sedimentation, coagulation, filtration, Redox potential. Soil Chemistry: Inorganic and organic

components of soil, Nitrogen pathways and NPK in soils.

**Suggested Readings:**

1. Environmental Chemistry - G.S. Sodhi
2. Environmental Chemistry - Mannahan
3. Fundamentals of soil science - Henry D. Futh
4. Textbook of limnology - G.A. Cole
5. Environmental Chemistry - Sharma and Kaur

**Course Title: Environmental Pollution**

**Course Code: FS-ENV-CC-104**

**Course Objectives:** To get familiarity about all kind of environmental pollutions and undesirable changes occur day to day in nature at local and global level.

**Course Description:** It describes various kinds of pollutions in consonance of their types, characteristics and their management strategies. It also contemplates short term and long term impact at various levels.

**Course Outcome:**

**CO1:** Examine the critical linkage between environmental pollution and human health.

**CO2:** Develop understanding on the mode of various diseases as triggered by the spread of contaminants in soil, water and air.

**CO3:** Analyze different types of pollution and the guidelines for their control in the context of public health.

**CO4:** Enable to estimate physico-chemical properties of water and evaluate hydrologic parameters; catchment delineation and water balance.

**CO5:** Trains on basic analytical methods to quantify water quality, analyze hydrographs and determine hydrological parameters.

**Unit I**

Overview of Environmental Pollution-Definition, types of pollutants, causes, effects, monitoring, prevention and control of pollution. Environment Pollution Local, Regional, Global aspect

**Air:** Natural and anthropogenic sources of pollution. Primary and Secondary pollutants. Transport and diffusion of pollutants. Gas laws governing the behaviour of pollutants in the atmosphere. Methods of monitoring and control of air pollution .SO<sub>2</sub>, NO<sub>2</sub>, CO, SPM. Effects of pollutants on human beings, plants, animals, materials and on climate. Acid Rain. Air Quality Standards. Global warming.

**Unit II**

**Water:** Types, sources and consequences of water pollution. Physico-chemical and Bacteriological sampling and analysis of water quality. Sewage and waste water treatment and recycling. Water quality standards.

**Marine:** Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system, coastal management.

**Soil:** Physico-chemical and bacteriological sampling and analysis of soil quality. Industrial waste/effluents and heavy metals, their interactions with soil components. Soil microorganisms and their functions, degradation of different insecticides, fungicides and weedicides in soil. Different kinds of synthetic fertilizers (NPK) and their interactions with different components of soil. Soil Pollution Control.

**Unit III**

Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes (Hospital Wastes and Hazardous Wastes)

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. Radioactive waste and

radioactivity from nuclear reactors; Thermal Pollution.  
Impacts of large-scale exploitation of Solar, Wind, Hydro and Ocean energy.

**Course Outcomes (COs)**

**Suggested Readings:**

1. Air pollution and control - K.V.S.G. Murlikrishan
2. Industrial noise control - Bell & Bell
3. Environmental engineering -Peary
4. Introduction to environmental engineering and science - Gilbert Masters.

**Practical**

**Course Code: FS-ENV-CP-105**

**Study of Local Flora & Fauna:**

1. Plant species diversity in a given area (one season data only)
2. Species-wise population count of birds in a wetland/ terrestrial habitat.
3. Qualitative and quantitative analysis of zooplankton, phytoplankton, periphyton and benthos.
4. List of bioproducts used by a community living inside or in the proximity of a protected area.
5. Study of Frequency, Abundance, density & IVI of give area.
6. Study of vegetation by using quardrat & line fransect methods.
7. Field study by using GPS & toposheet .
8. Field visit to institution/ industrial units.
9. Measurement of Noise level by using Noise level meter of residential, industrial & sensitive areas.
10. Estimation DO, BOD & COD of given water sample.

**Monitoring of Water:** Turbidity, pH, Dissolved oxygen, Free carbon dioxide, Alkalinity, Salinity, Sodium, Potassium, Calcium, Magnesium, Carbonates, Bicarbonates, Chlorides, Sulphates, Nitrate, Phosphate, Silica.

**M.Sc. Second Semester**

|               |                                     |
|---------------|-------------------------------------|
| FS-ENV-CF-200 | Human Values * (To be Incorporated) |
| FS-ENV-CC-201 | Environmental Monitoring            |
| FS-ENV-CC-202 | Desert Ecology                      |
| FS-ENV-CC-203 | Environmental Legislation           |
| FS-ENV-CC-204 | Environmental Toxicology            |
| FS-ENV-CP-205 | Practical                           |

**Course Title: Environmental Monitoring**

**Course Code: FS-ENV-CC-201**

**Course Objectives:** It provides basic ideas, tools and techniques pertaining to analysis and monitoring of various environmental pollutions adopting methods and methodologies.

**Course Description:** The course envisages various principles, analytical methods in environmental monitoring as a part of surrounding environmental problems. It also gives the statically presentation of the outcome of monitoring using various models.

**Course Outcome:**

**CO1:** Equip with various methods used in the collection and analyses of data for Environmental Studies.

**CO2:** Train on the theory and practice of biostatistical tools for analyzing the data and deriving meaningful conclusions.

**CO3:** Investigate the potential of simulation models to understand the complexity of environmental processes and enables to use environmental modeling, remote sensing and GIS in environmental studies.

**CO4:** Develop the concept of systems and sub-systems, monitoring.

**CO5:** Learn to model various environmental systems, particularly those dealing with ecology and eCOsystems and study of environmental pollution in monitoring air and water quality.

**CO6:** Empower with major approaches towards natural resource issues and enables to think creatively about conflict and concord in general, with special emphasis on the roles of ideas and institutions in environmental politics.

**CO7:** Trains on the computational techniques and simulation models to analyze environmental processes.

### Unit I

Principles of Analytical Methods and their application in Environmental monitoring, with special reference to: Titrimetry, Gravimetry, Colourimetry, Spectrophotometry, Chromatography, Gas Chromatography, Atomic Absorption Spectrophotometry, GLC, HPLC, Electrophoresis, X-ray fluorescence, X-ray diffraction, Flame photometry.

### Unit II

Systems analysis for Environmental problems. Environmental monitoring for Air, Water, Soil, Radiation and Microbiology: Common parameters, sampling procedures and analytical techniques. Sampling methodologies for Environment matrices, Environment modeling.

### Unit III

Basic elements and tools of statistical analysis; Probability, sampling. Measurement and distribution of attributes; Distribution-Normal, t and x', Poisson and Binomial; Arithmetic, Geometric and Harmonic means; moments: matrices, simultaneous linear equations. Tests of hypothesis and significance.

Introduction to environmental system analysis; Approaches to development of models; linear simple and multiple regression models, validation and forecasting. Models of population growth and interactions-Lotka-Volterra model, Leslie's matrix model, point source stream pollution model, box model. Gaussian plume model.

#### Suggested Readings:

1. Principles of Biophysical chemistry - Uppadahay- and Nath.
2. Analytical Techniques - S.K. Sahani
3. Dynamics of Environmental Bioprocesses-Modelling and simulation-Snape and Dunn.
4. Environmental Modelling – Jorgensen

#### Course Title: Desert Ecology

#### Course Code: FS-ENV-CC-202

**Course Objectives:** As the university situated amidst in Thar Desert, the content of course emphasize on various aspects of Desert Ecosystem as a generic system.

**Course Description:** Course content derived various attributes in the study of arid climate with particular emphasis on resource management, adaptation, and desertification and conservation strategies.

#### Course Outcome:

**CO1:** Demonstrate emerging importance of the arid setting.

**CO2:** Explores the importance for policy, community mobilization, law and governance in desert areas.

**CO3:** Insight into some key challenges facing desert sustainability in the 21<sup>st</sup> century.

### Unit I

Definition and types of deserts. Major deserts of the world- Distribution and characteristics. Causes of desertification. Arid climate.

### Unit II

Desert eCOsystem with special reference to the Indian desert: environment, flora, fauna. Desert adaptations among plants and animals. Drought and famine, migration. Aridity

index. Endangered plant and animal species of the Indian desert and their conservation strategies.

### Unit III

Resource management in deserts- traditional and modern approaches. Saline tracts of the Rajasthan desert. Impact of canal irrigation on the ecology of the Indian desert. Approaches for combating desertification. Dry land farming. Waterbodies in arid and semiarid lands and their management strategies.

#### **Suggested Readings:**

Bothma, J. duP. Carnivore Ecology in Arid Lands. Springer-Verlag Berlin Heidelberg 1998.

Cloudsley-Thompson, J.L. 1984, Key Environments, Sahara Desert, Oxford Pergamon Press, London.

Epstein, E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. Wiley Publishers, New York.

Goodall, D.W. and Perry, R. 1981. Arid Zone ECOsystems. Vol.I Cambridge University Press, Cambridge

Goodall, D.W. and Perry, R. 1981. Arid Zone ECOsystems. Vol.II Cambridge University Press, Cambridge.

Gupta, R.K. and Prakash, I. 1975. Environmental Analysis of the Thar Desert. English Book Depot, Dehradun.

Kalwar, S. C. Arid Ecology. Pointer Publishers.1999.

Levit, J. 1972. Response of Plants to Environmental Stresses. Academic Press. New York.

McGinnies, W. G. 1968. Deserts of the World – An appraisal of Research into their Physical and Biological Environment. University of Arizona Press, Tucson.

McGinnies, W.G., Goldman, B.J. and Paylore, (Eds.) 1968. Deserts of the World. University of Arizona Press. Tucson.

Prakash, I. 2001. Ecology of Desert Environments. Scientific Publishers, Jodhpur.

Sen, D.N. 1978. Concepts of Indian Ecology. S. Nagin & Co. Jullundur.

Sen, D.N. 1982. Environment and Plant Life in Indian Desert. Geobios International, Jodhpur.

### **Course Title: Environmental Legislation**

#### **Course Code: FS-ENV-CC-203**

**Course Objectives:** To give the domain knowledge of various environmental laws and legislations governing within country and outside the country.

**Course Description:** The overall idea and necessity of various environmental laws, legislations, protocols, conventions, policy and rules are introduced with current scenario of the environment. It also focuses on the environmental friendly aspect of various environmental concerns and issues.

#### **Course Outcome:**

**CO1:** Develop insights into the role of environmental laws for planetary housekeeping, protecting the planet and its people from activities that upset the earth and its life sustaining capacities.

**CO2:** Enable to apply a range of regulatory instruments to preserve and protect the environment.

**CO3:** Demonstrate the strengths and weaknesses in law and its enforcement for developing strategies to overcome the same.

### Unit I

Overview of the ISO 14000 family, Key aspects of the International Standard ISO 14001. Environmental Management Systems: Benefits, Principles and elements of successful environmental management. Comparison between EMAS, BS77560 and ISO

14001. Auditing of EMS. Occupational Health and safety Management System (OHSMS), OHSAS 18001.

### Unit II

Provision in Constitution of India regarding Environment (Article 48A and 51G). Environmental (Protection) Act, 1986 and Rules 1986. Air (Prevention and Control of Pollution) Act, 1981 as amended by Amendment Act 1987 and Rule 1982. Water (Prevention and Control of Pollution) Act, 1974 as amended up to 1988 and Rules 1975. Wildlife (Protection) Act, 1972 amended 1991. Indian Forest Act (Revised) 1982. Biological Diversity Act, 2002.

### Unit III

Scheme of labelling of environmentally friendly products (Ecomark). Life Cycle Assessment. Ecological Footprinting. Public Liability Insurance Act, 1991 and Rules 1991. Bio-Medical Waste (Management and Handling) Rules- 1975; Hazardous Waste (Management and Handling) Rules- 1989. National Environmental Policy, NGT Act 2020.

#### Suggested Readings:

1. Environmental administration & law - Paras Diwaa.
2. Environmental planning, policies & programs in India - K.D. Saxena.

#### Course Title: Environmental Toxicology

#### Course Code: FS-ENV-CC-204

**Course Objectives:** The paper delegate toxic aspects of various environmental attributes and pampering for the impact and their solutions.

**Course Description:** It gives comprehensive ideas about various toxic chemicals in environment with respect to hazards particularly occupational and subjugated with assessment of their impact by using bio indicators and environmental quality determinant.

#### Course Outcome:

**CO1:** Lay foundation for in-depth understanding on the sources, origins and effects of various toxic materials and heavy metals that adversely affect environmental health.

**CO2:** Develop perspective on the movement of toxicants in different components of environment, in different levels of biological organization and in trophic transfer across the food chain.

**CO3:** Demonstrates the relationship between types of contaminants and effect on human health.

**CO 4:** Trains on the methods used to assess the ecotoxicological impact and human health issues due to increase in the levels of contaminants in environment.

### Unit I

Toxic Chemicals in the environment--Air, Water: Pesticides in water. Bio-chemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, O<sub>3</sub> and PAN Pesticides, Insecticides, MIC, carcinogens in the air.

### Unit II

Occupational Health: Definition, Occupational Health Hazards, Common hazards: Pneumoconiosis. SiliCOsis, AnthraCOsis, Byssinosis, Bagassosis, Asbestosis, Farmers's Lung, Lead poisoning, Occupational Cancer, Occupational Dermatitis, and Radiation Hazards. Measures for health protection of workers and Role of WHO in Occupational Health. Occupational Health in India.

### Unit III

History and scope of toxicology. Toxicology of aquatic and terrestrial environments. Acute and chronic toxicity. Toxicity testing in field and enclosure. Toxic dose: Approximate acute LD50 /LC50 of some representative chemical agents. The use of



biomarkers in assessing the impact of environmental contaminants. Bioassay. Trophic level transfer of contaminants. Bioindicators of environmental quality.

**Suggested Readings:**

1. Principles of Environmental Toxicology: I. C. Shaw and J. Chadwick; Taylor & Francis Ltd
2. Basic Environmental Health (2001): Annalee Yassi, Tord Kjellström, Theo de Kok, Tee Guidotti
3. Environmental Health: Monroe T. Morgan
4. Handbook of Environmental Health and Safety – principle and practices: H. Koren; Lewis Publishers
5. C.Lu.Frank and Kacew.Sam (2002). Lu.s Basic toxicology: Fundamentals, target organs and risk assessment; 4th edition. Taylor and Francis, London.
6. Tambrell, J. (2002). Introduction to Toxicology. Taylor and Francis, London.
7. Rana, S.V.S. (2011). Environmental Pollution: Health and Toxicology. Narosa Publishing House, New Delhi.

**Practical**

**FS-ENV-CC-205**

**Monitoring of Soil:** Measurement of Bulk density, Specific gravity, Moisture content, Conductivity, pH, Alkalinity, Soluble ions, Nitrogen, Phosphorus, Sulphur.

**Geographical data:**

1. Meteorological records – Pressure, Temperature, Precipitation, Humidity, wind.
2. Drainage basin and network morphometry
3. Slope and aspect maps, Critical slope for specified activities, Profiles.
4. Climatic maps and diagrams: circular graph, climograph, water budget, wind roses (simple and compound)
5. Application of GPS in various environmental applications.
6. Estimation of Biodiversity by using various diversity indices.

**Visit:**

Visit to a terrestrial or aquatic location of ecological importance.

**M.Sc. Third Semester**

FS-ENV-CC-301  
FS-ENV-CC -302

Environmental Technology  
Environmental Impact Assessment-I  
FS-ENV-CE -303 (a) Population and Community  
OR

FS-ENV-CE -303

FS-ENV-CE -303 (b) Biomes and Biogeography  
FS-ENV-EO -304 (a) Climate Change  
OR

FS-ENV-EO -304

FS-ENV-EO -304 (b) Disaster Management

FS-ENV-CP -305

Practical

**Course Title: Environmental Technology**

**Course Code: FS-ENV-CC-301**

**Course Objectives:** To get acquaintance with monitoring aspects of all environmental attributes using environmental technology for qualitative and quantitative assessment.

**Course Description:** It describe the monitoring aspects of Air water, soil by using modern tool techniques for safeguard of environment.

**Course Outcome:**

**CO1:** Develop evolutionary perspective on the relationship between and evolution of technology and environment.

**CO2:** Develop in-depth understanding on the role and contribution of different types of economic and social mechanism in the contemporary societies shaping the structure and function environment.

**CO3:** Demonstrate the technological changes in the direction of sustainable development, which will help to achieve ecological and social justice.

### Unit I

Scope, Purpose and Objectives of Air Quality Monitoring Programme; Guidelines and Design of an air quality surveillance network; Period, frequency and duration of sampling; Principles and instruments for sampling and measurement of -(i) ambient air pollutants, and (ii) stack emissions (monitoring).

Dispersion of Pollutants: maximum mixing depth, lapse rate, stability conciliations, plume behaviour, calculation of effective stack height.

### Unit II

General methods of control of Gaseous pollutants-scrubbers, condensers, control equipment for particulate matter-gravity settling chambers, cyclone, fabric filters, electrostatic precipitators, case study of thermal power plants. Control of Mobile Source Emissions. Automobile Exhausts.

### Unit III

Water Pollution Control: Drinking Water Treatment Procedures, Flocculation, Settling, Filtration, reverse sand filter, cleaning, chlorination.

Methods of Cleaning Potable Water: Filtration, Electro-dialysis, principle & theory of chemical oxidation. Disinfection mechanism: Ozone, permanganate, chlorination. Reverse osmosis. Ultra filtration. Water quality standards.

Environmental Biotechnology: Fermentation, Vermiculture, Biogas, Biofertilizer, Bioremediation technologies.

#### Suggested Readings:

1. Air Pollution – Stern
2. Environmental Pollution Control Engineering: C. S. Rao
3. Environmental Chemistry: B.K. Sharma, and H. Kaur
4. Air pollution – threat and response: D. A. Lynn
5. Air pollution and Environmental Protection – Legislative policies, Judicial trend and Social perceptions: N. Kumar; Mittal Publication

#### Course Title: Environmental Impact Assessment-I

#### Course Code: FS-ENV-CC-302

**Course Objectives:** To build understanding and application aspects of environmental impact assessment as a tool.

**Course Description:** It gives analytical aspects of environmental impact due to various developmental activities using environmental appraisal, environmental auditing, planning with help of various methodologies to achieve sustainable development.

#### Course Outcome:

**CO1:** Lay foundation on the concept and components of environmental impact assessment.

**CO2:** Enable to practice EIA that examines the environmental consequences of development actions, in advance.

**CO3:** Investigate the agenda of all environmental agencies as a result of introduction of legislations in various countries.

**CO 4:** Develop skill to evaluate the issues and problems in environmental assessment from the perspective of process and methods, and goals of EIA.

### Unit I

Introduction to environmental impact analysis. Environmental impact Statement and Environmental Management Plan. EIA guidelines 2006, Notifications of Government of India. Impact Assessment Methodologies, their strengths and weaknesses. Generalized approach to impact analysis. Procedure for reviewing Environmental impact analysis and statement.

### Unit II

Guidelines and basic principles of Environmental auditing -Definition, functions, benefits and COsts of Environmental Auditing. Introduction to Environmental planning. Base line information and predictions (land, water, atmosphere, energy, etc.). Landuse policy for India. Urban planning for India. Rural planning and landuse pattern. Concept and strategies of sustainable development. COst-Benefit analysis. Environmental Appraisal Accounting, Green Balance Sheet-SJA.

### Unit III

Environmental Appraisal with particular reference to:

1. Mining Projects
2. Industrial Projects
3. Thermal Power Projects
4. River Valley, Multipurpose, Irrigation and H.E. Projects
5. Infrastructure Development and Miscellaneous Projects
6. Nuclear Power Projects

#### Course Outcomes (COs)

#### Suggested Readings:

1. Environmental Impact Assessment- John Glasson.
2. Methods of Environmental Impact Assessment - Morris and the rivel.
3. Environmental Imapct Assessment - L. W. Canter.
4. Chemical principles of Environmental pollution - Lalloway and Ayers.
5. Industrial Environment - Assessment and strategy - S.K. Aggarwal
6. Kulkarni, V.S., Kaul, S.N. and Trivedi, R.K. (2002). A Handbook of Environmental Impact Assessment. Scientific Publishers, India.

#### Course Title: Population and Community Ecology

#### Course Code: FS-ENV-CE -303 (a)

**Course Objectives:** It strives on dynamic aspects and approaches of population and community ecology.

**Course Description:** An approach has been made to conceptualize population dynamics, community dynamics and various ecological processes or life support system for the restoration of ecology with idea of stability and fragility.

#### Course Outcome:

**CO1:** Lay Explain Intraspecific and Interspecific interactions.

**CO2:** Explain the application of stage and age structured population dynamics.

**CO3:** Apply the riche concept and evaluate the importance of species composition and diversity for population and community dynamics.

**CO4:** Explain the importance of spatial scale for interactions within and between populations.

**CO5:** Assess the importance of interactions in food webs for the development of populations and communities.

**CO6:** Develop a comprehensive historical perspective on the interactions between human societies in relationship to eCOsystems in ancient to modern societies.

**CO7:** Gain knowledge on the present day environmental dilemmas, and the conflicts and choices that have their roots in the past.

**CO8:** Examine the ways in which environmental changes, often the result of humans actions, have caused historical trends in human societies.

### Unit I

Concepts and Scope Environmental Biology. Impact of environment at cellular level. Eco-physiological adaptations in plants and animals for stressed environments. Biosphere as an eCOsystem, its ecological processes and life support systems. Anthropogenic impact on the biosphere and its life support systems (including flora, fauna, soil, climate, atmosphere, terrestrial and aquatic eCOsystems). Role of biological processes in remedial measures and restoration.

### Unit II

**Population Ecology:** Factors determining population. Factors leading to the commonness, rarity and vulnerability of extinction of a species. Population Dynamics: Patterns of survival, age distribution, dispersal and rates of change. Attributes of K-selected and r-selected species. Population Growth. Common approaches in population density measurement.

### Unit III

**Community Ecology:** Concept and types of communities. Interspecific and intraspecific interactions. Concepts of niche and keystone species. Role of nutrients, water and energy in determining community. Succession, development, climax and stability of eCOsystems.

#### Suggested Readings:

- Brown, J.H. and Lomolino, M.V (1998). Biogeography. Sinauer Associates Inc., Sunderland, Massachusetts.
2. Cox, C. B. and Moore, P.D. (2000). Biogeography – An Ecological and Evolutionary Approach. Blackwell Scientific Ltd. pp. 298. London.
3. Fahrig, L., and K. Freemark. (1994). Landscape-scale effects of toxic events for ecological risk assessment. In J. Cairns and B.R. Niederlehner (eds.), Ecological Toxicity Testing, Scale, Complexity, and Relevance. Lewis Publishers, Boca Raton, FL.
4. Weinstein, D.A., and H.H. Shugart. (1983). Ecological modeling of landscape dynamics. In H.A. Mooney and M. Godron (eds.), Disturbance and ECOsystems. Springer-Verlag, New York.

### Course Title: Biomes and Biogeography

#### Course Code: FS-ENV-CE -303 (b)

**Course Objectives:** To determine the importance of biomes as an extensive ecosystem within country and outside.

**Course Description:** The emphasize given on terrestrial, aquatic biomes with their climatic classification challenges, human influences, composition, characteristics and extend in India and other region of the world.

#### Course Outcome:

**CO1:** Explain Biome concept.

**CO2:** Explain Biogeography.

**CO3:** Developing link between eCOsystem functionality & Biogeography.

**CO 4:** Understanding on drivers of vegetation patterns at large spatial scales based on biogeographical zones.

### Unit I

#### Biomes:

Climatic and edaphic factors of terrestrial biomes. Heinrich Walter's Biome Climate Diagrams.

Classification of land biomes with their soil, climate and vegetation characteristics. Their natural history, wildlife, geography and human influences.

Mountain Biome: Replication of latitudinal changes in the altitudes of high mountains.

Terrestrial biomes, eCOsystem diversity, forest and vegetation types in India.

### Unit II

Freshwater and Marine biomes:

Challenges and adaptations of life in aquatic biomes (freshwater: lentic and lotic; marine).

Freshwater Biomes (Rivers, streams, lakes, ponds) and their natural history.

Marine Biomes (including mangroves, coral islands, kelp forests, saltwater marshes, seashores, estuaries) and their natural history.

Estuaries, their characteristics and biota.

Wetlands- definitions, types, ecological functions and resources.

### Unit III

#### **Biogeography: India & World:**

Major biogeographic (zoogeographic and phytogeographic) regions of the world and India, extent, characteristics and species composition.

Continental Drift: Its causes and consequences for distribution of life on earth.

India's biogeographical history, current geographical position and their impact on biodiversity.

India's forests and vegetation types. Protected Area Network.

#### **Suggested Readings:**

Brown, J.H. and Lomolino, M.V (1998). Biogeography. Sinauer Associates Inc., Sunderland, Massachusetts.

2. Cox, C. B. and Moore, P.D. (2000). Biogeography – An Ecological and Evolutionary Approach. Blackwell Scientific Ltd. pp. 298. London.

3. Fahrig, L., and K. Freemark. (1994). Landscape-scale effects of toxic events for ecological risk assessment. In J. Cairns and B.R. Niederlehner (eds.), Ecological Toxicity Testing, Scale, Complexity, and Relevance. Lewis Publishers, Boca Raton, FL.

4. Weinstein, D.A., and H.H. Shugart. (1983). Ecological modeling of landscape dynamics. In H.A. Mooney and M. Godron (eds.), Disturbance and ECOSystems. Springer-Verlag, New York.

#### **Course Title: Climate Science**

#### **Course Code: FS-ENV-EO -304 (a)**

**Course Objectives:** To conceptualize the idea of climate or climate change at the pace of different time scale.

**Course Description:** Narration about the concept of climate change with respect to monitoring, anthropogenic drivers and policy framework. It also emphasize on various models of climate and resilience about climate.

#### **Course Outcome:**

**CO1:** Understand & explain the physical basis of the natural greenhouse effect and global climate change.

**CO2:** Explain the role of greenhouse gases in Earth's energy budget & climate system.

**CO3:** Describe the strengths & weakness of existing climate related policies.

**CO4:** Understand climate change mitigation & adaption practices.

### Unit I

Introduction to Climate Change Science: Climate, Weather, Earth's Climate System. Greenhouse Effect. Greenhouse gases and their main sources. Monitoring of Climate, Climate archives, climate data and models. Climate change on different timescales over the past.

### Unit II

Modern Climate change since industrial revolution: Anthropogenic Drivers of Climate Change. Observed Trends and Projected Trends of Climate change. Role of aerosols, black carbon and hydrocarbons in climate change. Impacts of Climate Change: food

security, energy security, water security, human health and diseases, climate resilient agriculture, climate refugees.

### Unit III

The Climate Change Policy Framework: Provisions of the United Nations Framework Convention on Climate Change (UNFCCC). The Kyoto Protocol. Climate Change Adaptation. National Action Plan on Climate Change, Climate Change Mitigation and Low Carbon Development: Strategic Frameworks and Policy Approaches. Climate Change Finance. Carbon sequestration and carbon credits.

#### **Suggested Readings:**

Brohe, Arnaud, Nick Eyre, and Nicholas Howarth. 2009. Carbon Markets: An International Business Guide (Environmental Market Insights). Routledge.

Labatt, Sonia, and Robert R. White. 2007. Carbon Finance: The Financial Implications of Climate Change (Wiley Finance). Wiley Finance.

Esty, Daniel C., and Andrew Winston. 2009. Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage. Wiley.

Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.

Burroughs, W.J. Climate Change: A Multidisciplinary Approach. 2nd ed. Cambridge University Press. 2007.

Chasek, P. S. The Global Environment in the Twenty-First Century - Prospects for International Co-operation. Indian Reprint by Manas Publications, New Delhi. 2004.

Claussen, E. ed. Climate Change: Scenario, Strategies and Solutions. Arlington VA. 2001.

Dash, S. K. Climate Change-An Indian Perspective. Centre for Environment Education and Cambridge University Press Pvt. Ltd., New Delhi. 2007.

Dodds, F. (ed.). Earth Summit. 2002. A New Deal. Earthscan Publications Ltd., UK. 2002.

Enger, E.D. and Smith, B. F. Environmental Science: A Study of Interrelationships. 11th ed. McGraw Hill Inc., USA. 2006.

Hardy, John T. Climate Change: Causes, Effects, Solutions. Wiley & Sons, USA. 2003.

Harris, F. Global Environmental Issues. Wiley & Sons, Inc., USA. 2004.

Harvey L. D. D. Global Warming: The Hard Science. NY: Prentice-Hall.2000.

Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.

Speth, J. C. Global Environmental Challenges – Transitions to a Sustainable World. Orient Longman Pvt. Ltd., New Delhi. 2004.

UNEP. Global Environmental Outlook 3: Past, Present and Future. Earthscan Publications. 2002.

#### **Course Title: Disaster Management**

#### **Course Code: FS-ENV-EO -304 (b)**

**Course Objectives:** Gives insight into various environmental hazards, risks and disaster in India and world scenario.

**Course Description:** Provides domain knowledge of natural hazards, vulnerability, and disasters with using reduction strategies, early warning system and management strategies in light of disaster management act, 2005.

#### **Course Outcome:**

**CO1:** Gain insights into various environmental hazards, their causes, nature preparedness and assessment of loss.

**CO2:** Empower to develop model hazards and learn methods of disaster management.

**CO3:** Trains on preparation of hazard zonation map of India for landslides, earthquakes, floods; methods to estimate earthquake-loss using remote sensing and GIS, and prepare master plan for any environmental hazard mitigation.

#### **Unit I**

Concepts of Hazard, Vulnerability, Risks, Natural Disasters (earthquake, Cyclone, Floods, Volcanoes), and Man Made Disaster ( Armed conflicts and civil strip, Technological disasters, Human Settlement, Slow Disasters (famine, drought, epidemics) and Rapid Onset Disasters (Air Crash, tidal waves, Tsunami) Risks, Difference between Accidents and Disasters, Simple and Complex Disasters.

#### **Unit II**

Disaster Cycle, Phases of Disaster. Disaster Risk Reduction Strategies, Early warning Systems.

Components of Disaster Relief-(Water, food, sanitation, shelter, Health and Waste Management). Principles of Disaster Epidemiology, Environment health hygiene and sanitation issues during disasters. United Nation International Strategy for Disaster Risk Reduction (UNISDR).

#### **Unit III**

India's Hazard and Vulnerability Profile, Disaster Management Indian scenario. Disaster Management Act 2005 and Policy guidelines. Cases Studies: Bhopal Gas Disaster, Gujarat Earth Quake, Orissa Super-cyclone, south India Tsunami, Bihar floods. Best practices in disaster management, Case Studies of drought in Rajasthan, India and World.

#### **Suggested Readings:**

Disaster Reduction: Living in harmony with nature Kurowa, Julio

Human Development Report 2005: Internation co-operation at a cross roads: Aid, trade and security in an unequal world Watkins, K

Know risk Jeggle, Terry

World disaster report: Focus on information in disasters Jonathan, Walter

Advances in natural technological hazards research: International perspectives on natural disasters Occurrences, mitigation and consequences De Chano LM, Lidstone J & Stoltman Joseph M

#### **Practical**

**Course Code: FS-ENV-CP -305**

#### **Geoinformatics:**

1. Introduction of the GIS software.
2. Georeferencing
3. Base layer preparation / Digitization
4. Preparation of Geodatabase.
5. Mosaicing.
6. Classification of Satellite Image.

#### **Solid Waste Analysis**

1. Physical composition (by weight)
2. Moisture content
4. pH and Conductivity

#### **Environmental Statistics**

1. Grouping of data and preparation of frequency distribution. Histogram and frequency polygon.
2. Calculating mean, median and mode for grouped and ungrouped data.
3. Calculating variance, standard deviation and coefficient of variation for grouped and ungrouped data.
4. Fitting simple linear regression. Plotting scatter diagram and regression line.

5. Computing correlation coefficient and testing its significance for grouped and ungrouped data.
6. Comparison between means of two independent samples. Paired t-test.
7. Analysis of variance one way classification.
8. Analysis of variance: two-way classification.

### **M.Sc. Fourth Semester**

|               |   |
|---------------|---|
| FS-ENV-CC-401 | Natural Resources and Management  |
| FS-ENV-CE-402 | FS-ENV-CE-402 (a) Environmental Impact Assessment-II<br>OR<br>FS-ENV-CE-402 (b) Biodiversity and Conservation   |
| FS-ENV-EO-403 | FS-ENV-EO-403 (a) Environmental Issues, Awareness and<br>Monitoring<br>OR<br>FS-ENV-EO-403 (b) Waste Management |
| FS-ENV-CC-404 | Dissertation  |
| FS-ENV-CP-405 | Practical   |

#### **Course Title: Natural Resources and Management**

#### **Course Code: FS-ENV-CC-401**

**Course Objectives:** Develop thinking about use of remote sensing in various environmental applications.

**Course Description:** It contemplates various aspects of remote sensing in environmental planning and also deliver about various energy use scenario in India concerned with the harness and feasibility

**Course Outcome:**

**CO1:** Demonstrate the human dimension of development and environment.

**CO2:** Gain insight on management of natural resources.

**CO3:** Train in tools and methodologies of ecological and environmental economics.

**CO4:** Empower with the integrated use of economics & ecology in decision making & law making process.

**CO5:** Acquire ideas and tools developed in other branches of economics to make significant contribution to valuation techniques, design of policy instruments for pollution control and management of commons.

**CO6:** Enables to use the COst-benefit analysis and instruments for pollution control and management of commons.

**CO7:** Analyze contemporary conflicts, struggles and policy choices around natural resources.

**CO8:** Develop critical thinking on who controls the environment and how, and who degrades nature and why.

**CO9:** Develop perspective on major approaches towards natural resource issues and enable to think creatively about conflict and concord in general, with special emphasis on the roles of ideas and institutions in environmental politics.

**CO10:** Learn skills to analyze case studies on big dams and endangered fauna, industrial pollution and global warming, the role of gender and empire.

#### **Unit I**

Principles of Remote sensing and their application in Environmental Sciences. Application of GIS in Environmental Management. Landuse Planning: The landuse plan. Soil surveys in relation to landuse planning. Methods of site selection and evaluation.

#### **Unit II**

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. Principles of generation of hydroelectric power, tidal, Ocean Thermal Energy Conversion, wind, geothermal energy; solar collectors, photovoltaic, solar ponds; nuclear energy- fission and fusion; magnetohydrodynamic power, bio-energy-energy from biomass and biogas, anaerobic digestion; energy use pattern in different parts of the world.

### Unit III

Water Resources and Environment: Global Water Balance. Ice sheets and fluctuations of sea levels. Types of water. Origin and composition of seawater. Hydrological cycle. Factors influencing the surface water. Resources of oceans.

Mineral Resources and Environment: Resources and Reserves. Minerals and Population. Oceans as new areas for exploration of mineral resources. Environmental impact of exploitation, processing and smelting of minerals.

#### **Suggested Readings:**

Living in the environmental - T.J. Miller.

Natural resource conservation - Owen & Chiras.

Encyclopaedia Energy - I & II.

Natural resources conservation -Oliver Ss. Owen.

Ecology of Natural resources – Ramade

Environmental Science- Cunningham Saigo

Restoration of degraded lands- J.S. Singh

Introduction to Environmental remote sensing – Curtis

Principles of Remote sensing - Lily and Kliffer.

Remote sensing of the Environment – Jenson

### **Course Title: Environmental Impact Assessment-II**

#### **Course Code: FS-ENV-CE-402 (a)**

**Course Objectives:** Develop professional understanding of EIA formulation.

**Course Description:** Contents gives idea about how to develop or prepare comprehensive EIA/SEIA report as a part of decision making and also address about procedure, process and implementation of EIA.

#### **Course Outcome:**

**CO1:** Lay foundation on the concept and components of environmental impact assessment.

**CO2:** Enable to practice EIA that examines the environmental consequences of development actions, in advance.

**CO3:** Investigate the agenda of all environmental agencies as a result of introduction of legislations in various countries.

**CO 4:** Develop skill to evaluate the issues and problems in environmental assessment from the perspective of process and methods, and goals of EIA.

### Unit I

Reporting: - Features & purpose of EIA Reports, Main elements of EIA Report, Shortcoming encountered in preparing EIA reports. Review of EIA Quality:- Role & purpose of the Review process, Aspects for consideration, EIA Review- Types of Procedures, Steps involved in EIA Review, EIA review criteria, EIA review methods, Four steps approaches for EIA review. Environmental Management plan Or Impact management Plan.

### Unit II

Decision Making: - concepts and its importance, responsibilities f decision makers in EIA process, Decision Making Process. Implementation & Follow up:- Need & purpose, Its components, Guiding Principles and elements, Aspects and Issues needs to be considered in EIA implementation & follow up.

### Unit III

EIA Project Management: - its concepts, Role of Project Manager, Characteristics & Attributes of an interdisciplinary of EIA team, Project Managers Responsibilities. Social Impact Assessment:- concept, role & purpose of SIA, Benefits of SIA, Steps & principles of SIA, Methods used for predicting Social Impacts.

#### Suggested Readings:

Canter, Larry W. Environment Impact Assessment. McGraw-Hill.

Rau, G.J. and C.D. Weeten. 1980. Environmental Impact Analysis Handbook. McGraw Hill.

Glasson, John, Rikki Therievel and Andrew Chadwic. 1996. Introduction to Environmental Impact Assessment, 2nd edition UCL Press.

Kulkarni, Vijay and T.V. Ramchandra. Date Environmental Management. Capital Publishing.

Mhaskar, A.K. Environmental Audits. Enviro Media Publications. Eccleston, Charles H. 2011. Environmental Impact Assessment: A Guide to Best Professional Practices. CRC Press.

Morris, Peter and Riki Therivel. 2009. Methods of Environmental Impact Assessment (Natural and Built Environment Series). Routledge.

#### Course Title: Biodiversity and Conservation

#### Course Code: FS-ENV-CE-402 (b)

**Course Objectives:** To address about critical aspects of biodiversity as cradle for civilization.

**Course Description:** Overall idea has been given about biodiversity with respect to their classification, importance, threats and conservation strategies.

#### Course Outcome:

**CO1:** Demonstration importance of diversity at different levels of biological organization.

**CO2:** Lay foundation on basis concept of ecological and biological processes that ensures long-term stability of ecosystems.

**CO3:** Train on the methods for measurement of species diversity and molecular diversity.

**CO 4:** Analyze the values of biodiversity and scientific approaches for conservation that can lead to sustainable development.

### Unit I

Definition, classification and importance of Biodiversity; Causes of biodiversity reduction and strategies for biodiversity conservation. Endangered and Threatened Species (Flora and fauna) of India and Rajasthan, Hotspots of Biodiversity. Strategies of biodiversity conservation in India and the world (in situ and ex situ).

1. Magnitude and distribution of Biodiversity (global and Indian) and its characterization.
2. Rapid assessment of biodiversity and its valuation, skill, trained personnel and resources needed for the task.
3. Evaluating nature, scale and intensity of the threats to biodiversity.

### Unit II

1. Role of plants in natural eCOsystems and life support system (terrestrial, freshwater and marine)
2. Importance of traditional cultivars and wild species in agriculture.
3. Role of plants in modern and traditional medicine.
4. Value of plants in scientific research and technological inventions.
5. Value of microbes in medicinal, scientific and technological research solutions and inventions.

6. Vegetation zones of India and Rajasthan.

### Unit III

1. Role of animals in conservation of natural eCOsystems.
2. Role of wild and domesticated fauna in human nutrition.
3. Importance of animal species (terrestrial and marine) in medicine.
4. Important wild animals of India and their distribution, Sanctuaries and National parks, Red data book. Gene pool.
5. Ecotourism in wilderness and protected area network.

#### Suggested Readings:

Global Biodiversity - W.R. L. IUCN  
 Ecology of natural resource - Ramade  
 Ecology - P.D. Sharma  
 Conservation Ecology- G.W.Cox.

#### Course Title: Environmental Issues, Awareness and Monitoring

#### Course Code: FS-ENV-EO-403 (a)

**Course Objectives:** It strives on contemporary environmental issues within or outside the country by disseminating knowledge at local level.

**Course Description:** It sensitize and provides the overall knowledge of environmental problems as contemporary issues and promulgated for public participation, as these issues are generalized with environmental policies in India or International Level.

#### Course Outcome:

**CO1:** Gain insights into the politics of environmental issues at the national and international levels.

**CO2:** Debate on environmental policies and regulations and environmental movements in India.

**CO3:** Empowers with the methods of communication to the masses and consumers for environmental issues.

**CO4:** Develop global perspective on the scenario of environmental education and communication at the national and international levels.

**CO5:** Lay foundation of environmental communication, education and interpretations to achieve the goal of sustainable development, protection of environment, and conservation of biodiversity and eCOsystem.

**CO6:** Develop perspective on important environmental issues that have become a matter of global policy making, international negotiations and trade disputes.

**CO7:** Develop critical thinking on the links between environment, property regimes, trade and information economics.

### Unit I

Environmental Issues: Environmental Ethics and Global imperatives.

Global Environmental problems: Ozone depletion, global warming and climatic change, Greenhouse gases, Acid rains, Oil spills, Rain water harvesting and Groundwater recharge. Eutrophication and restoration of lakes. Wetlands conservation.

Nuclear fallout, Nuclear and radiation accidents, Nuclear safety, Electronic waste. Intensive farming, Overgrazing, Soil conservation, Soil erosion, Soil salination,

### Unit II

Current Environmental issue in Indian Context: Narmada Dam, Tehri Dam, Almetti Dam, Soil Erosion. Formation and reclamation of Usar, Alkaline and Saline Soil. Waste lands and their reclamation, Floods and Drought.

Environmental priorities in India and sustainable development. Environmental education and awareness, role of governmental and non-governmental

organizations. Environmental issues with war, Genetically modified food controversies, Overpopulation, Gender Imbalance. Epidemiological issues (e.g., Goitre, Fluorosis, Arsenic),

### Unit III

Environmental Conservation Practices: Traditional Practices, Modern Practices. Environmental Monitoring: Air, Water, Soil, Monitoring of Natural Resources and Biodiversity.

Introduction of Geographical Information System (GIS): Definition, Components of GIS and Application of GIS in various fields

#### Suggested Readings:

Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.

Cunningham, W. P. and Cunningham, M. A. Principles of Environment Science. Enquiry and Applications. 2nd ed. Tata McGraw Hill, New Delhi. 2004.

Rajagopalan, R. Environmental Studies: From crisis to cure, Oxford University Press, New Delhi, 2008.

Richards, I. S. Principles and Practice of Toxicology in Public Health. Jones and Bartlett Publishers, London. 2008.

Singh, J.S., Singh, S.P. and Gupta, S.R. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi, India. 2006.

UNEP. Global Environment Outlook 3. Geneva: UNEP, Global Resource Information Division. 2003.

World Commission on Environment and Development (WCED): Our Common Future, Oxford University Press, London. 1987.

### Course Title: Waste Management

#### Course Code: FS-ENV-EO-403 (b)

**Course Objectives:** How the waste can be managed to conceptualize the theme of silver from sewage and gold from garbage.

**Course Description:** The contents strive on various types of waste in consonance of their classification, composition and characteristics. It also emphasizes on storage, collection, transport and disposal aspects of waste as implied by various management strategies.

#### Course Outcome:

**CO1:** Describe the components of solid waste management.

**CO2:** Explain solid waste collection systems, waste transportation & processing techniques.

**CO3:** Examine the waste treatment technologies.

#### Unit-I

Generation and characteristics of waste: Sources, types, composition, quantity, sampling and characteristics of waste, factors affecting generation of solid wastes. Proximate and ultimate analysis of solid wastes.

#### Unit-II

Waste collection, storage and transport: Methods of municipal solid waste collection, On site storage methods, transfer station and transportation methods, Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste

### Unit-III

Industrial waste, Hazardous waste, Electronic waste, Biomedical waste- characteristics, treatment and disposal. Plastic waste disposal, Fly ash: Sources, composition & utilization. Municipal solid waste in Indian conditions.

#### Suggested Readings:

1. Solid Waste Management CPCB. New Delhi.
2. Ecotechnology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr.
3. Basic Environmental Technology - J.A. Nathanson

#### Course Title: Dissertation

#### Course Code: FS-ENV-CC-404

**Course Objectives:** To access the analytical capacity of the student by using investigation on various environmental problems around the vicinity.

**Course Description:** A case study pertaining to environmental problem or EIA based studies exercised by individual students to find out the result of their research area and having systematic presentation of their findings.

#### Course Outcome:

**CO1:** Plan and engage in an independent investigation of a chosen research topic relevant to environment and society.

**CO2:** Systematically identify relevant concepts, methodologies, techniques and conclusions..

**CO3:** Able to do critical review.

**CO 4:** Communicate research concepts & contexts effectively both orally and in writing. The student will select a topic of research in consultation with his/her supervisor/guide to do a research work or carry out a case study on any topic related to environmental sciences.

The student shall prepare a report of his/her work carried out. The external examiner will evaluate the work carried out and shall award the marks accordingly.

#### Suggested Readings:

Work on the Dissertation topic initiated in Semester III with seminar presentation is to be completed with report submission by the end of semester IV.

1. Burchi, M. and B. Trench, editors. 2008. Handbook of Public Communication of Science and Technology. Routledge.
2. Bella Mody 2001 Designing Messages for Development Communication –An Audience participation-based approach. SAGE Publications.
3. Robert, A.D. and G. Barbara. 2006. How to Write and Publish a Scientific Paper, 6th Edition. Cambridge University Press.
4. Soraya, M.C. and A.S. Cynthia. 2001. Proposal Writing. Sage Publications.
5. Gregory, J. and S. Miller. 1998. Science in Public: Communication, Culture and Credibility. Plenum.
6. Holliman, R., et al., editors. 2009. Investigating Science Communication in the Information Age: Implications for Public Engagement and Popular Media. Oxford University Press.
7. Nelkin, D. 1995. Selling Science: How the Press Covers Science & Technology, 2nd Edition. WH Freeman.
8. Hoffmann, Angelika H. 2009. Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford.
9. Field, Anthony. 2003. How to Design and Report Experiments. Sage Publications.
10. Glass, David. 2006. Experimental Design for Biologists. Cold Spring Harbor Laboratory Press.

11. Underwood, A.J. 1997. Experiments in Ecology: Their Logical Design and Interpretation Using Analysis of Variance. Cambridge.

### **Practical**

**Course Code: FS-ENV-CP-405**

#### **Environmental Monitoring**

1. Determination of particle size using respirable dust sampler.
2. Determination of PM 2.5 using fine particle sampler.
3. Respirable Suspended Particulate Matter (RSPM) by Respirable suspended particulate matter sampler (RDS APM 460)
4. Dust retaining capacity of plants.
5. Measurement of noise.
6. Estimation of BOD
7. Estimation of COD
8. Estimation of Chlorophyll
9. Estimation of Total, organic and inorganic carbon
10. GPS – Application in field
11. Estimation of Biodiversity
12. Site visit to degraded landscapes/habitats- terrestrial and aquatic.
13. Visit to restored/ managed habitats & study of their practices.
14. Field use of contour Marker for alignment of contour lines on the ground.
15. Visit to watershed area, to study different characteristics of watershed preferably in rainy season.

#### **Advanced Instrumental Techniques:**

1. Flame photometry
2. UV-Visible Spectrophotometry
3. Atomic Absorption Spectrophotometry

**Case Study:** Related to Pollution Monitoring, Treatment and Control; Environmental Impact Assessment; Resource recycling and reclamation; Biodiversity and its conservation.

#### **Teaching Learning Process & Blended Learning**

- Lectures, Discussions, Simulations, Role Playing, Participative Learning, Interactive, Sessions, Seminars, Research-based Learning/Dissertation or Project Work, Technology-embedded Learning.
- Herbarium preparation, field research report, Participation in seminars/conferences, celebration of events related to environment, Script/play on environmental issues, social responsibility and community participation.

#### **Assessment and Evaluation**

- Continuous Comprehensive Evaluation will be adopted to find out each course-level learning outcome i.e. Assignment, Test, Quiz, Seminars.
- Formative Assessment on the basis of the activities of a learner throughout the program instead of one-time assessment.
- Individual Assignments i.e. Case Study, Practical Record, Dissertation.
- Seminar Presentation, Field/Excursion report writing

#### **(A) Theory Courses – 50 Marks**

##### **I. Internal Assessment – 10 Marks**

- (a) Test – 04 Marks
- (b) Term paper – 04 Marks
- (c) Overall performance – 02 Marks

##### **II. External Assessment – 40 Marks**

**(B) Practical Courses – 100 Marks****Distribution of Credit**

| Semester | I  | II | III | IV | Total |
|----------|----|----|-----|----|-------|
| Credit   | 25 | 25 | 25  | 25 | 100   |

| Academic Year       | Semester   | Core Compulsory | Core Elective | Open Elective | Foundation |
|---------------------|------------|-----------------|---------------|---------------|------------|
| Credit Distribution | I and II   | 80%             | -             | -             | 20%        |
|                     | III and IV | 40%             | 40%           | 20%           | -          |

1 Credit = 10 Marks

**Evaluation (Calculation of Score)**

Credits & Marks (Theory)

Course Credit = 5

Total Marks = 50

Credits & Marks (Practical)

Course Credit = 10

Total Marks = 100

**Grading**

| Grade Points | Description   | % of Marks | Division | Grade |
|--------------|---------------|------------|----------|-------|
| 10           | Outstanding   | 90-100     | First    | O     |
| 9            | Excellent     | 80-89      | First    | A+    |
| 8            | Very Good     | 70-79      | First    | A     |
| 7            | Good          | 60-69      | First    | B+    |
| 6            | Above Average | 50-59      | Second   | B     |
| 5            | Average       | 40-49      | Third    | C     |
| 4            | Pass          | 36-39      | Pass     | P     |
| 0            | Fail          | Below 36   | Fail     | F     |
| 0            | Absent        | -          | -        | Ab    |

**Performance Evaluation (Calculation)**

(i) Semester Grade Point Average (SGPA)

$$SGPA (S_i) = \frac{\sum (C_i \times G_i)}{\sum C_i}$$

Where  $G_i$  = Grade

$C_i$  = Credit of Course

(ii) Cumulative Grade Point Average (CGPA)

CGPA = Sum of Credits X SGPA of Entire Program/ Sum of Credits up to the end of program

(iii) Conversion of CGPA into Percentage

Percentage % = 9.5 X CGPA (Adopted from CBSE pattern where 9.5 means that percentage should not greater than 95%)

OR

\* Conversion of CGPA into Percentage is subject matter of examinations section of the university.