SWAMI VIVEKANAND SUBHARTI UNIVERSITY
UGC Approved Meerut
NAAC A
AN ISO 21001: 2018 ORGANIZATION

OFFICE OF THE REGISTRAR
Gp Capt M Yakoob
M-in-D (Retd.), M.Tech.
REGISTRAR
registrar@subharti.org

Ref.No.U-508(i)/SVSU/2025/1578 Date:25.01.2025

## NOTIFICATION

It is hereby notified for information of all the concerned that the Academic Council in its 34th meeting held on 25-07-2024 vide resolution No.34(7) has approved the ordinance relating to course curriculum & syllabus of degree of Four Year Degree Program (FYDP) of the following:

**Ordinance No.V-126 (B16)**, relating to B.Sc.-Environmental Science

The copies of all above are enclosed and shall be applicable from Academic Session 2024-25 onwards.

This issues with the approval of the Hon'ble Vice Chancellor.

25.01.2025
**Registrar**

Ref.No.U-508(i)/SVSU/2025/1578 Date: 25.01.2025

Copy forwarded to information of:

1. Hon'ble Vice-Chancellor
2. Controller of Examination
3. Dean-Academics
4. Director-IQAC
5. Dean-Faculty of Science (for compliance please)
6. CTO (with a request to upload the ordinance on University website)
7. Additional Registrar-Academics
8. Guard File

25.01.2025
**Registrar**

**SWAMI VIVEKANAND SUBHARTI UNIVERSITY**

**MEERUT**

# Keral Verma Subharti College of Science

# Ordinance Number V 126 B-16

## Bachelor of Science in Environmental Science

| All UG Courses offered by Department of Botany, KVSCOS (Session 2025-26 onwards) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sem | I | II | III | IV | V | VI | VII | VIII | Total |
| Credit | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 160 |
| Marks | 700 | 700 | 700 | 600 | 600 | 600 | 600 | 300 | 4800 |

**SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT**

**KERAL VERMA SUBHARTI COLLEGE OF SCIENCE**

**Department of Botany,**

**All UG Courses offered by Department of Environmental Science (Botany) (Session 2025-26 onwards)**

| | | I | II | III | IV | V | VI | VII | VIII | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Major | 6 | 6 | 9 | 15 | 10 | 14 | 16 | 4 | 80 |
| 2 | Minor | 3 | 3 | 3 | 3 | 6 | 6 | 4 | 4 | 32 |
| 3 | Multi Disciplinary | 3 | 3 | 3 | | | | | | 9 |
| 4 | Ability Enhancement Course | 2 | 2 | 2 | 2 | | | | | 8 |
| 5 | Skill Enhancement Course | 3 | 3 | 3 | | | | | | 9 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Value Added Course | 3 | 3 | | | | | | | 6 |
| 7 | Internship | | | | | 4 | | | | 4 |
| 8 | Research | | | | | | | | 12 | 12 |
| | Total | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 160 |

| SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **KERAL VERMA SUBHARTI COLLEGE OF SCIENCE** | | | | | | | | | | | | | |
| **Department of Botany** | | | | | | | | | | | | | |
| **Course Name - B.Sc Environmental Science** | | | | | | | | | | | | | |
| **Batch:2024 -25** | | | | | | | **SEM:I** | | | | | | |
| **S.No.** | **Course Type** | **Course Code** | **Course Name** | **Teaching Load** | | | **Credits** | | **Internal Assessment** | | **External Assessment** | **Total** | **Remark** |
| | | | | **L** | **T** | **P** | | | | | | | |
| **THEORY and PRACTICAL SUBJECTS** | | | | | | | | **Attendance (5)** | **quiz/PPT/Assignment (10)** | **Mid Sem Test (15)** | **End Sem Exam (70)** | | |
| 1 | Major 1 | B01501 01T | Fundamentals of Environmental Sciences | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 2 | Practical Major 1 | B01501 01P | Practical: Fundamentals of Environmental Sciences | 0 | 0 | 4 | 2 | 5 | 10 | 15 | 70 | 100 | |
| 3 | Minor 1 | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 4 | Multi Disciplinary | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 5 | Ability Enhancement Course | | | 2 | 1 | 0 | 2 | 5 | 10 | 15 | 70 | 100 | |
| 6 | Skill Enhancement | | | 1 | 0 | 3 | 3 | 5 | 10 | 15 | 70 | 100 | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Course | | | | | | | | | | | | |
| 7 | Value Added Course | | | 1 | 0 | 3 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 8 | IKS / Rastra bodh | | | 2 | 1 | 0 | 2 | 5 | 5 | 10 | 30 | 50 | Qualifying |
| **TOTAL CREDITS / ASSESSMENT** | | | | | | | **20** | **35** | **70** | **105** | **490** | **700** | |
| | | | | | | | | | | | | | |

# SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

## KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

### Department of Botany

### Course Name - B.Sc Environmental Science

**Batch:2024 -25** | **SEM:II**

| **S.No.** | **Course Type** | **Course Code** | **Course** | **Teaching Load** | | | **Credits** | | **Internal Assessment** | | **External Assessment** | **Total** | **Remark** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **L** | **T** | **P** | | | | | | | |
| **THEORY and PRACTICAL SUBJECTS** | | | | | | | | **Attendance (5)** | **quiz/PPT/Assignment (10)** | **Mid Sem Test (15)** | **End Sem Exam (70)** | | |
| 1 | Major 2 | B01502 01T | Earth and Earth Surface Processes | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 2 | Practical Major 2 | B01502 01P | Practical: Earth and Earth Surface Processes | 0 | 0 | 4 | 2 | 5 | 10 | 15 | 70 | 100 | |
| 3 | Minor 2 | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 4 | Multi Disciplinary 2 | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 5 | Ability Enhancement Course 2 | | | 2 | 1 | 0 | 2 | 5 | 10 | 15 | 70 | 100 | |
| 6 | Skill Enhancement Course 2 | | | 1 | 0 | 3 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 7 | Value Added | | | 1 | 0 | 3 | 3 | 5 | 10 | 15 | 70 | 10 | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Course 2 | | | | | | | | | | | 0 | |
| 8 | IKS / Rastra bodh | | | 2 | 1 | 0 | 2 | 5 | 5 | 10 | 30 | 50 | Qualifying |
| **TOTAL CREDITS / ASSESSMENT** | | | | | | | **20** | **35** | **70** | **105** | **490** | **700** | |
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# SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

## KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

### Department of Botany

### Course Name - B.Sc Environmental Science

**Batch:2024 -25** | **SEM:III**

| **S.No.** | **Course Type** | **Course Code** | **Course** | **Teaching Load** | | | **Credits** | | **Internal Assessment** | | **External Assessment** | **Total** | **Remark** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **L** | **T** | **P** | | | | | | | |
| **THEORY and PRACTICAL SUBJECTS** | | | | | | | | **Attendance (5)** | **quiz/PPT/Assignment (10)** | **Mid Sem Test (15)** | **End Sem Exam (70)** | | |
| 1 | Major 3 | B01 50301T | Environmental Biology | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 2 | Major 4 | B01 50302T | Water and Water Resources | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 3 | Minor 3 | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 4 | Multi Disciplinary 3 | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 5 | Ability Enhancement Course 3 (Disaster Risk Management) | | | 2 | 1 | 0 | 2 | 5 | 10 | 15 | 70 | 100 | |
| 6 | Skill Enhancement | | | 1 | 0 | 3 | 3 | 5 | 10 | 15 | 70 | 100 | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Course 3 | | | | | | | | | | | | |
| 7 | Practical 3 (based on Major 3+4 +Minor 3 | B01 503 01P | Practical 3 (based on Major 3+4 +Minor 3 | 0 | 0 | 4 | 3 | 5 | 10 | 15 | 70 | 100 | |
| **TOTAL CREDITS / ASSESSMENT** | | | | | | | **20** | **35** | **70** | **105** | **490** | **700** | |
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# SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

# KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

## Department of Botany

## Course Name - B.Sc Environmental Science

| **Batch:2024 -25** | | | | | | | **SEM:IV** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S.No.** | **Course Type** | **Course Code** | **Course** | **Teaching Load** | | | **Credits** | | **Internal Assessment** | | **External Assessment** | **Total** | **Remark** |
| | | | | **L** | **T** | **P** | | | | | | | |
| **THEORY and PRACTICAL SUBJECTS** | | | | | | | | **Attendance (5)** | **quiz/PPT/Assignment (10)** | **Mid Sem Test (15)** | **End Sem Exam (70)** | | |
| 1 | Major 5 | B01 504 01T | Biodiversity and its Conservation | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 2 | Major 6 | B01 504 02T | Environmental Pollution & Management | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 3 | Major 7 | B01 504 03T | Environment and Microbial Biotechnology | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 4 | Minor 4 | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 7 | Practical 4 (based on Major (5+6+7) | B01 504 01P | Practical 4 (based on Major (5+6+7) | 0 | 0 | 4 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 5 | Ability Enhancement Course | | | 2 | 1 | 0 | 2 | 5 | 10 | 15 | 70 | 100 | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 (Course on NCC/NSS/NGO,s/ Scout Guide / Sports) | | | | | | | | | | | | |
| **TOTAL CREDITS / ASSESSMENT** | | | | | | | **20** | **30** | **60** | **90** | **420** | **600** | |
| | | | | | | | | | | | | | |
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# SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

## KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

### Department of Botany

### Course Name - B.Sc Environmental Science

| **Batch:2024 -25** | | | | | | | **SEM:V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S.No.** | **Course Type** | **Course Code** | **Course** | **Teaching Load** | | | **Credits** | | **Internal Assessment** | | **External Assessment** | **Total** | **Remark** |
| | | | | **L** | **T** | **P** | | | | | | | |
| **THEORY and PRACTICAL SUBJECTS** | | | | | | | | **Attendance (5)** | **quiz/PPT/Assignment (10)** | **Mid Sem Test (15)** | **End Sem Exam (70)** | | |
| 1 | Major 8 | B01 505 01T | Natural Resources and its Management | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 2 | Major 9 | B01 505 02T | Environmental Microbiology and Biotechnology | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 3 | Minor 5 | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 4 | Minor 6 | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 5 | Internship | | | 2 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 6 | Practical 5 (based | B01 505 01P | Practical 5 (based on Major (8+9) | 0 | 0 | 4 | 2 | 5 | 10 | 15 | 70 | 100 | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | on Major (8+9) | | | | | | | | | | | | |
| **TOTAL CREDITS / ASSESSMENT** | | | | | | | **20** | **30** | **60** | **90** | **420** | **600** | |
| | | | | | | | | | | | | | |
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# SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

## KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

### Department of Botany

### Course Name - B.Sc Environmental Science

| **Batch:2024 -25** | | | | | | | **SEM:VI** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S.No.** | **Course Type** | **Course Code** | **Course** | **Teaching Load** | | | **Credits** | | **Internal Assessment** | | **External Assessment** | **Total** | **Remark** |
| | | | | **L** | **T** | **P** | | | | | | | |
| **THEORY and PRACTICAL SUBJECTS** | | | | | | | | **Attendance (5)** | **quiz/PPT/Assignment (10)** | **Mid Sem Test (15)** | **End Sem Exam (70)** | | |
| 1 | Major 10 | B01 506 01T | Water Pollution and Control Technologies | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 2 | Major 11 | B01 506 02T | Ecology and Biodiversity | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 3 | Major 12 | B01 506 03T | Environmental Geosciences | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 4 | Minor 7 | | | 4 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 5 | Minor 8 | | | 2 | 1 | 0 | 3 | 5 | 10 | 15 | 70 | 100 | |
| 6 | Practical 6 (based on Major (10+11+12) | B01 506 01P | Practical 6 (based on Major (10+11+12) | 0 | 0 | 4 | 2 | 5 | 10 | 15 | 70 | 100 | |
| **TOTAL CREDITS / ASSESSMENT** | | | | | | | **20** | **30** | **60** | **90** | **420** | **600** | |
| | | | | | | | | | | | | | |

# SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

## KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

### Department of Botany

### Course Name - B.Sc Environmental Science

**Batch:2024 -25** | **SEM:VII**

| S.No. | Course Type | Course Code | Course | Teaching Load | | | Credits | Internal Assessment | | | External Assessment | Total | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | | | | | |
| **THEORY and PRACTICAL SUBJECTS** | | | | | | | | **Attendance (5)** | **quiz/PPT/Assignment (10)** | **Mid Sem Test (15)** | **End Sem Exam (70)** | | |
| 1 | Major 13 | B01 507 01T | Instrumental Techniques For Environmental Analysis | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 2 | Major 14 | B01 507 02T | Environmental Laws | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 3 | Major 15 | B01 507 03T | Environmental Priorities and Research Tools | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 4 | Minor 9 | | | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 5 | Practical 7 (based on Major (13+14) | | Practical 7 (based on Major (13+14) | 0 | 0 | 4 | 2 | 5 | 10 | 15 | 70 | 100 | |
| 6 | Practical 8 (based on Major 15+ Minor 9 | | | 0 | 0 | 4 | 2 | 5 | 10 | 15 | 70 | 100 | |
| **TOTAL CREDITS / ASSESSMENT** | | | | | | | **20** | **30** | **60** | **90** | **420** | **600** | |
| | | | | | | | | | | | | | |

# SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

## KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

### Department of Botany

### Course Name - B.Sc Environmental Science

**Batch:2025-26** | | | **SEM:VIII**

| S.No. | Course Type | Course Code | Course | Teaching Load | | | CREDITS | Internal Assessment | | | External Assessment | Total | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | THEORY and PRACTICAL SUBJECTS | | | L | T | P | | Attendance (5) | Quiz/PPT/ Assignment (10) | Mid Sem Test (15) | End Sem Exam (70) | | |
| 1 | Major 16 | B01508 01T | Eco-toxicology and Environmental Health | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 2 | Minor 10 | | | 4 | 1 | 0 | 4 | 5 | 10 | 15 | 70 | 100 | |
| 4 | Research Project / Dissertation | B01508 01R | | 2 | 1 | 0 | 12 | 5 | 10 | 15 | 70 | 100 | |
| **TOTAL CREDITS / ASSESSMENT** | | | | | | | **20** | **120** | | | **280** | **300** | |
| | | | | | | | | | | | | | |

| ProgramObjectives(POs) | |
|---|---|
| The**B.Sc.EnvironmentalSciences**programdescribeaccomplishmentsthatgraduatesare expectedtoattainwithinfivetosevenyearsaftergraduation | |
| **PO1** | ThestudentscouldgetemploymentopportunitiesinCentralPollutionControlBoard(CPCB)andStatePollutionControlBoard(SPCB),ResearchInstitutions,Colleges,UniversitiesandNon-governmentalorganizations. |
| **PO2** | Aftersuccessfulcompletionofthecourse,thestudentscouldgetjobopportunitiesinurbanandruralenvironmentalmitigationandawarenessincludingsocialforestry programs, bio-fertilizer and bio-pesticide industries, waste managementandorganicfarmingdivisionsfundedbyNational,InternationalandRegionalagencies. |
| **PO3** | The students could get employment perspectives in R & D laboratories of wastewater treatment plants, metal, chemical and textile effluent treatment plants,municipal solidwastemanagementunitsandwastemanagementinbiomedicalindustriesandhospitals. |
| **PO4** | The students could find employment opportunities in agro industries, forestdepartments,waterharvestingandwatershedmanagementsectors,bio-resourceutilizationandbiodiversityconservationorganizations,foodandfeed Industries,environmentfriendlyandintegratedlivestockmanagementsectors. |
| **PO5** | Students also having the immense opportunities to pursue higher studies invariousresearchfieldssuchasenvironmentalpollution,environmentalchemistry,wastemanagementandbioremediation,environmentalmicrobiology,wastewatertreatment,recycle,reuseandmanagement,sustainableenvironmentalfoodsecurity,bio-resourceutilizationandbiodiversityconservation,functionalandecosystemecology,environmentaltoxicology, agro-waste ecosystem, non-biodegradable synthetic chemicals andpolymersinenvironment,occupationalhealthandindustrialsafety,environment analytical techniques, environmental impact assessment, remotesensingandgeographicalinformationsystem, environmentalbiotechnology,carbonsequestration,naturaldisastermanagementandmitigation,climatechange,marinepollutionandresourcesutilization,restorationofdifferentecosystems,renewableandgreenenergyandenvironmentallaw,policiesandauditing. |

# Detailed Syllabus

**Semester-wiseTitlesofthe Major Course PapersinB.Sc.(EnvironmentalSciences)**

| | | |
|---|---|---|
| **Programme/Class:Certificate** | **Year:First** | **Semester:First** |
| **Subject:Environmental Science** | | |
| **CourseCode:** | **CourseTitle:FundamentalsofEnvironmentalSciences,** | |

**Courseoutcomes:**Aftercompletingthecoursethestudentwillbeable to:

1. Learnfundamentalconceptofenvironmentalscience
2. Developunderstandingaboutenvironmentaleducation,justiceandenvironmentalism.
3. Gainknowledgeaboutoriginoflifeandrelated theories.
4. Abletounderstandthe relationshipbetweenman andenvironment.
5. Understandthestructure andcompositionofdifferentsphereofearth.
6. Also abletounderstandthedifferentmeteorologicalparameters

| | |
|---|---|
| **Credits: 4** | **Core: Compulsory** |
| **Max.Marks:100** | **Min.Passing Marks: 40** |

**TotalNo.ofLectures-Tutorials-Practical (inhoursperweek):L-T-P: 4-1-0**

| Unit | Topic | No. ofLectures (60) |
|---|---|---|
| I | **ConceptofEnvironment:**BhartiyaGyanParamparaaurbhartiyaVaigyanik;Definition,PrinciplesandScopeofEnvironmentalScience;MoralandAestheticNature of Environmental Science; Objectives and Historic roots of the subject; NeedforPublic Awareness. | 14 |
| II | **EnvironmentalEducation:**Goalsofenvironmentaleducation;EnvironmentalLiteracy, EnvironmentalCareers,EnvironmentalJustice,IndividualOrganisms,Environmentalism ,EnvironmentalEducationatPrimary, Secondarylevel. | 12 |
| III | **Evolution:** Origin of life and speciation, Darwinism and modern synthetic theory ofevolution, Natural Selection; Biochemical basis of origin of life; Hardy WeinbergEquilibrium;genetic drift. | 10 |

| | | |
|---|---|---|
| IV | **Man and Environment:** Man-Environment relationships; Impacts of human activityonenvironment(Agriculture,transportation,mining,urbanization,industrialization);EnvironmentalDegradationandConservationIssues,Modernconceptofenvironmentalconservation, Sustainability andCarryingCapacity. | 14 |
| V | **Meteorology:** Structure and composition of atmosphere, hydrosphere, lithosphereand biosphere; Meteorological Parameters- Pressure, Temperature, Precipitation,Humidity,WindSpeedandDirection,WindRose,Inversion. | 10 |

**SuggestedBooks:**


1. EnvironmentalSciencebyWilliamP.CunninghamandMaryAnnCunningham;McGraw-Hillpublications.
2. EnvironmentalScience:EarthasaLivingPlanetbyBotkinandKeller;JOHNWILEY&SONS,INC.
3. AtextBook ofEnvironmentStudies,Asthana,D.K.andAsthana,M.2006,S.Chand&Co.
4. EnvironmentalEncyclopedia,JaicoPubl.House,Mumabai,1196p
5. Atmosphere,WeatherandClimate,Barry, R.G.2003,RoutledgePress,UK.
6. EnvironmentalScience:S.C.Santra,NewCentralBook Agency.


| **CourseCode:** | **CourseTitle:PracticalonFundamentals of Environmental Sciences** |
|---|---|

**LabExperimentList:**

1. Studyofeffectsofhumaninteractionwithnaturalenvironment.
2. Describe theenvironmentalproblemofyourlocalityandsuggesta remedy.
3. ChoosefivecommonspeciesofTrees/plantsfromyourNEIGHBORHOODandlisttheircommonnames.Describeeach plant intermsof itsheight andleaves.
4. To recordthefollowingparametersofweathermonitoringstation:
   A. AtmosphericPressure,
   B. Rainfall
   C. Outdoor,indoortemperature
   D. WindspeedandDirection
   E. Humidity& draw point.

| Programme/Class:Certificate | Year:First | Semester:Second |
|---|---|---|
| **Subject:Environmental Science** | | |
| **CourseCode:** | **CourseTitle:Earth and Earth Surface Processes,** | |

**Courseoutcomes:**Aftercompletingthecoursethestudentwillbeable to:

1. Learnfundamentalconceptofearth structure and formation.
2. Learn fundamental concept of earth structure and formation.
3. Developunderstandingaboutvarious geological processes.
4. Gainknowledgeaboutoriginofvarious mountains and rocks.
5. Understandthestructure andcompositionofdifferentsphereofearth.
6. Also abletounderstandtheimportance of mountain on earth surface.

| Credits: 4 | Core: Compulsory |
|---|---|
| Max.Marks:100 | Min.Passing Marks: 40 |

**TotalNo.ofLectures-Tutorials-Practical (inhoursperweek):L-T-P: 4-1-0**

| Unit | Topic | No. ofLectures (60) |
|---|---|---|
| I | **History of Earth:**Solar system formation and planetary differentiation; formation of the Earth: formation and composition of core, mantle, crust, atmosphere and hydrosphere; chemical composition of Earth; geological time scale and major changes on the Earth's surface; Holocene and the emergence of humans, role of humans in shaping landscapes; development of cultural landscapes. | 10 |
| II | **Earth system processes:**Movement of lithosphere plates; mantle convection and plate tectonics, major plates and hot spots, plate boundaries; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental drift, Pangaea and present-day continents, paleontological evidences of plate tectonics; continental collision and mountain formation with specific example of the Himalaya. | 12 |
| III | **Minerals and rocks:** Minerals and important rock forming minerals; rock cycle: lithification and metamorphism; Three rock laws; rock structure, igneous, sedimentary and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: physical processes of erosion, factors affecting erosion; agents of erosion: rivers and streams, glacial and aeolian transportation and deposition of | 12 |

| | | |
|---|---|---|
| | sediments by running water, wind and glaciers. | |
| IV | **Earth surface processes:** Atmosphere: evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere–ocean interface, atmosphere–land interface, ocean–land interface; land surface processes: fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes; coastal processes. | 14 |
| V | **Importance of being a mountain:** Formation of Peninsular Indian mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis, etc. Formation of the Himalaya; development of glaciers, perennial river systems and evolution of monsoon in Indian subcontinent; formation of Indo-Gangetic Plains, arrival of humans; evolution of Indus Valley civilization; progression of agriculture in the Indian subcontinent in Holocene; withdrawing monsoon and lessons to draw. | 12 |

**SuggestedBooks:**


1. Bridge, J., &Demicco, R. 2008. Earth Surface Processes, Landforms and Sediment deposits. Cambridge University Press.
2. Duff, P. M. D., & Duff, D. (Eds.). 1993. Holmes' Principles of Physical Geology. Taylor & Francis.
3. Gupta, A. K., Anderson, D. M., &Overpeck, J. T. 2003. Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. Nature 421: 354-357.
4. Gupta, A. K., Anderson, D. M., Pandey, D. N., &Singhvi, A. K. 2006. Adaptation and human migration, and evidence of agriculture coincident with changes in the Indian summer monsoon during the Holocene. Current Science 90: 1082-1090.
5. Keller, E.A. 2011. Introduction to Environmental Geology (5th edition). Pearson Prentice Hall.
6. Krishnan, M. S. 1982. Geology of India and Burma. CBS Publishers & Distributors.
7. Leeder, M., Arlucea, M.P. 2005. Physical Processes in Earth and Environmental Sciences.
8. Blackwell Publishing.
9. Pelletier, J. D. 2008. Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago.


| CourseCode: | CourseTitle:**Experiment on Earth and Earth Surface Processes** |
|---|---|

**LabExperimentList:**

- **Study of Geological Time Scale** (chart-based practical)
- **Identification of Major Events** on Earth's surface using time-scale maps
- **Model/Demonstration of Plate Tectonics**
  - Using foam layers or clay models
- **Identification of Rock Forming Minerals**
  - Quartz, Feldspar, Mica, Calcite, etc.
- **Hand Specimen Identification of Rocks**
  - Igneous, Sedimentary, and Metamorphic
- **Demonstration of Physical Erosion**

- Water table experiment to show river meandering and sediment transport
- **Models of River Erosion and Deposition**
- **Experiment: Air Pressure and Temperature Gradient**
- **Wind and Ocean Current Simulation**
- **Map Exercise: Major Mountain Ranges (Peninsular & Himalaya)**
- **Tracing the Formation of Indo-GangeticPlains (maps and cross-sections**

| Programme/Class:**Diploma** | Year:**Second** | Semester:**Third** |
|---|---|---|
| Subject:**EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:EnvironmentalBiology** | |

**Courseoutcomes:**Aftercompletingthe coursethe student willbeable to:

- Learnbasicelementsofecologyandenvironmentalfactors.
- Developingunderstandingaboutecosystemdynamics.
- Understandthedifferentfunctionsplayedbyecosystem.
- Learnthe positiveandnegativeinteractionoftheorganism.
- Developconceptualskillsaboutbiogeochemicalcycles.

| **Credits:4** | **Compulsory** |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| **Unit** | **Topic** | **No. ofLectures (60)** |
|---|---|---|
| I | **Ecology:** Introduction of Ecology (Definition, History, Branches and Scope). Basicprinciples of Environment and Ecology; Environmental factors (Abiotic and biotic)theirimportanceandrole. | 10 |
| II | **Ecosystem:** Components, structure and function of ecosystem; Major ecosystems(terrestrial, aquatic, and marine); Trophic Levels, food chain and food webs; Energyflow inEcologicalsystems;EcologicalPyramids,Productivity. | 10 |
| III | **Autecology:**PopulationCharacteristics-Dispersion,Density,Natality,Mortality,Age-Structure, Population Growth; Human population & growth; Ecological niche andhabitat;PositiveandNegativeInteractionsofPopulations. | 14 |
| IV | **Synecology:** Community Structure, Growth Forms; Methods of Plant CommunityAnalysis;ConceptofKeystoneSpecies,Ecotone,Ecotypes,Ecophene,ecological indicators; EcologicalSuccession. | 12 |

| | | |
|---|---|---|
| V | **BiogeochemicalCycles:**Hydrological,GaseousandSedimentaryCycle-Carbon,Oxygen,Nitrogen,PhosphorusandSulphurCycles;Majorbiomeof theworld. | 14 |

**SuggestedBooks:**


1. Ecology and Environment: P.D. Sharma., Rastogi Publication.
2. Fundamental of Ecology: E. P. Odum,W. B. Sauders Company, USA
3. Ecology, 2nd Edition by Paul Colinvaux, Wiley.
4. Ecology: From Individuals to Ecosystems by Michael Begon& Colin R. Townsend & John L. Harper; Blackwell publishing.
5. Ecology: Theories and Applications (4th Edition) by Peter Stiling; Prentice Hall.
6. Text Book of Environmental Studies, ErachBharucha, Orient longmanPvt. Ltd., Ernakulam.

| Programme/Class: Diploma | Year:Second | Semester:Third |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:** | **CourseName:Water and Water Resources** | |

**Courseoutcomes:**Aftercompletingthe coursethe student willbeable to:

To know hydrological cycle, properties of water, physico- chemical and biological water quality assessment and indices, types of water resources, their use and management.

- To solve problems associated with water shortages in India and familiarizes students with case studies on international and national conflicts on water.

| **Credits:4** | **Compulsory** |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures (60) |
|---|---|---|
| I | **Introduction:** Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapo- transpiration; classification of water resources (oceans, rivers, lakes and wetlands).Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: major inorganic and organic constituents, dissolved gases, DO, COD, BOD, acidity and alkalinity, electrical conductivity, sodium adsorption ratio; Biological: phytoplankton, phytobenthos, zooplankton, macro-invertebrates and microbes. | 14 |
| II | **Surface and subsurface water:**Introduction to surface and ground water; surface and ground water pollution; water table; vertical distribution of water; formation and properties of aquifers; techniques for ground water recharge; river structure and patterns; watershed and drainage basins; importance of watershed and watershed management; rain water harvesting in urban settings. | 10 |
| III | **Wetlands and their management:** Definition of a wetland; types of wetlands (fresh water and marine); ecological significance of wetlands; threats to wetlands; wetland conservation and management; Ramsar Convention, 1971; major wetlands of India.**Marine resource management:**Marine resources; commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approach, construction techniques and monitoring of coastal zones). | 12 |

| | | |
|---|---|---|
| IV | **Water resource in India:**Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; hot spots of surface water; role of state in water resources management. | 12 |
| V | **Water resources conflicts:**Water resources and sharing problems, case studies on Kaveri and Krishna river water disputes; Multi- purpose river valley projects in India and their environmental and social impacts; case studies of dams- Narmada and Tehri dam – social and ecological losses versus economic benefits; International conflicts on water sharing between India and her neighbours; agreements to resolve these conflicts. | 12 |

**SuggestedBooks:**


1. Bansil, P.C. 2004. *Water Management in India*. Concept Publishing Company, India.
2. Brebbia, C.A. 2013. *Water Resources Management VII*. WIT Press.
3. CEA. 2011. *Water Resources and Power Maps of India*. Central Board of Irrigation & Power.
4. Grumbine, R.E. &Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science* **339**: 36- 37.
5. Loucks, D.P., Stedinger, J.R. &Haith, D. A. 1981. *Water Resource Systems Planning and Analysis*. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. *Water Resources Sustainability*. The McGraw-Hill Publications.
7. Schward& Zhang, 2003. *Fundamentals of Groundwater*. John Willey and Sons.
8. Souvorov, A.V. 1999. *Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management*. Elsevier Publications.
9. Vickers, A. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press.


| **CourseCode:** | **CourseTitle:Practical on EnvironmentalBiology and Water Quality LabI** |
|---|---|

**LabExperimentList:**

1. Surveyofvegetation, birds,insectsandotheranimals inan area.
2. To study thequalityofa sampleofwatercollectedorprovided.
3. TodetermineTextureofvarioussoilsamples.
4. To set upanaquarium.
5. Advances of water sampling
6. Estimation of water pH
7. Estimation of water Hardness (total, calcium and magnesium)
8. Estimation of water chloride
9. Estimation of water nitrate
10. Estimation of water sulphate
11. Estimation of water acidity
12. Estimation of water alkalinity

| Programme/Class:Diploma | Year:Second | Semester:Fourth |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:BiodiversityanditsConservation major** | |

**Courseoutcomes:**Aftercompletingthe coursethe student willbeable to:

- Gainknowledgeonbiodiversity itsvalue andvariousapproachforconservations.
- BiodiversityofIndia androleoflocal communities andtraditionalknowledgeinconservation.
- DevelopknowledgeaboutbiodiversityidentificationandIUCN.
- Understandthevariousconservationprocess.
- Learnwildlife itsimportance,threat andmanagement.

| **Credits:4** | **Compulsory** |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

**TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0**

| Unit | Topic | No. ofLectures (60) |
|---|---|---|
| I | **Biodiversity:**Basicconceptsandimportance;Types(Speciesdiversity,Geneticdiversity, Ecosystem diversity); Measurement of Biological Diversity; Biological andPhylogeneticSpeciesConcept;Basic ConceptofSpecies andSpeciation. | 10 |
| II | **Identification:** Concept and basis of identification of Biodiversity Hotspots; hotspotsinIndia.FactorsforDeclineofBiologicalDiversity,ConceptofExtinction,ThreatenedandEndangered Species;IUCNcategorization. | 12 |
| III | **Conservation:**ApproachesforConservationofBiologicalDiversity:*In-situ*conservation,*Ex-situ*conservation;Roleoflocalcommunitiesandtraditionalknowledgeinconservation;Biodiversityconvention;Internationalandnationaleffortstoconservebiodiversity. | 14 |
| IV | **BiodiversityofIndia**:Indiaasamegadiversitynation;Biogeographiczonesofcountry; Forest Types and Forest Cover in India; National parks, Sanctuaries, andSacred groves in India; important conservation projects; Concepts of gene pool,Biopiracyandbio-prospecting. | 14 |
| V | **Wildlife:**Generalintroduction;Definition,Importance;ReasonforwildlifeDepletion;WildlifeManagement;ProtectionofWildFlora, FaunaandNaturalHabitats. | 10 |

**SuggestedBooks:**


1. The Biodiversity of India, BharuchaErach, Mapin Publishing Pvt. Ltd.
2. Ecology and Environment: P.D. Sharma., Rastogi Publication.
3. Biodiversity: An Introduction, Gaston, K. J. & Spicer, J. I., Blackwell Science, Londan, UK.
4. Global Biodiversity: Status of the Earth's Living Resources, World conservation Monitoring Centre, Groombridge, B., UNEP, Cambridge.
5. Biodiversity: a beginner's guide, john I. spicer, Oneworld Publications.
6. Environmental Science: S. C. Santra, New Central Book Agency.


| **Programme/Class:Diploma** | **Year:Second** | **Semester: Fourth** |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:EnvironmentalPollution&Management** | |

**Courseoutcomes:**Aftercompletingthe coursethe student willbeable to:

- Understandthebasicconcept ofpollutionanditseffect onenvironment.
- Developunderstandingabouthistory,sources,typesandeffectofair,waterandsoilpollution.
- Gainskillsonvariouscontrolmeasuresof pollutionproblems.
- Understandthesolidwastepollution,noise pollution,radioactiveandthermalpollution.
- Gainknowledgeabout sustainablemanagementofdifferentwastes.

| **Credits:4** | **Compulsory** |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

**TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0**

| **Unit** | **Topic** | **No. ofLectures (60)** |
|---|---|---|
| I | **EnvironmentalPollution:**Introduction;RootsofOurEnvironmentalProblems;Pollution and Pollutants; Principal Pollutants; Classification of Pollutants; Cost ofPollutants;TypesofEnvironmentalPollution;PollutionandEnvironmentalEthics. | 10 |
| II | **Airpollution:**History,Sources,Types,EffectsandControlofairPollutants(Particulate Matter, Oxides of $CO_x$, $NO_x$, $SO_x$); Factors affecting distribution of airpollution;PhotoChemicalSmog;Monitoringofairquality;Greenhouseeffect,Ozonedepletion,andAcidRain;National AirQualityMonitoringProgram; AQI. | 14 |

| | | |
|---|---|---|
| III | **Water Pollution:** Types and sources of Water Pollutions; impact on humans, plantsand animals; Water Quality Parameters- DO, BOD, COD, Acidity, Alkalinity, Salinity,Hardness;DrinkingWaterQualityStandards;WaterTreatment- Adsorption,Flocculation,Ion Exchangeand ReverseOsmosis Methods;Eutrophication, Algalbloom. | 14 |
| IV | **Soil Pollution:** Physico-Chemical and Biological Properties of Soil (structure, texture,inorganic,organic);SoilPollutionsourcesandcontrolmeasures;MetalandPesticides;**SolidWastePollution:**Municipalsolidwaste,BiomedicalWaste,Hazardous Waste; Container Systems; Solid Waste management: Concept of 3R;CompostingandVermicomposting. | 12 |
| V | **NoisePollution:**Sourceofnoise,Noiseexposurelevel,Effectofnoise,NoisePollutionControl; **Radioactive Pollution:** Types of radiations, Sources of radiations, Biologicaleffectsofradiations;**Thermalpollution:** Cause,EffectandControl;**E-Waste**. | 10 |

**SuggestedBooks:**


1. A text book of environmental chemistry and pollution control, Dara, S. S., S. Chand &CompanyLtd, NewDelhi.
2. EnvironmentalPollution,Khitoliya,R.K.,S.ChandandCompany, NewDelhi.
1. Air Pollution, Rao. M. N. and Rao, H. V. N., Tata McGraw -Hill Publishing Company, New Delhi.
2. Environmental Pollution and Control, 4th edition, J. Jeffrey Peirce, Ruth E Weiner, E AarneVesilind, Boston Oxford Johannesburg Melbourne New Delhi Singapore.
3. Principles of Environmental Chemistry, 3rd edition, J. E. Girard, Jones & Bartlett Learning, Company, Burlington.
4. The Science of Environmental Pollution, 3rd edition, Frank R. Spellman, CRC Press, Taylor & Francis Group.

| Programme: Degree | Year: Third | Semester: Fifth |
|---|---|---|
| **Subject: Environmental Science** | | |
| **Couse Code:** | **Course Name: Environment and Microbial Biotechnology** | |

**Course Outcomes**

On the successful completion of the course, student will be able to:

This paper presents an objective view of the application of biotechnological know-hows in tackling environmental problems. It starts with basic knowledge about molecular biology and later links to application based processes and techniques.

| **Credits:4** | **Compulsory** |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. of Lectures (60) |
|---|---|---|
| I | **The Structure and Function of DNA, RNA and Protein:**<br>**DNA:** structural forms and their characteristics (B, A, C, D, T, Z); physical properties: UV absorption spectra, denaturation and renaturation kinetics; biological significance of different forms; Synthesis.<br>**RNA:** structural forms and their characteristics (rRNA, mRNA, tRNA; SnRNA, Si RNA, miRNA, hnRNA); biological significance of different types of RNA; synthesis.<br>**Protein:** hierarchical structure (primary, secondary, tertiary, quaternary), types of amino acids; post- translational modifications and their significance; synthesis; types and their role: structural, functional (enzymes).<br>Central dogma of biology; genetic material prokaryotes, viruses, eukaryotes and organelles; mobile DNA; chromosomal organization (euchromatin, heterochromatin - constitutive and facultative heterochromatin). | 12 |
| II | **Recombinant DNA Technology:**Recombinant DNA: origin and current status; steps of preparation; toolkit of enzymes for manipulation of DNA: restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reverse transcriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase); genomic and cDNA libraries: construction, screening and uses; cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes; nucleic acid microarrays | 12 |
| III | **Ecological restoration and bioremediation:**Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques; treatment schemes for waste water: dairy, distillery, tannery, sugar, antibiotic industries; solid waste treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment); | 12 |

| | | |
|---|---|---|
| **IV** | specific bioremediation technologies: land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wetlands, use of bioreactors for bioremediation; phytoremediation; remediation of degraded ecosystems; advantages and disadvantages; degradation of xenobiotics in environment, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, heavy metals degradative pathways.<br>Bioremediation of contaminated sites due to industrial pollution, oil spills, pesticides, explosives. In situ and ex situ bioremediation techniques, role of genetically engineered microbes in bioremediation | 12 |
| **V** | **Ecologically safe products and processes:** PGPR bacteria: biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation, accumulation and concentration of metals, metal leaching, extraction; exploitation of microbes in copper and uranium extraction. | 12 |

**Suggested Reading**


1. Biotechnology, U.Satyanarayan. Books and Allied Pvt. Ltd
2. Applied Microbiology, Tata McGraw Hill New Delhi.
3. An introduction to Microbial culture: M .K. Razdan Elsevier publication
4. Biotechnology and genomics: P.K. Gupta
5. Evans, G.G. & Furlong, J. 2010. *Environmental Biotechnology: Theory and Application* (2nd edition). Wiley-Blackwell Publications.
6. Jordening, H.J. & Winter J. 2005. *Environmental Biotechnology: Concepts and Applications*. John Wiley& Sons.
7. Lodish, H.F., Baltimore, D., Berk, A. Zipursky, S.L. Matsudiara, P. & Darnell, J. 1995.
8. *Molecular Cell Biology*. W.H. Freeman.
9. Nelson, D.L. & Cox, M.M. 2013. *Lehninger's Principles of Biochemistry*. W.H. Freeman.
10. Rittman, B.E. & McCarty, P.L. 2001. *Environmental Biotechnology. Principles and Applications.* McGraw-Hill, New York.
11. Scagg, A.H. 2005. *Environmental Biotechnology*. Oxford University Press.
12. Snustad, D.P. & Simmons, M.J. 2011. *Principles of Genetics* (6th edition). John Wiley& Sons.
13. Wainwright, M. 1999. *An Introduction to Environmental Biotechnology*. Springer.

| **CourseCode:** | **CourseTitle:**Practical 4 (based on Major (5+6+7) |
|---|---|

**LabExperimentList:**

1. Preparationoffieldreportbased onthe surveyof localflora (herbariumsheet).
2. Todeterminetheprimaryproductivitybylightanddarkbottlemethod.
3. To determinechlorophyllcontentofthe given plantmaterial.
4. To studypore space,waterholdingcapacity andbulkdensityofsoil.
5. Qualitative analysisofsoilorganiccarbon, SoilpH.
6. DeterminationfollowingWaterparameter:
   - DO
   - BOD
   - Alkalinity
   - TDS
   - Turbidity
7. Determinationfollowingairpollutants:
   - RSPM
   - SPM
8. Toestimatetheamountdust(particulatematter)depositionontheleavesofroadsideplants.
9. Tosegregate domesticwasteinto bio-degradableandnon-biodegradablecomponents.
10. Determinationthe Noiselevelsofresidential,institutional andindustrialarea.
11. Isolation of DNA
12. Preparation of cDNA Libraries
13. Calculate the heavy metals percentage removal from soil by bioremediation

| **Programme: Degree** | **Year: Third** | **Semester: Fifth** |
|---|---|---|
| Subject:**EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:NaturalResourcesanditsManagement** | |

**Courseoutcomes:**Aftercompletingthe coursethe student willbeable to:

- Developtheunderstandingonnaturalresourcesandtheirsignificance.
- Abletoknowthestrategiesforsustainablemanagement.
- Understandthebasicprinciples andapplicationofremotesensingandGIStechniques.
- Gainskillsonrenewableenergyresourcesandbio-energyoptions.
- Understandthepresentscenarioofstatesondifferentenvironmentalissuesrelatedtomining.

| **Credits:4** | **Compulsory** |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures (60) |
|---|---|---|
| I | **Natural Resources:** Concept and types of natural resources; classification of naturalresources;Factorsinfluencingresourceavailability,distributionanduses;Interrelationshipsamongdifferenttypesofnaturalresources. | 10 |
| II | **LandResource**:Soiltypes,profileandcomposition;degradationoflandandagriculturallands;impactsoflanduseonenvironment;SoilManagement:SoilerosionandConservation,Desertification;Soilreclamation.<br><br>**Water Resources:** Surface and Ground Water- distribution and supply; Causes ofwater resource depletion; water resource management- Ground water recharging,rain water harvesting; Watershed management; Wetlands: definition, importanceandclassification. | 14 |
| III | **ForestResource:**TypesandextentofforestsinIndia;forestfragmentation;ImportanceofForest;ExploitationofForestresources;Deforestation;ForestManagement;National forestpolicy;CarbonSequestration.<br><br>**Agriculture Resources:** Types of Agriculture; Basic Resources of Agriculture; MajorCrop of India; Agriculture and Environment; Effect of Modern Agriculture; Fertilizer-PesticidesProblems;Agroforestry; SocialForestry. | 12 |
| IV | **EnergyResource:**ConceptofConventionalandNon-conventionalEnergyResources;Fossil fuels; Hydro-power; Tidal Energy; Ocean Thermal Energy Conversion; WindPower; Geothermal Energy;SolarEnergy.<br><br>**Bioenergy:** Methods to produce energy from biomass; Biogas Plant; Nuclear energy;Hydrogen as an alternative Fuel; Energy use pattern in India; Emissions of $CO_2$ indevelopedanddevelopingcountriesincludingIndia. | 14 |
| V | **Mineral Resources:** Types, distribution and reserves of mineral resources; use andexploitation; environmental effects of mining; **Case Studies-** Mining in Aravali Hills;Bundelkhand Region; Sand mining in UP; **Remote Sensing and GIS**: Basic PrinciplesandApplication. | 10 |

**SuggestedBooks:**


1. EcologyandEnvironment:P.D.Sharma.,RastogiPublication.
2. EcologyofNatural Resources, Ramade,F., JohnWiley&SonsLtd.
3. Singh, J.S., Singh, S.P. and Gupta, R.S., Ecology, Environment and Resource Conservation,AnamayaPublishers, NewDelhi.
4. TextBookofEnvironmentalStudies,ErachBharucha,OrientlongmanPvt.Ltd.,Ernakulam.
5. Encyclopedia of Indian Natural History, Hawkins R.E., Bombay Natural History Society,Bombay.
6. Fundamental of Remote sensing, Joseph, G., 2018, University Press (India) Private Ltd,Hyderabad.


| Programme/Class:Degree | Year:Third | Semester:Sixth |
|---|---|---|

| Subject:EnvironmentalSciences | |
|---|---|
| **CourseCode:** | **CourseTitle:EnvironmentalMicrobiologyandBiotechnology** |

**Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:

- Impartknowledgeonmicrobialdiversity andrecentadvancement.
- Gainin-depthknowledgeofroleofbeneficialandpathogenicmicroorganismsinenvironment.
- Understandtheapplicationofmicrobesforproductionof differenteco-friendlyproducts.
- Understandmolecularbiotechnologyanditsapplicationsin Environmentalmanagement.
- LearnaboutBioethics, biosafetyandIPR.

| **Credits:3** | **Compulsory** |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures |
|---|---|---|
| I | **EnvironmentalMicrobiology1:**Conceptandscope;distributionofmicrobesinnature-soil/air/water;Cultivationofmicroorganism;ExtremeEnvironmentAdaptation–ArchaeBacteria,Acidophilic,Alkalophilic,Thermophilic,Barophilic,OsmophilicandRadiodurant Microbes. | 10 |
| II | **EnvironmentalMicrobiology2:**Importanceofmicrobesintheenvironment;Microbial pathogens and Parasites and their effects on Human, Animal and Planthealth,Indicatormicroorganismsinair,waterandsoilEnvironment;Biologicaltreatmentofwastewater;Bioremediation. | 14 |
| III | **Foodmicrobiology:**SpoilageandPreservationoffoods;Fermentedfood;foodpoisoning; Microbiologyofmilk;<br><br>**Industrial Microbiology:** Industrial use of bacteria, fungi, yeast, biogas production,vaccineproduction;Roleofmicrobesinproductionofbiopolymersandbiodegradableplastics. | 14 |
| IV | **Biotechnology:**ScopeandImportanceofBiotechnology;Developmentofgeneticallyengineered microorganisms (GEMs); Biotechnology and its application-, Biofertilizer,VermicultureTechnology,Microbialenhancedoilrecovery(MEOR),Biomining,Biosensors. | 12 |
| V | **Bioethics, Biosafety and IPR:** Ethics of Genetically modified (GM) plants, animals,microbes;GMfoodandBiowarfare;BiosafetyguidelinesinIndia;IntellectualPropertyRight. | 10 |

**SuggestedBooks:**


1. Environmental Microbiology, Pepper, I. L., Gerba, C. P. and Gentry, T. J., 3rd edition, AcademiaPress,Elsevier.
2. TextbookofEnvironmentalMicrobiology,Mohapatra,P.K.,I.K.International(P)Ltd.
3. BasicBiotechnology,Ratledge,C.andKristiansen,B.,2ndedition,CambridgeUniversityPress.
4. Environmental Biotechnology, Theory and Application, Gareth M. Evans and Judith C. Furlong.JohnWiley &Sons.
5. BioethicsandBiosafetyinBiotechnology,SreeKrishna. V.,NewAgeInternationalPublishers.


| | | |
|---|---|---|
| | | |
| **CourseCode:** | **CourseTitle:**Practical 5 (based on Major (8+9) | |
| **LabExperimentList:**<br>1. To examine soil texture, color, pH, moisture content, and to identify soil horizons.<br>2. To test physical and chemical parameters of water (pH, TDS, hardness) and design a rainwater harvesting system.<br>3. To identify and map major forest types using remote sensing data.<br>4. To understand biogas production and energy generation from biomass.<br>5. To map key mineral regions of India and study the environmental impact of mining using a case<br>6. To isolate and quantify microbes from environmental samples.<br>7. To observe the growth of acidophilic, thermophilic, or halophilic bacteria.<br>8. To detect microbial contamination in milk or study microbes in curd/yogurt.<br>9. To demonstrate anaerobic microbial digestion and gas production. | | |

| **Programme/Class:Degree** | **Year:Third** | **Semester:Sixth** |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:Water Pollution and Control Technologies** | |
| **Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:<br>1. Acquire the knowledge of basic rationale of water quality management.<br>2. Characterize the typical inorganic and organic pollutants from a variety of sources entering into water bodies.<br>3. Design and develop water purification techniques for safe drinking water and wastewater treatment technologies for abatement of water pollution.<br>4. Apply the knowledge of various methods for water resource management. | | |
| **Credits:4** | **Compulsory** | |
| **Max.Marks:100** | **Min.Passing Marks: 40** | |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures |
|---|---|---|
| I | **DRINKING WATER CHARACTERISTICS AND PURIFICATION TECHNIQUES** Water Sources – Availability and quality of Surface water and Groundwater, Water Requirements for Domestic Consumption (Population forecasting), Drinking water standards (physical, chemical & bacteriological), Water Treatment process – Principal, process design and applications (Aeration, flocculation, Sedimentation, Filtration, Disinfections (Chlorination, UV, Ozonation), water softening. | 12 |
| II | **WATER POLLUTION** Sources, types, Causes and consequences of water pollution, water pollutants (organic, inorganic, biological and radioactive pollutants), Marine pollution, Thermal pollution, Oil pollution, Classification of wastewater, Bioindicators. Characteristics of water and wastewater, Sampling of water and wastewater, collection and storage, physical chemical and biological analysis of water and wastewater. | 12 |
| III | **WASTEWATER TREATMENT -I** Wastewater generation, objectives of waste water treatment, Primary, secondary, Tertiary treatment: sedimentation, coagulation and flocculation, filtration, disinfection, activated sludge process, trickling filters, and anaerobic (UASB) processes, | 12 |
| IV | **WASTEWATER TREATMENT-II** Suspended, attached and hybrid reactors. Sludge treatment – Preliminary operation, Thickening, Conditioning, Dewatering, Filtration, Digestion and Drying of sludge, Sludge disposal. An introduction to common ETPs and STPs. wastewater treatment for small communities – Oxidation ditch, SBR, aerated lagoon. | 12 |
| V | **WATER RESOURCE MANAGEMENT** Eutrophication, Recovery of eutrophicated lakes, rehabilitation of polluted rivers-Ganga Action Plan, Yamuna Action Plan and new Plans introduced by Govt. of India. | 12 |

**SuggestedBooks:**


1. Wastewater Engineering: Treatment, disposal, Reuse – Metcalf & Eddy Inc.4th ed. TMGHl, New Delhi, 2003.
2. Environmental Engineering- Peavy, HS, Donald RR & G. Tchobanoglous, MGH Int. Ed. New York, 1985.
3. Edzwald, James K. (ed.) Water quality & treatment: A handbook on drinking water
4. Ujang, Zaini (Ed.) Municipal wastewater management in developing countries: Principles and Engineering.
5. Natural Resources conservation-Oliver S Owen &Chiras
6. Natural Resource Conservation-Owen &Chiras
7. Living in the Environment –T.J.Miller

| Programme/Class:Degree | Year:Third | Semester:Sixth |
|---|---|---|
| Subject:EnvironmentalSciences | | |
| CourseCode: | CourseTitle:Ecology and Biodiversity | |

**Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:

1. Demonstrate knowledge of ecological principles operating at different levels of organization.
2. Understand the concepts of ecosystems and compare them with real life processes.
3. Analyze components of population and community ecology.
4. Interpret ecological and social phenomena from a biodiversity view point and develop new conservation measures on new or endangered species in a given habitat.

| Credits:4 | Compulsory |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures |
|---|---|---|
| I | **INTRODUCTION TO ECOLOGY**<br>Definition, subdivisions and scope, basic concepts of ecology, Autecology and Synecology, biological levels of organization-genes to biosphere, Interaction of ecological factors - Light, temperature, precipitation, humidity. Atmospheric gases, wind and fire, topographic and edaphic factors, adaptation, Ecological concepts of species (Liebig's law of minimum, Shelford's law of Tolerance, Combined concept of limiting Factors). | 14 |
| II | **POPULATION AND COMMUNITY ECOLOGY**<br>Population characteristics, population interaction, prey-predator relations, competition, exploitation, mutualism, parasitism, allelopathy, Population growth and regulation. Community structure and organization, Concept of metapopulation, demes and dispersal, Habitat, niche- concept and types, keystone species, Flagship species and umbrella species; dominant species, ecotone, edge effect, ecotypes, plant indicators, ecological succession - types and mechanism. | 10 |
| III | **ECOSYSTEM DYNAMICS**<br>Introduction, kinds of ecosystem, structure and function of ecosystem, food chain, food web, trophic level, ecological pyramids, energy flow models, ecosystem productivity, methods of measuring primary productivity, Ecosystem stability and regulation, biogeochemical cycles- cycling of water and nutrients, Structure of some typical ecosystems - forest, desert, grassland, pond, marine, wetland, estuaries, cropland. | 14 |
| IV | **BIODIVERSITY**<br>Definition, levels of biodiversity, measuring biodiversity, values of biodiversity, Hotspots of biodiversity, Biodiversity hotspots of India, threats to biodiversity. Biological Invasion: concept; pathways, process, mechanism, impacts, examples of major invasive species in India. | 12 |
| V | Endangered and threatened species, IUCN Categories of threatened species, Red data book, List of threatened flora and fauna in India. Biodiversity conservation; National and international efforts for wildlife and forest conservation, wetland conservation, Convention on Biodiversity. | 10 |

**SuggestedBooks:**


1. Brewer, R. The Science of Ecology, Sanders College Publishing Co., Tokyo, 1994.
2. Odum, E.P. Basic Ecology, W.B. Saunders, Philadelphia, 1983.
3. Fatik B. Mandal and Nepal C. Nandi. Biodiversity: Concepts, Conservation and Biofuture,

4. Asian Books, 2013.
5. Jorgensen, Sven Erik. Encyclopedia of Ecology. Vol 1-5. Elsevier Publishers. Netherlands, 2008.
6. Joshi, B.D., Tripathi, C.P.M and Joshi, P.C. Biodiversity and Environmental Management.
7. APH, New Delhi, 2009.
8. Joshi, P.C. and Joshi, N. Biodiversity and conservation. APH Publishing Co-operation, New Delhi, 2009.
9. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R. Invasive Plants and Forest Ecosystems. CRC Press / Taylor and Francis, 2009.
10. Odum, E.P., Barrick, M. and Barrett, G.W. Fundamentals of Ecology (5th Ed). Thomson Brooks/Cole Publisher, California, 2005.
11. Rana, S.V.S. Essentials of Ecology and Environmental Science (5th Ed), PHI Learning Pvt. Ltd, 2013.
12. Sharma, P.D. Ecology and Environment. Rastogi Publications. New Delhi, 2016.
13. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, Ne7thw York.
14. Smith, T.M and Smith, R.L. Elements of Ecology (8th Ed), Benjamin Cummings, 2012.
15. Vandermeer, John H., Riddle, B.R. and Brown, J.H. Population Ecology: First principle
16. (2nd Ed). Princeton University Press, 2013.
17. Singh, J.S., Singh, S.P. and Gupta, S.R. (2015). Ecology, Environment and Resource Conservation, S. Chand Publishing, New Delhi.

| **Programme:Hon's Degree** | **Year:Fourth** | **Semester:Seventh** |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:Environmental Geosciences** | |

**Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:

1. Understand the basics of the Earth's structure, composition and evolution of landforms CO2: Analyze the effects of meteorological parameters on the dispersion of pollutants.
2. Understand and apply the basic concepts of meteorology, climatology and oceanography for solving relevant environmental issues.
3. Identify the issues related to climate change, understand reasons and recommend remedial measures

| **Credits:4** | **Compulsory** |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| **Unit** | **Topic** | **No. ofLectures** |
|---|---|---|
| I | **EARTH PROCESSES**<br>Earth Structure and Materials of the Earth; Minerals and Rocks; Weathering and Erosion. Plate tectonics; Volcanicity; Seismicity; Geological Time Scale. | 12 |

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|---|---|---|
| II | **METEOROLOGY**<br>Fundamentals of meteorology, Scales of meteorology, Parameters of meteorology- pressure, wind, temperature, humidity, radiation; Radiation laws, shortwave and long wave radiations, Albedo, Emissivity, Inversion; | 10 |
| III | The boundary layer; Radiation balance of the Earth; Heating of Earth' surface and its atmosphere; Rotation of the Earth- Coriolis acceleration; Circulation of water and energy in atmosphere, El Nino, La Nina | 14 |
| IV | **CLIMATOLOGY**<br>Seasons and monsoons, Precipitation, Cloud classification and formation Local microclimate Weather and Climate in India, Climatic classification schemes, Climate change - Emissions and Global warming. | 12 |
| V | **OCEANOGRAPHY**<br>Sea water properties, Chemistry of seawater, Waves, Tides and Currents, Upwelling and El Nino, Marine Resources, Marine Pollution, Global Warming and Oceans - Greenhouse effect, Ocean warming, Sea level rise, Acidification, Carbon sequestration. | 14 |

**SuggestedBooks:**


1. Bell F. G., (1998). *Environmental Geology: Principles and Practice*. Blackwell Science Publisher, USA.
2. Critchfield H. J. (2009). *General Climatology*, PHI Learning, New Delhi.
3. Kale, V. S. and Gupta, A. (2001). *Introduction to Geomorphology*. Orient Longman, Bangalore.
4. Singh, S. (2011), *Physical Geography*, PrayagPustakBhavan, Allahabad.
5. Strahler, A.N. and Strahler (1996). *An Introduction to Physical Geography*. John Wiley & Sons, UK.
6. D.S. Lal (2011). *Climatology*, ShardaPustak.
7. Frank Press, Raymond Siever, John Grotzinger, *Understanding Earth*. Editors Thomas
8. H. Jordan, Tom Jordan W. H. Freeman & Co Ltd ISBN-10: 1464138745; ISBN-13: 978- 1464138744
9. Frederick K. Lutgens Edward J. Tarbuck Pearson Education, *The Atmosphere An Introduction to Meteorology* Inc. ISBN-10 0-32-158733-2 ISBN-13 978-0-321-58733-6
10. Tom Garrison *Essentials of Oceanography* ISBN-13: 978-0-495-55531-5 ISBN-10: 0- 495-55531- Brooks/Cole Cengage Learning 10 Davis Drive Belmont, CA 94002-3098 USA


| **Course Code:** | **Course Name:**<br>Practical 6 (based on Major (10+11+12) |
|---|---|

1. To analyze physical and chemical parameters of drinking water.
2. To detect coliform bacteria as indicators of fecal contamination.
3. To determine the optimum dose of coagulant (e.g., alum) for turbidity removal.
4. To determine the Biochemical Oxygen Demand and Chemical Oxygen Demand of a wastewater sample
5. To determine minimum quadrat size for studying vegetation in a grassland.
6. To study the community by quadrat method by determining frequency, density and abundance of different plant species present in a grassland.
7. To determine basal area and dominance of species.
8. To calculate Importance value index (IVI) of species.
9. To calculate index of diversity, richness, evenness and dominance of species.
10. To study ecology of some more exotic invasive weeds.
11. To study and enlist various biotic and abiotic components of pond and forest

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| | ecosystem.<br>12. To identify common minerals and rocks based on physical properties like color, luster, hardness, and cleavage<br>13. To record and interpret basic weather parameters – temperature, humidity, wind speed, pressure.<br>14. To read and interpret weather maps (temperature, pressure, wind patterns).<br>**15.** To analyze sea surface temperature, salinity, and current patterns using remote sensing or historical data sets |

| **Programme/Class:Hon's Degree** | **Year:Fourth** | **Semester:Seventh** |
|---|---|---|
| **\Subject:EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:Instrumental Techniques For Environmental Analysis** | |
| **Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:<br>• Understand the problem and identify suitable techniques to analyze the environmental samples.<br>• Explain and use suitable sampling methods for collection of different samples to perform physical, chemical and biological characterization of environmental pollutants.<br>• Appraise the principles, working and applications of the instrumental techniques used for analysis of physical, chemical and biological entities.<br>• Differentiate between the various analytical methods and capable to design method required for quantitative and qualitative analysis of environmental components. | | |
| **Credits:4** | **Compulsory** | |
| **Max.Marks:100** | **Min.Passing Marks: 40** | |
| TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0 | | |

| **Unit** | **Topic** | **No. ofLectures** |
|---|---|---|

| | | |
|---|---|---|
| I | **BASICS OF ANALYTICAL APPROACH**<br>***Analytical Approach:*** Defining of Problem and Designing of Analytical Method; Sampling: Types and Methods for Solid, Liquid and Gaseous Matrix; Sample Storage; Sample Preparation; Measurement and Assessing of Data; Method Validation and Documentation;<br>***Wet Chemical Methods:*** Titrimetry; Gravimetry | 14 |
| II | **ANALYTICAL TECHNIQUES**<br>UV- Visible spectrophotometer, Flame photometry, atomic absorption spectrophotometry; Plasma Emission | 10 |
| III | Spectroscopy; X-Ray Spectroscopy (X-Ray Fluorescence, X-Ray Diffraction); Fourier-transform Infrared Spectroscopy (FTIR); Nephelometry and Turbidimetry | 10 |
| IV | **CHROMATOGRAPHIC TECHNIQUES**<br>Chromatographic Techniques (Paper Chromatography, Thin Layer Chromatography, Gas Liquid Chromatography, High Performance Liquid Chromatography, Ion-exchange Chromatography); Electrophoresis | 14 |
| V | **MICROSCOPY TECHNIQUES**<br>Optical Microscopy (Brightfield and Darkfield, Phase Contrast, Fluorescence, Confocal); Electron Microscopy (Scanning and Transmission Electron Microscopy) | 12 |

**SuggestedBooks:**


1. Hussain, C. M., &Kecili, R. (2019). Modern Environmental Analysis Techniques for Pollutants. Elsevier.
2. Khopkar, S.M. (2015). Basic Concepts of Analytical Chemistry. Wiley Eastern Ltd., New Delhi.
3. Mitra, S., &Kebbekus, B. B. (2018). Environmental Chemical Analysis. CRC Press.
4. Robinson, J. W., Frame, E. M. S., & Frame, G. M. (2014). Undergraduate Instrumental Analysis. CRC Press, New York
5. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of Instrumental Analysis. Cengage learning.
6. Willard, H.H., Merritt, L.L, Deen, J.A. and Settle, F.A. (2015). Instrumental Methods of Analysis. CBS Publishers and Distributers, New Dehi.
7. Patnaik, P. (2017). Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes. CRC Press.


| **Programme/Class: Hon's Degree** | **Year:Fourth** | **Semester:Seventh** |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:Environmental Laws** | |

**Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:

1. Become aware about the rights of nature and natural resources.
2. To understand the various environmental laws, thereby become aware about environmental protection.

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| **Credits:4** | **Compulsory** |
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| **Unit** | **Topic** | **No. ofLectures** |
|---|---|---|

| | | |
|---|---|---|
| I | Scheme of lebelling of environmentally friendly products (ecomark). Public liability Insurance Act. 1991. Provision of constitution of India regarding environment (article 48 A & 58A). | 12 |
| II | Environmental policy resolution, legislation, public policy strategies in pollution control. Wild life protection act, 1972 amended 2002. Forest conservation act, 1980. Indian forest act 1927. | 12 |
| III | Air (prevention & control of pollution) Act 1981 as amended by amendment 1987 & rule 1982. Motor vehicle act, 1988, The environment (protection) Act, 1986, rules 1986. | 12 |
| IV | The water (prevention & control of pollution) Act, 1974 as amended by amendment 1978 & rules 1975. | 12 |
| V | Environment protection issues & problems, international & national efforts for environment protection. | 12 |

**SuggestedBooks:**

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

| CourseCode: | CourseTitle:**Practical on Environmental Management System, Auditing, Safety and Risk Analysis** | |
|---|---|---|
| I | **LIST OF EXPERIMENTS**:<br>1. EIA methods and variables.<br>2. Cost – benefit analysis.<br>3. Elements of ISO 14000 series standards.<br>4. Environment auditing procedures and report writing.<br>5. Environmental damage measurement methods.<br>6. Safety components and planning.<br>7. Risk assessment methods.<br>8. Chemical toxicity tests in wastewater (Industrial).<br>9. Heavy metal analysis.<br>10. Predicting techniques (impact prediction). | |

**SuggestedBooks:**

1. Stern A. C.,(1977)., Air Pollution, Academic Press, New York
2. S.K. Maiti.(2001) Hand book of methods in Environment Studies vol1. Water & waste Analysis, ABD Pub.

| Programme/Class: Hon's Degree | Year:Fourth | Semester:Eight |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:EnvironmentalPrioritiesandResearchTools** | |

**Courseoutcomes:**Aftercompletingthecoursethestudentwillbeable to:

- Learnaboutgeneralnationalenvironmentalmovements.
- Abletounderstandthe environmentalprioritiesinIndia.
- Developunderstandingaboutdifferentenvironmentaldisastersandtheirmanagement.
- Gainknowledgeonbasicofstatistics andinstrumentation.

| Credits:4 | Compulsory |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures |
|---|---|---|
| I | **National Environmental movement:** Silent valley movement, Chipko movement,Narmada movement, Green Revolution, Appiko movement, Tehri Dam movement;NamamiGangeandYamuna ActionPlan;InternationalSolarAlliance. | 12 |
| II | **EnvironmentalPrioritiesinIndia:**SustainableDevelopment;UrbanandRuralplanning, Power generation; Human Population Explosion; Environment and humanhealth;Sanitationandhealtheducation;Roleofinformationtechnologyinenvironmentandhumanhealth. | 10 |
| III | **Environmental Disaster & Toxicology:** Natural hazards; earthquake, flood, cyclones,landslides,desertificationandfire;Resettlementandrehabilitationprocess;NDRF/SDRF;NDMA;Introductionandnatureoftoxicity(acuteandchronic),Doseandtimeresponse relationship,Teratogenicity,Carcinogenicity andmutagenicity. | 14 |
| IV | **Biostatistics:** Introduction and historical perspective; definition; characteristics andapplication of biostatistics; statistical terms and symbols; mean, mode and median;varianceandstandarddeviation. | 14 |
| V | **Instrumentation:**IntroductiontoTechniques,Basicprinciples,andapplications-Centrifuge;colorimetric,volumetric,titration,Conductometry;Nephelometry;Gravimetry;Microscopy;Ultraviolet-visible(UV- VIS)Spectroscopy. | 12 |

**SuggestedBooks:**


1. EcologyandEnvironment:P.D.Sharma.,RastogiPublication.
2. DisasterManagement,Singh,S.andSingh,J.,PravalikaPublications,Allahabad.
3. ElementsofBiostatistics,Prasad.S.,RastogiPublications,Meerut.
4. Vogel's Text Book of Quantitative Inorganic Analysis, Barnes, J.D. J., Denney, R.C., Jeffery, G.H.andMendham, J., 6thEdition,PearsonEducationLtd.,U.K.
5. Instrumental Methods of Chemical Analysis, Sharma, B.K. (2005), Goel Publishing House,Meerut,India.
6. Instrumentalmethodsofanalysis,Malathi,S.,Patil, P.M.,Kumar,S.(2020).Thakur

publications(pvt.)Ltd,Lucknow,India.

| **CourseCode:** | **CourseTitle:** |
|---|---|

**LabExperimentList:**

1. Findouttheconcentrationofunknownsolutionbyspectrophotometer.
2. Todeterminetheconcentrationofironinwatersamplebyspectrophotometricmethod.
3. Calculationofmean,modeandmedianfromdata.
4. Calculationofstandarddeviationfromdata.
5. Calculationofvariancefrom data.
6. Tomake anauditoftheelectrical energyconsumptionby varioushouseholdappliances.
7. HypotheticalEIAoffollowing:
    i. Urbanization
    ii. Tourism
    iii. Sugarmills
8. Visitandreporttostudythefunctioningofwatertreatment/ Sewagetreatmentplant.

| Programme/Class: Hon's Degree | Year:Fourth | Semester:Eight |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:** | **CourseTitle:**Research Methodology in Environmmental Science | |

1. **Understand** the fundamental principles of scientific research and its relevance in environmental science.
2. **Formulate** appropriate research problems, hypotheses, and research designs for environmental investigations.
3. **Utilize** environmental field and laboratory tools, including GIS and remote sensing, for scientific data collection.
4. **Analyze and interpret** environmental data using statistical methods and scientific software.
5. **Prepare and communicate** scientific reports, research papers, and project proposals in the domain of environmental science.

| Credits:4 | Compulsory |
|---|---|
| **Max.Marks:100** | **Min.Passing Marks: 40** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures |
|---|---|---|
| I | **Introduction to Research and Environmental Science**<br>Definition and objectives of research, Types of research: Basic, Applied, Descriptive, Analytical, ExperimentalScientific method in environmental researchInterdisciplinary nature of environmental science research<br>Formulation of research problemsReview of literature and identification of knowledge gaps. | 12 |
| II | **Research Design and Data Collection**<br>Research design: Exploratory, Descriptive, Experimental, and Case Study<br>Hypothesis: Characteristics, types, and formulationSampling methods: Random, stratified, cluster, systematicMethods of data collection:Primary data: Surveys, interviews, field studies, questionnairesSecondary data: Literature, satellite data, government/environmental reportsEthical issues in environmental research. | 10 |
| III | **Tools and Techniques in Environmental Research**<br>Measurement scales: Nominal, Ordinal, Interval, RatioEnvironmental monitoring techniques:Air, water, soil, and noise pollution sampling and analysisUse of sensors and probes, Laboratory methods: Chromatography, Spectrophotometry, Microscopy, Remote sensing and GIS applications ,Field instrumentation and data logging. | 12 |
| IV | **Data Analysis and Interpretation**<br>Descriptive statistics: Mean, median, mode, standard deviation<br>Inferential statistics: t-test, chi-square test, ANOVA, regression analysis<br>Use of software: Excel, SPSS, R, MATLAB (basic introduction)<br>Data visualization: Graphs, charts, maps, histograms<br>Interpretation and significance of environmental data<br>Error analysis and uncertainty in measurements | 14 |

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|---|---|---|
| V | **Scientific Communication and Reporting**<br>Structure of scientific papers and reports, Referencing styles: APA, MLA, Chicago, etc.<br>Plagiarism and how to avoid it, Proposal writing for research grants<br>• Presenting research: Posters, oral presentations, conference participationPublication process: Peer review, impact factor, open-access journals. | 12 |

**SuggestedBooks:**


1. **Kothari, C.R., &Garg, G. (2019).** *Research Methodology: Methods and Techniques* (4th ed.). New Age International Publishers.
2. **Aery, N.C. (2009).** *Methods in Environmental Science*. Ane Books Pvt. Ltd.
3. **Ghosh, M.K. (2012).** *Research Methodology for Environmental Sciences*. Dominant Publishers and Distributors.

**Semester-wiseMinor Course (MIC) PapersinB.Sc.Evnironmental Science**

| Programme: Certificate | Year:First | Semester: First |
|---|---|---|
| Subject:EnvironmentalSciences | | |
| CourseCode: | CourseTitle:Natural Hazards& Disaster Management | |
| **Courseoutcomes:**Aftercompletingthe coursethe student willbeable to:<br>This paper introduces the students to various aspects of environmental hazards, their causes, classifications, and impacts. It also focuses on the management strategies and governmental action plan to mitigate and prepare for such hazards. | | |
| Credits: 3 | Compulsory | |
| Maximum Marks: 100 | Minimum Passing Marks: 40 | |
| TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P: 3-1-0 | | |

| Unit | Topic | No. ofLectures (45) |
|---|---|---|
| I | Natural hazards: Hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter;volcanoes: causes of volcanism, geographic distribution; floods: types and nature, frequency of flooding; landslides: causes and types of landslides, landslide analysis; drought: types of drought - meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF);tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis; coastal erosion, sea level changes and its impact on coastal areas and coastal zone management. | 12 |
| II | Anthropogenic hazards:Impacts of anthropogenic activities such as rapid urbanization, injudicious ground waterextraction, sand mining from river bank, deforestation, mangroves destruction; role ofconstruction along river banks in elevating flood hazard; disturbing flood plains. deforestation<br>and landslide hazards associated with it; large scale developmental projects, like dams andnuclear reactors in hazard prone zones; nature and impact of accidents, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster. | 11 |
| III | Risk and vulnerability assessment:Concept of risk and vulnerability; two components of risk: likelihood and consequences,qualitative likelihood measurement index; categories of consequences (direct losses, indirect<br>losses, tangible losses, and intangible losses); application of geoinformatics in hazard, risk &vulnerability assessment. Concept of mitigation; types of mitigation: use of technologies inmitigations such as barrier, deflection and retention systems; importance of planning, exercise,and training in preparedness; role of public and media in hazard preparedness. | 12 |

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|---|---|---|
| IV | Disaster management in India:Lessons from the past considering the examples of Bhuj earthquake, tsunami disaster, andBhopal tragedy; National Disaster Management Framework, national response mechanism, roleof government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management; case study of efficient disastermanagement during cyclone 'Phailin' in 2013. | 10 |
| | **SUGGESTED READINGS:**<br>1. Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. LewisPublishers, New York, NY.<br>2. Coppola D. P. 2007. Introduction to International Disaster Management. ButterworthHeinemann.<br>3. Cutter, S.L. 2012. Hazards Vulnerability and Environmental Justice. EarthScan, Routledge Press.<br>4. Keller, E. A. 1996. Introduction to Environmental Geology. Prentice Hall, Upper SaddleRiver, New Jersey.<br>5. Pine, J.C. 2009. Natural Hazards Analysis: Reducing the Impact of Disasters. CRC Press,Taylor and Francis Group.<br>6. Smith, K. 2001. Environmental Hazards: Assessing Risk and Reducing Disaster.Routledge Press.<br>7. Wallace, J.M. & Hobbs, P.V. 1977. Atmospheric Science: An Introductory Survey.Academic Press, New York. | |

| Programme: Certificate | Year:First | Semester:Second |
|---|---|---|
| Subject:EnvironmentalSciences | | |
| CourseCode:BMIC 150201T | CourseTitle:Solid Waste Management | |
| **Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:<br>1. Identify the hazardous and non-hazardous waste.<br>2. Learn the various hazardous waste management strategies.<br>3. Learn the various domestic waste management strategies.<br>Learn the various acts related to hazardous and domestic waste. | | |

| Credits:3 | Compulsory |
|---|---|
| **Maximum Marks: 100** | **Minimum Passing Marks: 40** |
| TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0 | |

| Unit | Topic | No. ofLectures (45) |
|---|---|---|
| I | Solid & industrial waste management Sources and generation of solid waste, their classification and chemical composition;characterization of municipal solid waste; hazardous waste and biomedical waste; impact of solid waste on environment, human and plant health; different techniques used in collection, storage,transportation and disposal of solid waste (municipal, hazardous and biomedical waste); landfill;thermal treatment (pyrolysis and incineration) of waste material; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant. | 12 |
| II | Resource Recovery 4R- reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment. Concept of waste-to-energy (WTE), energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification | 11 |
| III | Integrated waste management Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management. Cradle-to-grave approach; lifecycle inventory of solid waste; role of life cycle assessment (LCA) in waste management; advantage and limitation of LCA; case study on LCA of a product. | 11 |
| IV | Policies for solid waste management Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Eco-friendly or green products. Practicals: Based on the theory and field-based. | 11 |
| | **SUGGESTED READINGS:**<br>1. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley & Sons.<br>2. Asnani, P. U. 2006. Solid waste management. India Infrastructure Report | |

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|---|---|---|
| | 570.<br>3. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press.<br>4. McDougall, F. R., White, P. R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons.<br>5. US EPA. 1999. Guide for Industrial Waste Management. Washington D.C.<br>6. White, P.R., Franke, M. &Hindle P. 1995. Integrated Solid waste Management: A Lifecycle Inventory. Blackie Academic & Professionals.<br>7. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. Improving Municipal Solid waste Management in India. The World Bank, Washington D.C. | |
| | | |

| Programme: Degree | Year: Second | Semester: Third |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:BMIC 150301T** | **CourseTitle:EnvironmentandSociety, Minor III** | |
| **Course Outcomes:**Aftercompletingthecoursethe studentwillbeable to:<br>1. Understandrelationshipbetweentheenvironmentandsocietyenabling the students<br>2. Understand and appreciate the role played by environment, society, and,theirinterfaceinshapingenvironmentaldecisions.<br>3. EnabledtothinkcriticallyonenvironmentalissuesTutorialsarebasicallyMCQtypeorQuiz. | | |
| **Credits:3** | **Compulsory** | |
| **Maximum Marks: 30+70= 100** | **Minimum Passing Marks: 45** | |
| TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0 | | |

| Unit | Topic | No. ofLectures (45) |
|---|---|---|
| **I** | Development-environmentconflict: Social and cultural construction of 'environment'; environmental thought from historicalandcontemporaryperspectiveinlightoftheconceptsofGrossNetHappinessandAldoLeopold's Land Ethic. Developmental issues and related impacts such as ecological degradation;environmental pollution; development-induced displacement, resettlement, and rehabilitation:problems,concerns,andcompensativemechanisms;discussiononProjectAffectedPeople(PAPs). | **12** |
| **II** | Urbanizationandenvironment: Production and consumption oriented approaches to environmental issues in Indian aswell as global context; impact of industry and technology on environment; urban sprawl, trafficcongestionandsocial-economicproblems;conflictbetweeneconomicandenvironmentalinterests. | **11** |
| **III** | Environment,socialinequalitiesandregulatoryframework.Inequalities of race, class, gender, region, and nation-state in access to healthy and safeenvironments;history and politicssurrounding environmental,ecologicaland social justice;environmental ethics,issues and possible solutions.Regulatoryframework:BriefaccountofForestConservationAct19801988; ForestDwellersAct2008;LandAcquisitionAct1894,2007,2011,2012;LandAcquisitionRehabilitationandResettlement Act2013. | **11** |
| IV | Communityparticipation" State,corporate,civilsociety,community,andindividual-levelinitiativestoensuresustainable development; case studies of environmental movements (Appiko Movement, ChipkoMovement,NarmadaBachaoAndolan);corporateresponsibilitymovement;appropriatetechnology movement; environmental groups and movements, citizen groups; role played byNGOs;environmentaleducationand awareness. | **11** |
| | **TextBooks:**<br>- Elliot, D.2003.*Energy,SocietyandEnvironment,TechnologyforaSustainableFuture*.Routledge Press.<br>**ReferenceBooks:** | |

- Chokkan, K.B., Pandya, H. &Raghunathan, H. (eds). 2004. *UnderstandingEnvironment*.Sagar Publication IndiaPvt. Ltd.,New Delhi.
- Guha,R.1989.*EcologicalchangeandpeasantresistanceintheHimalaya*.UnquietWoods,OxfordUniversity Press, Delhi.
- Leopold,A.1949.*TheLandEthic*.pp.201-214.Chicago, USA.
- NationalResearchCouncil(NRC).1996.*LinkingScience andTechnologytoSociety'sEnvironmental Goals*. NationalAcademyPress.
- Pandit, M.K. 2013. Chipko: Failure of a Successful Conservation Movement. In: Sodhi,N.S.,Gibson,L.&Raven,P.H.*ConservationBiology: VoicesfromtheTropics*.pp.126-127.Wiley-Blackwell, Oxford,UK.


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| Programme: Degree | Year: Second | Semester: Fourth |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:BMIC 150401T** | **CourseTitle:Human-WildlifeConflictAndManagement, Minor IV** | |

**Course Outcomes:** Aftercompletingthecoursethe studentwillbeable to:

1. Deals with the conflicts that have arisen as a result of shrinkage ofwildlife habitats and the same being shared by human communities.
2. Raises questions about themoral obligations of humans, need for conservation, and social impacts of conflicts.
3. Introducingthestudentstothescientific andsocial perspectiveofconservation.

| Credits:3 | Compulsory |
|---|---|
| **Maximum Marks: 30+70= 100** | **Minimum Passing Marks: 45** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures (45) |
|---|---|---|
| I | Evolutionoftheconceptofwildlife management: Journeyofmankindfrompredatortoconservator;prehistoricassociationbetweenwildlife and humans: records from Bhimbetkawall paintings; conservation of wildlife in the reignofkingAshoka:excerptsfromrockedicts;Bishnoicommunity;understandingwildlifemanagement, conservation and policies regarding protected areas in 21st century; positive valuesprovided by wildlife conservation (monetary, | 11 |

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|---|---|---|
| | recreational, scientific and ecological benefits).What is the role of government, wildlife biologists and social scientists, concept of deep andshallowecology. | |
| **II** | Wildlifeconservation lawsinIndia: Need of environmental management; wildlife conservation: moral obligation? philosophyofwildlifemanagement;Typesofprotectedareas(WildlifeSanctuaries,NationalParks,Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; conceptofcoreandbufferareainaprotectedrange,briefintroductiontoWildlifeProtectionActof 1972, Forest act 1927, Environmental Protection Act 1986, and Forest conservation Act 1920;introductionofTigertaskforce,Statusofcurrentprotected areasinIndia. | **11** |
| **III** | Socio-economicandlegalbasisofconflicts: Concepts of development and encroachment, who is the intruders: human or animal?Impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality interms of forest conservation:forest produce asa need vs. forest exploitation,introductiontotribal rights in India, demographic profile of tribes in India, importance of forest produce to tribalpopulations, Forestdwellers(Recognitionof forestright)Act, 2006. Insightintotheimportantwildlifeconflicts:KeoladeoNationalparkconflictofBharatpur,Human and elephant conflicts of Kerala, Fisherman and tiger conflict of Sundarbans forest,shifting cultivationin North eastIndia. | **12** |
| **IV** | Humanwildlifecoexistence:Symbiotic relationship between tribals and forest, forest and development, focus on theinclusive growth of tribes: community participation in forest management, case study of Chipkomovement, sacred groves forests, India's Bishnoi community and their conservation practices;ecological economic welfare and development: conservation of indigenous culture and traditions,role of international organizations: Man and biosphere programmes; concept of conservationreserves and community reserves, importance of wildlife corridors in minimizing the conflictsand conservation. | **11** |
| | **Text Books:**<br>- Woodroffe,R.2005.*PeopleandWildlife: ConflictandCoexistence*.Cambridge.<br>- Woodroffe, R., Thirgood, S., &Rabinowitz, A. 2005. *People and Wildlife, Conflict orCoexistence?*(No. 9).CambridgeUniversityPress.<br>**ReferenceBooks:**<br>- Conover,M.2001.*ResolvingHumanWildlife Conflicts*,CRCPress.<br>- Dickman, A. J. 2010. Complexities of conflict: the importance of considering socialfactors for effectively resolving human–wildlife conflict. *Animal Conservation* 13: 458-466.<br>- Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turningchallenges into opportunities. *International Biodeterioration& Biodegradation* 45: 97-102.<br>- Paty,C.2007.*ForestGovernmentandTribe*.ConceptPublishingCompany.<br>- Treves,A.&Karanth,K.U.2003.Human--carnivoreconflictandperspectivesoncarnivore management worldwide. *Conservation Biology*17:1491-1499. | |

| Programme: Degree | Year: Third | Semester: Fifth |
|---|---|---|
| Subject:EnvironmentalSciences | | |
| CourseCode:BMIC 150501T | CourseTitle:GenderandEnvironment, Minor V | |
| **Course Outcomes:**Aftercompletingthecoursethe studentwillbeable to:<br>1. Expose the concept of gender in society andits relevance in the environmental context.<br>2. Examine environmental issues froma gender-sensitized perspective. | | |

| Credits:3 | Compulsory |
|---|---|
| **Maximum Marks: 30+70= 100** | **Minimum Passing Marks: 45** |
| TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0 | |

| Unit | Topic | No. ofLectures (45) |
|---|---|---|
| I | Genderandsociety:Thesociallyconstructed'gender'concept;Genderexistenceinsociety;gender:matriarchyand patriarchyas means of social exclusion(case studies in an Indian context);gender equityissues inruralandurbansettings. | 11 |
| II | Genderandtheenvironment:Relevance of the concept in an environmental context; evolution of gender hierarchies inhistoricalandcontemporaryperspective;gendereddivisionofrolesincultural,social andeconomicperspective;genderinequalities. | 11 |
| III | Gender,resourcesandtheenvironment:Knowledge about the environment among men and women; differential dependencies onenvironmentalresources;implications ofgenderedresponsestoenvironmentaldegradation. | 11 |
| IV | Gender,environmentalmanagementandfuture:Women's participation in environmental movements and conservation; historical andcontemporarycasestudies;roleofwomeninenvironmentaleducation,awarenessandsustainable development.Need for gender equity; Instruments for change: education, media, action groups, policy andmanagement;equity inresourceavailability andconsumption forasustainablefuture. | 12 |
| | **TextBooks:**<br>- Miller,B.1993.*SexandGenderHierarchies*.CambridgeUniversityPress<br>**ReferenceBooks:**<br>- Agarwal,B.1992. *TheGenderandEnvironmentDebate:LessonsfromIndia*.Feminist Studies(Minnesota).<br>- Agarwal,B.1997.Gender,EnvironmentandPovertyInterlinks:Regional VariationsandTemporalShiftsin Rural India: 1971-1991.*World* | |

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| | *Development* **25:** 1-42.<br>- Agarwal,B.2001.Participatoryexclusions,communityforestry,andgender:AnanalysisforSouthAsiaand aconceptual framework.*World Development* **29:** 1623-1648.<br>- Jackson,C.1993.Doingwhatcomesnaturally?Womenandenvironmentindevelopment *WorldDevelopment* **21:**1947-63.<br>- Krishna,S.2004.*LivelihoodandGender*.NewDelhi,Sage.<br>- Leach,M.2007.EarthMothermythsandotherecofeministfables:Howastrategicnotion roseand fell. *Developmentand Change***38:** 67-85.<br>- Stein, R. (ed.). 2004. *New Perspectives on Environmental Justice: Gender, Sexuality, andActivism*.RutgersUniversityPress.<br>- Steingraber,S.1998.*LivingDownstream:AScientist'sPersonalInvestigationofCancerandtheEnvironment.*New York:VintageBooks.<br>- Zwarteveen, M.Z.1995.*Linkingwomentothemaincanal:Genderandirrigationmanagement*.GatekeeperSeries 54, IIED. | |

| **Programme: Degree** | **Year: Third** | **Semester: Fifth** |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:BMIC 150502T** | **CourseTitle:GreenTechnologies, Minor VI** | |
| Course Outcomes: Aftercompletingthecoursethe studentwillbeable to:<br>1. **Understand**greentechnology,itsgoalsandadvantages.<br>2. Highlightpotentialroleofgreentechnologiesinrealizingthegoalofsustainable development and focuses on community participation to tap the economic benefitsassociated withswitchingto green technologies. | | |

| **Credits:3** | **Compulsory** |
|---|---|
| **Maximum Marks: 30+70= 100** | **Minimum Passing Marks: 45** |
| TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0 | |

| **Unit** | **Topic** | **No. ofLectures (45)** |
|---|---|---|
| **I** | Green technologies:concept: Definition and concepts: green technology, green energy, green economy, and greenchemistry; sustainable consumption of resources; individual and community level participation,energy conservation; encouraged use of public transport instead of private transport. successfulgreen | **11** |

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|---|---|---|
| | technologies: wind turbines, solar panels; 3 R's of green technology: recycle, renew andreduce; paradigm shift from 'cradle to grave' approach. Agenda of green development; reductionof ecological footprint; role of green technologies towards a sustainable future; major challengesand their resolution for implementationofgreentechnologies. | |
| **II** | Greeninfrastructure,planningandeconomy:Green buildings; history of green buildings, need and relevance of green buildings overconventional buildings, outlined examples of green buildings; LEED certified building; Eco-mark certification, Green planning: role of governmental bodies, land use planning, concept ofgreencities,wastereductionandrecyclingincities,publictransportationforsustainabledevelopment,greenbelts.;IntroductiontoUNEP'sgreeneconomyinitiative,inclusiveeconomicgrowthofthesociety,REDD+initiative,andcap andtradeconcept;greenbanking. | **11** |
| **III** | Applicationsofgreen technologies:Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing,isothermalmeltingprocess,energyefficientfumehoods.GreenHouseGas(GHG)emissionsreduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets,methaneemissionsreductionand/orreuse.Pollutionreductionandremoval(FlueGasDesulfurization(FGD)methods,catalyticorthermaldestructionof$NO_X$,FluidizedBedCombustion, Dioxins reduction and removal methods, Thermal Oxidizers or Wet Scrubbers toneutralizechemicalsorheavymetals,solventrecoverysystems,LowVolatileOrganicCompound (VOC)paintsand sealers). | **12** |
| **IV** | Green chemistryandfuture:Introduction to green chemistry; principles and recognition of green criteria in chemistry;biodegradable and bio-accumulative products in environment; green nanotechnology; reagents,reactionsandtechnologiesthatshouldbeandrealisticallycouldbereplacedby greenalternatives; photodegradable plastic bags, green practices to conserve natural resources (organicagriculture,agroforestry,reducingpaperusageandconsumption,etc.);emphasisonwastereduction instead of recycling, emphasis on innovation for green future; role of advancement inscience indeveloping environmentalfriendlytechnologies. | **11** |
| | TextBooks:<br>- Anastas,P.T.&Warner,J.C.1998.*GreenChemistry:Theory&Practice*.OxfordUniversity Press.<br>- Arceivala, S.L. 2014. *Green Technologies: For a Better Future*. Mc-Graw HillPublications.<br><br>ReferenceBooks:<br>- Baker,S.2006.*Sustainable Development*.RoutledgePress.<br>- Hrubovcak, J., Vasavada, U. &Aldy, J. E. 1999. *Green technologies for a moresustainableagriculture*(No.33721).UnitedStatesDepartmentofAgriculture,EconomicResearch Service.<br>- Thangavel, P.&Sridevi,G.2015.*EnvironmentalSustainability:RoleofGreenTechnologies*.SpringerPublications.<br>- Woolley, T. &Kimmins, S. 2002. *Green Building Handbook* (Volume 1 and 2). SponPress. | |

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| Programme: Degree | Year: Third | Semester: Sixth |
|---|---|---|
| **Subject:EnvironmentalSciences** | | |
| **CourseCode:BMIC 150601T** | **CourseTitle:ATMOSPHEREANDGLOBALCLIMATECHANGE, Minor VII** | |

**Course Outcomes:** Aftercompletingthecoursethe studentwillbeable to:

1. Understanddynamicsofatmosphericprocesses,whichincludeitscomposition, meteorological phenomena and atmospheric chemistry.
2. Highlightthe anthropogenic intervention in 'anthropocene', which has led to global climate change.
3. Explore the effects of global changes on human communities and initiatives taken atglobal and regionallevels tocombat them.

| **Credits:3** | **Compulsory** |
|---|---|
| **Maximum Marks: 30+70= 100** | **Minimum Passing Marks: 45** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures (45) |
|---|---|---|
| I | Atmosphericcirculation andenergybalance: Movementofairmasses;atmosphereandclimate;airandseainteraction;southernoscillation; western disturbances; *El Nino* and *La Nina*; tropical cyclone; Indian monsoon and itsdevelopment,changingmonsooninHoloceneintheIndiansubcontinent,itsimpactonagriculture and Indus valley civilization; effect of urbanization on micro climate; Asian brownclouds.Earth's energy balance; energy transfers in atmosphere; Earth's radiation budget; green housegases(GHGs);greenhouseeffect;global conveyor belt. | **11** |
| II | Meteorology, atmosphericstabilityandchemistry:Meteorological parameters (temperature, relative humidity, wind speed and direction,precipitation); atmospheric stability and mixing heights; temperature inversion; plume behavior;Gaussianplumemodel.Chemistryofatmosphericparticlesandgases;smog–typesandprocesses;photochemicalprocesses;ionsandradicalsinatmosphere;acid-basereactionsin atmosphere;atmosphericwater; roleof hydroxyland hydroperoxylradicalsinatmosphere. | **11** |

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|---|---|---|
| **III** | Global warmingandclimate change:EvolutionanddevelopmentofEarth'satmosphere;atmosphericstructureandcomposition; significance of atmosphere in making the Earth, the only biosphere; Milankovitchcycles, atmosphericwindows.Trends of global warming and climate change; drivers of global warming and Global WarmingPotential (GWP) & climate change; impact of climate change on atmosphere, weather patterns,sea level rise, agricultural productivity and biological responses - range shift of species, CO2fertilization andagriculture; impactoneconomy and spreadofhumandiseases. | **12** |
| **IV** | Ozonelayerdepletion,environmentalpolicy&agreements:Ozonelayerorozoneshield;importanceofozonelayer;ozonelayerdepletionandcauses; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depletingsubstances(ODS);effects ofozonedepletion;mitigationmeasures andinternationalprotocols.Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol1997; Convention on Climate Change; carbon credit and carbon trading; clean developmentmechanism. | **11** |

**TextBooks:**


- Hardy,J.T.2003.*ClimateChange:Causes,EffectsandSolutions*.JohnWiley&Sons.
- Harvey,D.2000.*ClimateandGlobalClimateChange*.PrenticeHall.


**ReferenceBooks:**


- Barry,R.G.2003.*Atmosphere,Weather andClimate*.RoutledgePress,UK.
- Gillespie, A. 2006. *Climate Change, Ozone Depletion and Air Pollution: LegalCommentarieswithPolicyandScience Considerations*.MartinusNijhoffPublishers.
- Manahan,S.E.2010.*EnvironmentalChemistry*.CRCPress,TaylorandFrancisGroup.
- Maslin,M.2014.*ClimateChange:AVeryShortIntroduction*.OxfordPublications.
- Mathez,E.A.2009.*ClimateChange:TheScienceofGlobalWarmingandourEnergyFuture*.ColumbiaUniversityPress.
- Mitra,A.P.,Sharma,S.,Bhattacharya,S.,Garg,A.,Devotta,S.&Sen,K.2004. *ClimateChange and India.* UniversitiesPress,India.
- Philander, S.G. 2012. *Encyclopedia of Global Warming and Climate Cha*nge (2ndedition).SagePublications.


| Programme: Degree | Year: Third | Semester: Sixth |
|---|---|---|
| Subject:**EnvironmentalSciences** | | |
| **CourseCode:BMIC 150602T** | **CourseTitle:EnvironmentalPollutionAndHumanHealth, Minor VIII** | |

**Course Outcomes:**Aftercompletingthecoursethe studentwillbeable to:

1. deals with different aspects of environmental contamination, whichhave adverse effects on human health.
2. Understand mechanisms ofpollutantsimpactinghumanhealthbydevelopinganunderstandingofdifferenttypesofpollutants, their sources and mitigation measures.
3. Introduced to theconcept of permissiblelimits.

| Credits:3 | Compulsory |
|---|---|
| **Maximum Marks: 30+70= 100** | **Minimum Passing Marks: 45** |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures (45) |
|---|---|---|
| I | Chemistryofenvironmentalpollutants:Definition of pollution; pollutants; classification of pollutants; solubility of pollutants(hydrophilic and lipophilic pollutants), transfer of pollutants within different mediums, role ofchelating agents in transferring pollutants, concept of biotransformation and bioaccumulation,conceptofradioactivity,radioactivedecayandhalf-lifeofpollutants,organometalliccompounds, acid minedrainage. | **11** |
| II | Airpollution:Ambient air quality: monitoring and standards (National Ambient Air Quality Standardsof India); air quality index; sources and types of pollutants (primary and secondary); smog (casestudy); effects of different pollutants on human health and control measures; indoor/outdoor airpollution: sources and effects on human health, emission Inventory and its application, urban airquality. | **11** |
| III | Freshwater,marineandsoilpollution: Sources of surface and ground water pollution; water quality parameters and standards;eutrophication; COD, BOD, DO; effect of water contaminants on human health; water bornediseases; Marine resources and their importance; sources of marine pollution; oil spill and itseffects; coral reefs and their demise; coastal area management; Causes of soil pollution anddegradation; effect of soil pollution on environment, vegetation and other life forms; controlstrategies. | **11** |
| IV | Noisepollution,Radioactive/Thermalpollutionandpollutioncontrol: Noise pollution – sources; frequency, intensity and permissible ambient noise levels;effect on communication, impacts on life forms and humans; control measures. Radioactivematerial and sources of radioactive pollution; effect of radiation on human health (somatic andgenetic effects); thermal pollution and its effects. Activated Sludge Process (ASP) – TricklingFilters – oxidation ponds, fluidized bed reactors, membrane bioreactor neutralization, up flowanaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors,bioscrubbers,biotricklingfilters. | **12** |

## TextBooks:


- Pepper,I.L.,Gerba,C.P.&Brusseau,M.L.2006.*EnvironmentalandPollution Science*.Elsevier AcademicPress.
- Purohit, S.S. &Ranjan, R. 2007. *Ecology, Environment & Pollution.* AgrobiosPublications.


## ReferenceBooks:


- Gurjar,B.R.,Molina,L.T.&OjhaC.S.P.2010.*AirPollution: HealthandEnvironmentalImpacts*.CRCPress, Taylor&Francis.
- Hester,R.E.&Harrison,R.M.1998. *AirPollutionandHealth*.TheRoyalSocietyofChemistry, UK.
- Park,K.2015.*Park'sTextbookofPreventiveandSocialMedicine*(23rdedition).Ban arsidasBhanotPublishers.

| Programme/Class:**Hon's Degree** | Year:**Fourth** | Semester: **Seventh** |
|---|---|---|
| Subject:**EnvironmentalSciences** | | |
| **CourseCode:BMIC 150701T** | **CourseTitle:Energy and Environment, Minor IX** | |

**Courseoutcomes:**Aftercompletingthe coursethe student willbeable to:

1. Understand the existing energy resources, issues related to energy and the environment, challenges and possible paths to sustainable energy generation and use.

| **Credits:4** | **Compulsory** |
|---|---|
| **Maximum Marks:** 30+70=100 | **Minimum Passing Marks:** 45 |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:4-1-0

| **Unit** | **Topic** | **No. ofLectures (60)** |
|---|---|---|
| I | **Introduction:**Defining energy; forms and importance; energy use from a historical perspective: discovery of fire, discovery of locomotive engine and fossil fuels, electrification of cities, oil wars in the Middle East, advent of nuclear energy; sources and sinks of energy; energy over-consumption in urban setting | 08 |
| II | **Energy resources:**Global energy resources; renewable and non-renewable resources: distribution and availability; past, present, and future technologies for capturing and integrating these resources into our energy infrastructure; energy-use scenarios in rural and urban setups; energy conservation. | 08 |
| III | **Energy demand:** Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector; generation and utilization in rural and urban environments; changes in demand in major world economies; energy subsidies and environmental costs. | 10 |
| IV | **Energy, environment and society:** Nature, scope and analysis of local and global impacts of energy use on the environment; fossil fuel burning and related issues of air pollution, greenhouse effect, global warming and, urban heat island effect; nuclear energy and related issues such as radioactive waste, spent fuel; social inequalities related to energy production, distribution, and use. | 10 |
| V | **Energy, ecology and the environment:**Energy production as driver of environmental change; energy production, transformation and utilization associated environmental impacts (Chernobyl and Fukushima nuclear accidents, construction of dams, environmental pollution); energy over-consumption and its impact on the environment, economy, and global change. | 06 |
| VI | **Politics of energy policy:**Political choices in energy policy globally and in the Indian context (historical and contemporary case studies); domestic and international energy policy; energy diplomacy and bilateral ties of India with her neighbors. | 08 |
| VI | **Our energy future:**Current and future energy use patterns in the world and in India; evolution of energy use over time; alternative sources as green energy (biofuels, wind energy, solar energy, geothermal energy; ocean energy; nuclear energy); need for energy efficiency; energy conservation and sustainability; action strategies for sustainable energy mix and management from a future perspective. | 10 |

**SuggestedBooks:**

1. McKibben, B. 2012. Global Warming's Terrifying New Math, Rolling Stone Magazine.
2. Craig. J.R., Vaughan, D.J., Skinner. B.J. 1996. Resources of the Earth: Origin, use, and environmental impact (2nd edition). Prentice Hall, New Jersey.
3. Elliott, D. 1997. Sustainable Technology. Energy, Society and Environment (Chapter 3). New York, Routledge Press.
4. Rowlands, I.H. 2009. Renewable Electricity: The Prospects for Innovation and Integration in Provincial Policies in Debora L. Van Nijnatten and Robert Boardman (eds), Canadian Environmental Policy and Politics: Prospects for Leadership and Innovation, Third Edition. Oxford University Press, pp. 167-82.
5. Oliver, J. 2013. Dispelling the Myths about Canada's Energy Future, Policy: Canadian Politics and Public Policy, June-July.

| Programme/Class:Hon's **Degree** | Year:**Fourth** | Semester:**Eight** |
|---|---|---|
| Subject:**EnvironmentalSciences** | | |
| **CourseCode:BMIC 150801T** | **CourseTitle:Application of Biostatistics and Computer in Environmental Science, Minor X** | |

**Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:

- Understand the need of statistics
- Understand the arrangement of data for the application of statistics
- Apply the various statistical tools.
- In the Interpretation of obtained value of statistical measures.

| **Credits:4** | **Compulsory** |
|---|---|
| **Maximum Marks: 30+70=100** | **Minimum Passing Marks: 45** |

**TotalNo.ofLectures-Tutorials-Practical (in hoursperweek):L-T-P:4-1-0**

| Unit | Topic | No. ofLectures (60) |
|---|---|---|
| I | **Data Collection and Analysis**<br>▪ Sampling types, Data: sources, structures, types and collection.<br>▪ Measurements of central tendency<br>▪ Statistical Methods: Standard deviation and variance.<br>▪ Basic concepts: Measures of central tendency and deviations | 15 |
| II | **Application of Biostatistics in Analyses of Data**<br>▪ Types of Probability, Normal and Binomial Distribution.<br>▪ Hypothesis testing, significance and correlations: Linear models and regressions.<br>▪ Multiple regressions. Difference among means: F-test: 1 way ANOVA; F-test: 2 way ANOVA., T-test<br>▪ FUZZI technology, Analytical Hierarchy Process | 20 |

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|---|---|---|
| III | **Computer application & Web designing**<br>▪ Computer-based modeling: Linear, regression, validation and forecasting.<br>▪ Computer-based modeling for population and population studies.<br>▪ Computer application for environmental : Linear, regegression, validation and forecasting<br>▪ Introduction to database , networking, LAN,WAN , Website design | 20 |

**SuggestedBooks:**


1. Robert S. and Rohlf J.(1997). Biometry, Freeman Press, New York, U.S.
2. Walpole, R. and Myers R. (1993). Statistics for Engineers and Scientists, 5$^{th}$edn. MacMillan, New York, U.S.
3. Ott W.R. (1995). Environmental Statistics and Data Analysis, CRC Press.
4. Manly (2001) Statistics for environmental science and management, Chapman and Hall / CRC Press
5. Ramsay F. and Schafer D. (1997). The Statistical Sleuth, Duxbury Press
6. Smith J. and Smith P.(2007) Environmental modelingand introduction.OxfordUniversityPress,UK, .
7. Jerrold H. Z.(1998). Biostatistical Analysis. Prentice Hall, New jersy, U.S.

# Semester-wiseMultidisciplinary Courses (MDC) inB.Sc. Environmental Science

| Programme/Class:Certificate | Year:First | Semester:First |
|---|---|---|
| **Subject:Environmental Science** | | |
| **CourseCode:BMDC 150101T** | **CourseTitle:Land & Soil Conservation & Management** | |

**Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:

- Understand the need of soil conservation
- Understand the need of land conservation
- Apply the various statistical tools.
- In the Interpretation of obtained value of statistical measures.

| Credits:3 | Compulsory |
|---|---|
| **Maximum Marks: 30+70=100** | **Minimum Passing Marks: 45** |

**TotalNo.ofLectures-Tutorials-Practical (in hoursperweek):L-T-P:3-1-0**

| Unit | Topic | No. ofLectures (50) |
|---|---|---|
| I | Fundamentals of soil science:Land as a resource, ecological and economic importance of soil; Soil formation;classification of soil; soil architecture; physical properties of soil; soil texture; soil water holding capacity; soil temperature; soil colloids; soil acidity and alkalinity; soil salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphorus economy of soil; soil biodiversity; soil taxonomy maps. | 12 |
| II | Soil degradation – causes, Types and causes of soil degradation; Soil resistance and resilience; nature and types ofsoil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation;nutrient depletion; soil pollution due to mining and mineral extraction, impact soil degradationon agriculture and food security; industrial and urban development, toxic organic chemicals, and organic contaminants in soils; fertilizers and fertilizer management; recycling of soil | 13 |

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|---|---|---|
| | nutrients. | |
| III | Land use changes and land degradation: Land resources: types and evaluation; biological and physical phenomena in landdegradation; visual indicators of land degradation; drivers of land degradation deforestation,desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors; drivers of land use andland cover change in major geographic zones and biodiverse regions with particular reference tothe Himalaya and the Western Ghats. | 13 |
| IV | Land degradation and its control: Economic valuation of land degradation; onsite and offsite costs of land degradation; lossof ecosystem services; effects on nutrient cycles; future effects of soil degradation; emergingthreats of land degradation to developing countries Sustainable land use planning; role ofdatabases and data analysis in land use planning control and management; land tenure and landpolicy; legal, institutional and sociological factors; integrating land degradation assessment intoconservation. | 12 |

**Text Books:**


1. Brady, N.C. & Well, R.R. 2007.The Nature and Properties of Soils (13th edition), Pearson Education Inc.


**Reference Books:**


1. Gadgil, M. 1993. Biodiversity and India's degraded lands. Ambio 22: 167-172.
2. Johnson, D.L. 2006. Land Degradation (2nd edition). Rowman& Littlefield Publishers.
3. Marsh, W. M. & Dozier,J. 1983. Landscape Planning: Environmental Applications. John
4. Wiley and Sons.
5. Oldeman, L. R. 1994. The global extent of soil degradation. Soil resilience and sustainable land use, 9. (http://library.wur.nl/isric/fulltext/isricu_i26803_001.pdf).
6. Pandit, M.K. et. al. 2007. Unreported yet massive deforestation driving loss of endemic biodiversity in Indian Himalaya. Biodiversity Conservation 16: 153-163.
7. Pandit, M.K. &Kumar, V. 2013. Land use and conservation challenges in Himalaya: Past, present and future. In: Sodhi, N.S., Gibson, L. & Raven, P.H. Conservation Biology: Voices from the Tropics. pp. 123-133. Wiley-Blackwell, Oxford, UK
8. Peterson, G. D., Cumming, G. S. & Carpenter, S. R. 2003. Scenario planning: a tool for
9. conservation in an uncertain world. Conservation Biology 17: 358-366.
10. Scherr, S. J. 1999. Soil degradation: A threat to developing-country food security by
11. 2020? (Vol. 27). International Food Policy Research Institute.

| Programme/Class:Certificate | Year:First | Semester:Second |
|---|---|---|
| **Subject:Environmental Science** | | |
| **CourseCode:BMDC 150201T** | **CourseTitle:SystematicsandBiogeography** | |

**Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:

1. Discuss principles and applications of classical and modern daysystematic.
2. Classificationoflivingorganisms,developunderstandingofhistoricalandcontemporary patterns of distributions of organisms, and design effective conservation strategiesusingbiogeographictheoriesinaneraofglobalchangeandlargescalehumaninducedde gradation.

| Credits:3 | Compulsory |
|---|---|
| **Maximum Marks: 30+70=100** | **Minimum Passing Marks: 45** |

**TotalNo.ofLectures-Tutorials-Practical (in hoursperweek):L-T-P:3-1-0**

| Unit | Topic | No. ofLectures (50) |
|---|---|---|
| I | Conceptandsystematicapproaches:Concept of taxa (species, genus, family, order, class, phylum, kingdom); concept ofspecies(taxonomic,typological,biological,evolutionary,phylogenetic);categoriesandtaxonomichierarchy.Definition of systematic; taxonomic identification; keys; field inventory; herbarium; museum;botanicalgardens;taxonomicliterature;nomenclature;evidencefromanatomy,palynology,ultrastructure,cytology,phyto-chemistry,numericalandmolecularmethods;taxonomydatabases. | 12 |
| II | Taxonomichierarchy,Nomenclature&Systemsofclassification:Principles and rules (International Code of Botanical and Zoological Nomenclature);ranks and names; types and typification; author citation; valid publication; rejection of names;principle of priority and its limitations; names of hybrids; classification systems of Bentham andHooker; Angiosperm Phylogeny Group (APG III) classification. OperationalTaxonomic Units;DNAbarcoding;phylogenetictree (rooted,unrooted,ultrametrictrees). | 13 |
| III | Biogeography,Speciationandextinction:Genesasunitofevolutionarychange;mutation;geneticdrift;geneflow;naturalselection;geographicandecologicalvariation;biogeographicalrules–Gloger'srule,Bergmann's rule, Allen's rule, Geist rule; biogeographical realms and their fauna; endemic, rare,exotic, andcosmopolitanspecies.Types and processes of speciation – allopatric, parapatric, sympatric; ecological diversification;adaptiveradiation,convergentandparallelevolution;dispersalandimmigration;meansofdispersal and barriersto dispersal; extinction. | 13 |
| IV | Historical, ecological&conservationbiogeography:Paleo-records of diversity and diversification; role in biogeographic patterns – past andpresent;biogeographicaldynamicsofclimatechangeandIceAge.Species'habitats;environment and niche concepts; biotic and abiotic determinants of communities; species-areарelationships;conceptofrarityandcommonness;IslandBiogeographytheory;EquilibriumTheoryofIshlandBiogeography.Applicationofbiogeographicalrulesindesignofprotectedarea and biosphererereserves. | 12 |
| | **TextBooks:**<br>• Mani,M.S.1974.*Ecology andBiogeographyinIndia*.Dr.WJunkPublishers.,TheHague.<br>• Williams,D.M.,Ebach,M.C.2008.*FoundationsofSystematicsandBiogeo* | |

| | | |
|---|---|---|
| | *graphy*.Springer.<br>**ReferenceBooks:**<br>• Lomolino, M.V., Riddle, B.R., Whittaker, R.J. & Brown, J.H. 2010. *Biogeography* (4thedition).Sinauer Associates,Sunderland.<br>• Singh, G. 2012. *Plant Systematics: Theory and Practice* (3rd edition). Oxford & IBH Pvt.Ltd., New Delhi.<br>• Wheeler, Q.D.&MeierR.2000.*SpeciesConceptsandPhylogeneticTheory:ADebate.* Columbia UniversityPress,NewYork.<br>• Wilkins,J.S.2009.*Species:AHistoryoftheIdea*(Vol. 1).UniversityofCaliforniaPress. | |

| **Programme/Class:Certificate** | **Year:Second** | **Semester:Third** |
|---|---|---|
| **Subject:Environmental Science** | | |
| **CourseCode:**BMDC 150301T | **CourseTitle:UrbanEcosystems** | |

**Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:

**Introduction:**Thepaperisdesignedtoenablethestudentstoexaminetheexistingenvironmentalissues,conflictsandtheirpotentialroleinurbandevelopment.Itbeholdsimportance as interaction between urban society and its environmenttranspires in governanceand policy decisions. It also aims to address key challenges posed by increasing development tofar-reaching goalof sustainabilityin urban areas.

| **Credits:3** | **Compulsory** |
|---|---|
| **Maximum Marks: 30+70=100** | **Minimum Passing Marks: 45** |

**TotalNo.ofLectures-Tutorials-Practical (in hoursperweek):L-T-P:3-1-0**

| Unit | Topic | No. ofLectures (50) |
|---|---|---|
| I | Environmentinanurbansetting<br><br>Introduction to urbanization; urban sprawl and associated environmental issues. Man asthe driver of urban ecosystem; commoditizationof nature; metros, citiesand towns as sourcesand sinks of resources; resource consumption and its social, cultural, economic and ecologicalperspectives;urbantransformation;increasingchallengesposedbymodernityfortheenvironment; urban pollution(air, water,soil). | 12 |
| II | Urbandwelling<br><br>Housing scenario across a range of large-medium-small cities; poverty and slums in anurban context; Town planning Acts and their environmental aspects; energy consumption andwastedisposalaswellasaccumulation;environmentalcostsofurbaninfrastructure,urbansettings aslociofsustainability;challenges associatedwithsustainabilityand | 13 |

| | | |
|---|---|---|
| | urbanfuture. | |
| **III** | Naturalspacesinacity<br><br>Conceptof‘controllednature’;scope,importanceandthreatstonatureinthecity;organization and planning of green spaces such as parks, gardens and public spaces; concept ofgreen belts;urban natural forestecosystemas green lungs. | 13 |
| **IV** | Planningandenvironmentalmanagement<br><br>Urbanplanninganditsenvironmentala<br><br>spectsfromhistoricalandcontemporaryperspectives;benefits of environmentalmanagement;introduction to green buildings; urbangovernance; political complexity of applying ecological science to urban policy and planning,smart cities, management of urban environment; alternative resources; policy and managementdecisions. | 12 |

**TextBooks:**


- Gaston,K.J.2010.*UrbanEcology*.CambridgeUniversityPress,NewYork.
- Richter,M.&Weiland,U.(ed.).2012.*AppliedUrbanEcology*.Wiley-Blackwell,UK.


**ReferenceBooks:**


- D’Monte,Darryl.1985.*IndustryversusEnvironmentTemplesorTombs*.ThreeControversies, Delhi, CSE.
- Ernstson, H. 2011. *Re-translating nature in post-apartheid Cape Town: The materialsemiotics of people and plants at Bottom Road*. In: Heeks, R., (Ed.) Conference on“UnderstandingDevelopmentthroughActor-NetworkTheory”,LondonSchoolofEconomics, 30 June, London.
- Grimm,N.B.,Faeth,S.H.,etal.2008.GlobalChangeandtheEcologyofCities. *Science* **319**:756-760.
- Hinchliffe,S.&Whatmore,S.2006.Livingcities:Towardsapoliticsofconviviality. *ScienceasCulture***15**:123–138.

# SEMESTER-WISESKILL ENHANCEMENT COURSE (SEC) PAPERSINB.SC ENVIRONMENTAL SCIENCE

| Programme/Class:**Certificate** | Year:**First** | Semester:**First** |
|---|---|---|
| Subject:**EnvironmentalSciences** | | |
| **CourseCode:BSEC 150101T** | **CourseTitle:Remote Sensing, Geographic Information System &Modeling** | |
| **Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:<br><br>This course introduces the students to various computer-based and statistical methods used for study and management of natural resources and the environment. The students are expected to learn about remote-sensing techniques, physical principles, sampling, statistics and image-analysis methods. | | |
| **Credits:3** | **Compulsory** | |
| **Maximum Marks: 30+70= 100** | **Minimum Passing Marks: 45** | |
| TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0 | | |

| **Unit** | **Topic** | **No. ofLectures** |
|---|---|---|
| I | Remote Sensing: definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation. | 12 |
| II | Geographical Information Systems: definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system; land use/ land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping. | 13 |
| III | Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies. | 12 |
| IV | Basic elements of statistical analyses: sampling; types of distribution – normal, binomial, poisson; measurements of central tendency and dispersion; skewness; kurtosis; hypothesis testing; parametric and non-parametric tests; correlation and regression; curve fitting; analysis of variance; ordination. | 13 |

**SuggestedBooks:**

Zar, J.H. 2010. Biostatistical Analysis (5th edition). Prentice Hall Publications.
Edmondson, A. &Druce, D.1996.Advanced Biology Statistics. Oxford University Press.
Demers, M.N. 2005. Fundamentals of Geographic Information System. Wiley & Sons.
Richards, J. A. &Jia, X. 1999. Remote Sensing and Digital Image Processing. Springer.
Sabins, F. F. 1996. Remote Sensing: Principles an Interpretation. W. H. Freeman.

| Programme/Class:**Certificate** | Year:**First** | Semester:**Second** |
|---|---|---|
| Subject:**EnvironmentalSciences** | | |
| **CourseCode:BSEC 150201T** | **CourseTitle:**EnvironmentalImpactAndRiskAssessment | |
| **Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:<br><br>**Introduction:** This course recognizes the growing need of industry to anticipate and incorporateenvironmental concerns and risks while developing large-scale projects. The course emphasizeson the contemporary tools and techniques to assess various environmental impacts and outlinesvariousmanagementoptionsneededto mitigate theserisks. | | |
| **Credits:3** | **Compulsory** | |
| **Maximum Marks: 30+70= 100** | **Minimum Passing Marks: 45** | |
| TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0 | | |

| Unit | Topic | No. ofLectures |
|---|---|---|
| I | Environmental impact assessment (EIA): definitions, introduction and concepts; rationaleand historical development of EIA; scope and methodologies of EIA. Cost-Benefit analysis; Lifecycle assessment; environmental appraisal; environmental management – principles, problemsandstrategies;environmentalplanning;environmentalaudit;introductiontoISO 14000;sustainable development. | 12 |
| II | Role of project proponents, project developers and consultants; Terms of Reference;impact identification and prediction; baseline data collection; Environmental Impact Statement(EIS),EnvironmentalManagementPlan (EMP) | 13 |
| III | EIA regulations in India; status of EIA in India; current issues in EIA; case study ofhydropower projects/ thermal projects. Rapid EIA; Strategic Environmental Assessment; SocialImpact Assessment. | 13 |

| | | |
|---|---|---|
| IV | Risk assessment: introduction and scope; project planning; exposure assessment; toxicityassessment; hazard identification and assessment; risk characterization; risk communication;environmental monitoring; community involvement; legal and regulatory framework; human andecological risk assessment. | 12 |

**TextBooks:**

- Marriott,B.1997.*EnvironmentalImpactAssessment:APracticalGuide*.McGraw-Hill,NewYork, USA.

**ReferenceBooks:**

- Barrow,C.J.2000.*SocialImpactAssessment:AnIntroduction.*OxfordUniversityPress.
- Glasson,J.,Therivel,R.,Chadwick,A.1994.*IntroductiontoEnvironmentalImpactAssessmen t*.London, ResearchPress, UK.
- Judith,P.1999.*HandbookofEnvironmentalImpactAssessment*.Blackwell Science.
- McIntyre,N.E.2000.Urbanecologyasaninterdisciplinaryfield:differencesintheuseof‘urb an’ betweenthe social andnaturalsciences. *UrbanEcosystems* **4**: 5-24.
- Montgomery,M.R.2009.UrbanTransformationofthedevelopingworld.*Science***319:**761-764.

| Programme/Class:**Diploma** | Year:**Second** | Semester:**Third** |
|---|---|---|
| Subject:**EnvironmentalSciences** | | |
| CourseCode:BSEC 150301T | CourseTitle:**Air and Noise: Pollution and Abatement** | |

**Courseoutcomes:**Aftercompletingthecoursethe studentwillbeable to:

1. Understand the fundamentals of origin, impacts and control of different air pollutants.
2. CO2: Explain the types, nature and behavior of air pollutants under the influence of atmospheric conditions.
3. Appraise the monitoring techniques and control measures to curb the air pollution, considering the standards limits.
4. Understand the technical aspects of sound waves and controlling methods for vibration and noise pollution.

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| **Credits:3** | **Compulsory** |
| **Maximum Marks: 30+70=** 100 | **Minimum Passing Marks:** 45 |

TotalNo.ofLectures-Tutorials-Practical(in hoursperweek):L-T-P:3-1-0

| Unit | Topic | No. ofLectures |
|---|---|---|

| | | |
|---|---|---|
| I | **AN INTRODUCTION TO AIR POLLUTION**<br>Air Pollution: World and Indian scenario; Sources and classification of air pollutants; Criteria Air Pollutants and their properties; Atmospheric Aerosols; Long Range Transport of Atmospheric Pollutants; Impacts of air pollutants on health, plants and materials; The Air (Prevention and Control of Pollution) Act, 1981 and its amendments, National Air Quality Standards | 10 |
| II | **AIR POLLUTION MONITORING**<br>Air pollutants sampling: Sedimentation, High-volume Filtration, Tape sampler, Impingement and Electrostatic precipitator; Collection of gaseous air pollutants: Grab sampling, Absorption in liquid, Adsorption on solids, Freeze out sampling; Indoor Air Monitoring.<br>Source Sampling: Representative sampling, isokinetic sampling, Flue gas analyzer principles for monitoring COx, NOx, SOx, Hydrocarbon.<br>Air Pollutants Dispersion and Modelling: Meteorological aspects of air pollutants dispersion, Plume behavior; Gaussian Plume Model, Line source model and Area source model. | 15 |
| III | **AIR POLLUTION CONTROL TECHNOLOGIES**<br>Particulate pollutants Control: Gravitational Settling Chambers, Cyclonic separator, Fabric filter System, Electrostatic precipitators, Wet scrubbers<br>Gaseous Pollutants Control: Absorption; spray chambers (and towers or columns), plate or tray towers, packed towers, and venturi scrubbers; Adsorption, Pressure-Swing Adsorption (PSA), Condensation: Surface and contact condensers; Combustion: Direct-flame, thermal and catalytic combustion<br>Vehicular Pollution Control: Air-Fuel ratio, Catalytic convertor: Selective catalytic reduction (SCR), Selective non-catalytic reduction (SCNR), Bharat Stage Emission Standards (BSES) | 20 |
| IV | **NOISE POLLUTION**<br>Definition; Sources; Decibel Scale, Sound Pressure Level, Combining Decibel, Frequency Weighting Networks, Noise Indices (L10, L50, L90, Leq, LDN, TNI). Noise & vibration measurement and noise standards, Noise control and abatement measures: Active and Passive methods, Impact of noise and vibrations on human health. | 15 |

**SuggestedBooks:**


1. Bell, L.H. and Bell, D.H., 1994. Industrial noise control: Fundamentals and applications.
2. New York.
3. Cheremisinoff, N.P., 2002. Handbook of air pollution prevention and control. Elsevier.
4. Clarke, A.G. ed., 2012. Industrial air pollution monitoring. Springer Science & Business Media.
5. Rao, C.S., 2007. Environmental pollution control engineering. New Age International.
6. Tiwary, A. and Williams, I., 2018. Air pollution: measurement, modelling and mitigation. CRC Press.
7. Vallero, D.A., 2014. Fundamentals of air pollution. Academic press.
8. Wang, L.K., Pereira, N.C. and Hung, Y.T. eds., 2005. Advanced air and noise pollution control. Totowa, NJ, USA: Humana Press.
9. Wark, K., Warner, C.F. and Wayne T, D., 1998. Air pollution: its origin and control. Addison-Wesley.

# Detailed Syllabus

# Value Added Courses (VAC)

| **Programme/Class:Certificate** | **Year:First** | **Semester:First** |
|---|---|---|
| **Subject:BOTANY** | | |
| **CourseCode: BVAC01** | **CourseTitle:Indian Knowledge System (IKS)** | |

**Courseoutcomes:**By studying this course, students will be able to:

- Explain the evolution of Indian Knowledge system.
- Identify the characteristics of various era's in History of IKS.
- Identify the Nature of Indian Knowledge System.
- Enlist the key characteristics of IKS.
- Identify Key aspects of the epistemology of the Indian Knowledge System.
- Explain the knowledge framework & classification.
- List the ancient scripts of India.
- Outline the influence of ancient sacred texts on Indian Society.
- List the ancient scripts of India.
- Outline the influence of ancient sacred texts on Indian Society.

| **Credits: 3** | **Core: Compulsory** |
|---|---|
| **Max.Marks:30+70=100** | **Min.Passing Marks: 45** |

**TotalNo.ofLectures-Tutorials-Practical (inhoursperweek):L-T-P: 3-1-0**

| Unit | Topics | TotalNo.of Lectures(60) |
|---|---|---|
| I | History of Indian Knowledge System<br>• Genesis of Bhartiya Knowledge System<br>• History of IKS | |
| II | India's characteristic knowledge & India's epistemology<br>• IKS: Nature, Philosophy and Character<br>• India's Epistemology Knowledge Frameworks & Classification | |
| III | Ancient Scriptures<br>• Ancient Scriptures | |
| IV | Ancient Education System<br>• Ancient Education<br>• Educating Sciences | |
| V | Scientific approaches of IKS & Torch-bearers<br>• KhagolVijnana (Astronomy)<br>• Vastukala (Architecture)<br>• Ayurveda KrishiVijnana (Agricultural) Practices | |
| VI | Scientific approaches of IKS & Torch-bearers<br>• DhatuVijnana (Metallurgy)<br>• Ganita: Mathematics in India<br>• YuddhaVidhya (Military Sciences)<br>• Niyuddha Kala (Martial Arts)<br>• Environmental Sciences | |
| VII | Literary Aspects of IKS & Torch-bearers.<br>• Chandashastra (Prosody)<br>• BhasaVaVyakarana (Language and Grammar)<br>• Bharata'sNatyashastra (Science of Drama, Dance and Music) | |
| VIII | Governance in IKS & Way Forward<br>• Science of Consciousness in Ancient India (Cognitive Science)<br>• Anviksiki (Logic and Disputation) | |

| | | |
|---|---|---|
| | • Governance & Public Administration<br>• IKS way forward | |

**SUGGESTED READINGS:**


1. Introduction to Indian Knowledge System: Concepts and Applications, Archak, K.B. (2012). Kaveri Books, New Delhi.ISBN-13:978-9391818203
2. Introduction To Indian Knowledge System: Concepts and Applications, Mahadevan, B.Bhat, VinayakRajat,NagendraPavana R.N.PHI, ISBN: 9789391818203
3. Glimpse into Kautilya'sArthashastraRamachandrudu P. (2010), Sanskrit Academy, Hyderabad ISBN:9788380171074
4. "Introduction" in Studies in Epics and Purāṇas, (Eds.), KM Munshi and N ChandrashekaraAiyerBhartiyaVidyaBhavan


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|---|---|
| SuggestedContinuousEvaluationMethods:<br>TotalMarks:30 | |
| One Mid Semester written Test (1x15): | 15Marks |
| Project/Seminar/ Quiz / Presentation/ Assignment: | 10Marks |
| Attendance & Conduct: | 05Marks |