# INSTITUTE OF SCIENCE, NAGPUR

**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science

## Credit Structure, Evaluation Scheme and Syllabus

**Of**

**Four-Year Bachelor of Science (Honors/Research) Degree with a Semester Pattern in Environmental Science (Faculty of Science & Technology)**

**Based on**

**Direction 1 of 2024 Issued by the Institute of Science, Nagpur As Per NEP- 2020**

**To be implemented from Academic Year 2024-25**

**Four-Year (Eight Semesters) Bachelor of Science (Honors/Research) Degree Course**

# B.Sc.
# Environmental Science-Major

## *Programme Outcomes*

**At the time of graduation, Students will be able to** :

**PO1**. **Critical Thinking:** Take the logical, scientific and practical understanding-based decisions with the precise and lawful extent with due recognition to the existing facts leading towards perilous thought process and thereafter performing judgment with every possible perception.

**PO2**. **Effective communication:** Communicate interpersonal and intrapersonal through all the modes of communication verbally as well as digitally in their choice of Indian Language and henceforth contribute to the developing society with new thoughts and perspectives.

**PO3**. **Social Interaction:** Provide due recognition to everyone's opinion and arbitrate the incongruities and aid the assemblage of intellects to achieve a final universally acceptable inference.

**PO4**. **Effective Citizenship:** Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

**PO5**. **Ethics:** Assimilate the personal and professional values driven by moral, scientific and unprejudiced work culture and practice throughout the life.

**PO6**. **Environment and Sustainability:** Recognize the present scenario of Environmental Pollution and degradation of Natural Resources and address the implementation of Sustainability with achievement of SDG's and MDG's.

**PO7**. **Self-directed and Life-long learning:** Accomplish the skills as an self-determined person and become open for learning at every step of life milieu.

## Programme Specific Outcomes:

**Upon completion of the program, students will be able to**

1. Apply the fundamental knowledge of theory and principles of Classic Ecology and Environmental Science.
2. Identify the Ecological species in Biosphere and apply their functions for the eradication of pollution as a clean and green mechanism.
3. Execute the field-based survey and experimentation to arrive at a solution on the present issues in regard of Environmentally Sound Development mechanism.
4. Develop the new scientific conceptual models based on renewable source of energy applicable for enhancing the present energy intensive technological inventions for pollution free environment.
5. Assess the various AI based software's and its application for advancing the scientific study projections in both the aspects theoretically and practically.
6. Perform the field as well as laboratory-based analysis of all the environmental segments for industrial as well as research purpose.
7. Understand the various types of source of pollution in Environment and suggest the appropriate preventive measures with the basis of Policies and Acts.
8. Utilize the various technical, methodical and systematic skills of science as an efficient environmentalist and contribute for nation building.

# INSTITUTE OF SCIENCE, NAGPUR

**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science

## Teaching and Examination Scheme

## Bachelor of Science (Honors/Research)

## Four-Year (Eight Semester Degree Course)

### B.Sc. Sem.-I (Environmental Science-Major, Minor from Basket)

| Sr. No. | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1. | **4.5** | **DSC** (One will be major and the other minor in Semester III) | **Subject 1: Environmental Science**<br>**Paper I**: Fundamentals of Environmental Science | **B-ES111T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSC Lab1: Practical – I** (**Related to Subject 1**) | **B-ES112P** | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| | | | Subject 2 : | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | Subject 2 Lab : | -- | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| 2. | | **GE** | **Refer to GE Basket** | **B-ES113T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Refer to GE Basket** | **B-ES114T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 3. | | **VSEC** | **Refer VSC Basket** (**Related to Subject 1**) | **B-ES115P** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| | | | **Refer VSC Basket** (Related to Subject 2) | -- | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 4. | | **AEC** | English Compulsory | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 5. | | **VEC** | **Environmental Studies** | **B-ES116T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Office Automation** | -- | | | | | | | | |
| 6. | | **IKS** | **Indian Knowledge System** | **B-ES117T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 7. | | **CC** | NSS /NCC/Sports /Cultural | -- | -- | -- | 4 | 2 | -- | -- | 100 | 50 |
| | **Total** | | | | **14** | **--** | **16** | **22** | **--** | **390** | **360** | -- |

## B.Sc. Sem.-II (Environmental Science-Major, Minor from Basket)

| Sr. No. | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1. | **4.5** | **DSC** (One will be major and the other minor in Semester III) | **Subject 1**: **Environmental Science** **Paper I**: Monitoring of Water, Soil and Air | **B-ES121T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSC Lab 2 : Practical – II** (**Related to Subject 1**) | **B-ES122P** | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| | | | Subject 2 : | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | Subject 2 Lab : | -- | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| 2. | | **GE** | **Refer to GE Basket** | **B-ES123T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Refer to GE Basket** | **B-ES124T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 3. | | **VSEC** | **Refer VSC Basket** (Related to Subject 1) | **B-ES125P** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| | | | **Refer VSC Basket** (Related to Subject 2) | -- | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 4. | | **AEC** | English Compulsory | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 5. | | **VEC** | Constitution of India | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 6. | | **IKS** | **Indian Knowledge System** | **B-ES126T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 7. | | **CC** | NSS /NCC / Sports / Cultural | -- | -- | -- | 4 | 2 | -- | -- | 100 | 50 |
| | **Total** | | | | **14** | **--** | **16** | **22** | **--** | **390** | **360** | **--** |

## B.Sc. Sem.-III (Environmental Science -Major, Minor from Basket)

| Sr. No | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1 | **5.0** | **DSC** | **Paper 1** : Introduction to Green Chemistry, Soil Pollution and Water Resources | **B-ES231T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Paper 2** : Environmental Biology | **B-ES232T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSC Lab 3** : **Practical - III** (Based on Paper 1 + Paper 2) | **B-ES233P** | -- | -- | 4 | 2 | 4 – 6 | 60 | 40 | 50 |
| 2 | | **Minor** | **Paper 1** : Refer Minor Basket | **B-ES234T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Paper 2** : Refer Minor Basket | **B-ES235T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Minor Lab 1** : **Practical – I** (Based on Minor, Paper 1+Paper 2) | **B-ES236P** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 3 | | **GE** | **Refer to GE Basket** | **B-ES237T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 4 | | **VSEC** | **Refer SEC Basket** | **B-ES238P** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 5 | | **AEC** | Second Language | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 6 | | **FP** | **Field Project** | **B-ES239P** | -- | -- | 4 | 2 | 4 - 6 | --- | 100 | 50 |
| 7 | | **CC** | NSS / NCC / Sports / Cultural | -- | -- | -- | 4 | 2 | -- | --- | 100 | 50 |
| | **Total** | | | | **12** | **--** | **20** | **22** | **--** | **360** | **440** | **--** |

## B.Sc. Sem.-IV (Environmental Science - Major, Minor from Basket)

| Sr. No | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE** | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1 | **5.0** | **DSC** | **Paper 1**: Solid and Hazardous Waste Management | **B-ES241T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Paper 2**: Biodiversity Conservation and Environmental Management | **B-ES242T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSC Lab 4** : **Practical - IV** (Based on Paper 1 + Paper 2) | **B-ES243P** | -- | -- | 4 | 2 | 4 – 6 | 60 | 40 | 50 |
| 2 | | **Minor** | **Paper 1** : Refer Minor Basket | **B-ES244T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Paper 2** : Refer Minor Basket | **B-ES245T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Minor Lab 2** : **Practical - II** (Based on Minor, Paper 1+ Paper 2) | **B-ES246T** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 3 | | **GE** | **Refer to GE Basket** | **B-ES247T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 4 | | **VSEC** | **Refer SEC Basket** | **B-ES248P** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 5 | | **AEC** | Second Language | **--** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 6 | | **CEP** | **Community Service** | **B-ES249P** | -- | -- | 4 | 2 | 4 - 6 | -- | 100 | 50 |
| 7 | | **CC** | NSS / NCC /Sports /Cultural | | -- | -- | 4 | 2 | -- | -- | 100 | 50 |
| | **Total** | | | | **12** | **--** | **20** | **22** | **--** | **360** | **440** | **--** |

## B.Sc. Sem.-V (Environmental Science -Major, Minor from Basket)

| Sr. No | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1 | **5.5** | **DSC** | **Paper 1**:- Principles of Air & Noise Pollution | **B-ES351T** | 3 | -- | -- | 3 | 3 | 45 | 30 | 38 |
| | | | **Paper 2**:- Environmental Management | **B-ES352T** | 3 | -- | -- | 3 | 3 | 45 | 30 | 38 |
| | | | **DSC Lab 5: Practical - V** (Based on Paper 1+ Paper 2) | **B-ES353P** | -- | --- | 6 | 3 | 6 | 90 | 60 | 75 |
| | | | **Paper 3:** Environmental Microbiology | **B-ES354T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSC Lab 6** : **Practical - VI** (Based on Paper 3) | **B-ES355P** | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| 2 | | **DSE** | **Elective 1**:- Earth Evolution, Atmosphere and Climate Change | **B-ES356T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSE Lab 1** : **Practical - I** Earth Evolution, Atmosphere and Climate Change (Based on DSE-Elective 1) | **B-ES357P** | -- | -- | 4 | 2 | 4-6 | 60 | 40 | 50 |
| 3 | | **Minor** | **Paper** 1:- Refer Minor Basket | **B-ES358T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Minor Lab 3 : Practical - III** (Based on Minor Paper 1) | **B-ES359P** | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| 4 | | **VSEC** | **Refer SEC Basket** | **B-ES3510P** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 5 | | **CEP** | **Community Service** | **B-ES3511P** | -- | -- | 2 | 1 | -- | -- | 50 | 25 |
| | **Total** | | | | **12** | **--** | **20** | **22** | **--** | **450** | **350** | **--** |

## B.Sc. Sem.-VI (Environmental Science -Major, Minor from Basket)

| Sr. No | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1 | **5.5** | **DSC** | **Paper 1**:- Water Pollution: Monitoring & Management | **B-ES361T** | 3 | -- | -- | 3 | 3 | 45 | 30 | 38 |
| | | | **Paper 2**:- Water Supply & Wastewater Treatment | **B-ES362T** | 3 | -- | -- | 3 | 3 | 45 | 30 | 38 |
| | | | **DSC Lab 7: Practical - VII** (Based on Paper 1 + Paper 2) | **B-ES363P** | -- | --- | 6 | 3 | 6 | 90 | 60 | 75 |
| | | | **Paper 3**: Natural Resources and GIS | **BES364T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSC Lab 8: Practical - VIII** (Based on Paper 3) | **B-ES365P** | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| 2 | | **DSE** | **Elective 2** :- Earth Resources & Remote Sensing, GIS | **B-ES366T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSE Lab 2** : **Practical - II** Earth Resources & Remote Sensing, GIS (Based on DSE-Elective 2) | **B-ES367P** | -- | -- | 4 | 2 | 4-6 | 60 | 40 | 50 |
| 3 | | **VSEC** | **Refer VSC Basket** | **B-ES368P** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 4 | | **OJT** | **Internship / Apprenticeship** (Related to DSC) | **B-ES369P** | -- | -- | 8 | 4 | -- | -- | 200 | 100 |
| | **Total** | | | | **10** | **--** | **24** | **22** | **--** | **390** | **460** | **--** |

## B.Sc. Sem.-VII (Honors) (Environmental Science -Major, Minor from Basket)

| Sr. No. | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1 | **6.0** | **DSC** | **Paper 1**:- Environmental Chemistry | **B-ESH471T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| | | | **Paper 2**:- Environmental Biology, Microbiology and Biotechnology | **B-ESH472T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| | | **DSE** | **Elective 3**: Atmospheric Science & Climate Change **OR** **Elective 4**: Environmental Legislation And Policy | **B-ESH473T** / **B-ESH474T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| 2 | | **DSC/ DSE** | **DSC Lab 9** : **Practical - IX** Environmental Chemistry, Microbiology and Biotechnology (**Based on Paper 1+Paper 2**) | **B-ESH475P** | -- | -- | 12 | 6 | 6-8 | 180 | 120 | 150 |
| 3 | | **RM** | **Research Methodology** | **B-ESH476T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| **Total** | | | | | **16** | **--** | **12** | **22** | | **420** | **280** | **--** |

## B.Sc. Sem.-VIII (Honors) (Environmental Science-Major, Minor from Basket)

| Sr. No | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1 | **6.0** | **DSC** | **Paper 1**:- Environmental Ecosystem and Biodiversity | **B-ESH481T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| | | | **Paper 2**:- Analytical Techniques for Environmental Monitoring | **B-ESH482T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| | | **DSE** | **Elective 5**: Environmental Sampling and Resource Management **OR** **Elective 6:** Environmental Impact Assessment and Audit | **B-ESH483T** / **B-ESH484T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| 2 | | **DSC/ DSE** | **DSC Lab 10** : **Practical - X** Environmental Ecosystem and Analytical Techniques **(Based on Paper 1+ Paper 2)** | **B-ESH485P** | -- | -- | 12 | 6 | 6-8 | 180 | 120 | 150 |
| 3 | | **OJT** | **Internship / Apprenticeship (Related to DSC)** | **B-ESH486P** | -- | -- | 8 | 4 | -- | --- | 200 | 100 |
| **Total** | | | | | **12** | **--** | **20** | **22** | **--** | **360** | **440** | -- |

## B.Sc. Sem.-VII (Honors with Research) (Environmental Science -Major, Minor from Basket)

| Sr. No. | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1 | **6.0** | **DSC** | **Paper 1**:- Environmental Chemistry | **B-ESR471T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| | | | **Paper 2**:- Environmental Biology, Microbiology and Biotechnology | **B-ESR472T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| | | **DSE** | **Elective 7**: Atmospheric Science & Climate Change **OR** **Elective 8**: Environmental Legislation And Policy | **B-ESR473T** / **B-ESR474T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| 2 | | **DSC/ DSE** | **DSC Lab 11** : **Practical - XI** Environmental Chemistry, Microbiology and Biotechnology (**Based on Paper 1+ Paper 2**) | **B-ESR475P** | -- | -- | 4 | 2 | 4– 6 | 60 | 40 | 50 |
| 3 | | **RM** | **Research Methodology** | **B-ESR476T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| 4 | | **RP** | **Research Project / Dissertation(Core)** | **B-ESR477P** | -- | -- | 8 | 4 | -- | -- | 200 | 100 |
| **Total** | | | | | **16** | **--** | **12** | **22** | **--** | **300** | **400** | **--** |

## B.Sc. Sem.-VIII (Honors with Research) (Environmental Science -Major, Minor from Basket)

| Sr. No | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1 | **6.0** | **DSC** | **Paper 1**:- Environmental Ecosystem and Biodiversity | **B-ESR481T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| | | | **Paper 2**:- Analytical Techniques for Environmental Monitoring | **B-ESR482T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| | | **DSE** | **Elective 9**: Environmental Sampling and Resource Management<br>**OR**<br>**Elective 10:** Environmental Impact Assessment and Audit | **B-ESR483T**<br>**B-ESR484T** | 4 | -- | -- | 4 | 3 | 60 | 40 | 50 |
| 2 | | **DSC/ DSE** | **DSC Lab 12** : **Practical - XII** Environmental Ecosystem and Analytical Techniques<br>**(Based on Paper 1+ Paper 2)** | **B-ESR485P** | -- | -- | 4 | 2 | 4 – 6 | 60 | 40 | 50 |
| 3 | | **RP** | **Research Project / Dissertation 1 (Core)** | **B-ESR486P** | -- | -- | 8 | 4 | -- | -- | 200 | 100 |
| 4 | | | **Research Project / Dissertation 2 (Core)** | **B-ESR487P** | -- | -- | 8 | 4 | -- | -- | 200 | 100 |
| **Total** | | | | | **12** | **--** | **20** | **22** | **--** | **240** | **560** | **--** |

**Table 16: Table showing course category wise credit distribution semester wise**

| Exit Point / Course Category | **Certificate in Science** | **Diploma in Science** | **Three Year Bachelor of Science** | **Bachelor of Science (Honors) Degree** | **Bachelor of Science (Honors with Research) Degree** |
|---|---|---|---|---|---|
| Major Credits | 6 | 12 | 32 | 36 | 28 |
| Minor Credits | 6 | 12 | 3 | -- | -- |
| GE | 8 | 4 | -- | -- | -- |
| VSEC | 8 | 4 | 4 | -- | -- |
| AEC | 4 | 4 | -- | -- | -- |
| VEC | 4 | -- | -- | -- | -- |
| IKS | 4 | -- | -- | -- | -- |
| CC | 4 | 4 | -- | -- | -- |
| FP | -- | 2 | -- | -- | -- |
| CEP | -- | 2 | 1 | -- | -- |
| OJT | -- | -- | 4 | 4 | -- |
| RP | -- | -- | -- | -- | 12 |
| RM | -- | -- | -- | 4 | 4 |
| Total Credits | 44 | 44 | 44 | 44 | 44 |

**Table 16: Table showing total marks in theory and Practical semester wise**

| Semester | Theory | Practical | Total Marks |
|---|---|---|---|
| 1 | 350 | 400 | 750 |
| II | 350 | 400 | 750 |
| III | 300 | 500 | 800 |
| IV | 300 | 500 | 800 |
| V | 300 | 500 | 800 |
| VI | 250 | 600 | 850 |
| VII (Honors) | 400 | 300 | 700 |
| VIII (Honors) | 300 | 500 | 800 |
| VII (**Honors with Research**) | 400 | 300 | 700 |
| VIII (**Honors with Research**) | 300 | 500 | 800 |
| **For Honors** | **2550** | **3700** | **6250** |
| **For Research** | **2550** | **3700** | **6250** |

**Total Credits:**

1. **Three-Year UG Degree Program: 132**
2. **Four-Year UG Degree Program: 176**

**Abbreviations:** Generic/Open Electives: **OE**, Vocational Skills & Skill Enhancement Courses: **VSEC**, Vocational Skill Courses: **VSC**, Skill Enhancement Courses: **SEC**, Ability Enhancement Courses: **AEC**, Indian Knowledge Systems: **IKS**, Value Education Courses: **VEC**, On Job Training (Internship/Apprenticeship): **OJT**, Field Project: **FP**, Community Engagement & Service: **CEP**, Co-curricular Courses: **CC**, Research Methodology: **RM**, Research Project: **RP.**

# Institute of Science, Nagpur
**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science

**Semesterwise Details of DSC available for Environmental Science as Major Subject in accordance to NEP to be implemented from 2024-25**

| Course/Year | Semester | Theory / Practical | Name of Paper | Course Code | Total Period Hrs. | Credits | Total Credits |
|---|---|---|---|---|---|---|---|
| **B.Sc./ I** | **I** | Theory | **Paper 1**: Fundamentals of Environmental Science | **B-ES111T** | 30 | 2 | **3** |
| | | Practical | DSC Lab 1 : **Practical-I** (Related to Subject 1) | **B-ES112P** | 30 | 1 | |
| | **II** | Theory | **Paper 1**: Monitoring of Water, Soil and Air | **B-ES121T** | 30 | 2 | **3** |
| | | Practical | DSC Lab 2: **Practical -II** (Related to Subject 1) | **B-ES122P** | 30 | 1 | |
| **B.Sc. /II** | **III** | Theory | **Paper 1**: Introduction to Green Chemistry, Soil Pollution and Water Resources | **B-ES231T** | 30 | 2 | **6** |
| | | Theory | **Paper 2**: Environmental Biology | **B-ES232T** | 30 | 2 | |
| | | Practical | DSC Lab 3: **Practical-III** (Based on Paper 1 + Paper 2) | **B-ES233P** | 60 | 2 | |
| | **IV** | Theory | **Paper 1**: Solid and Hazardous Waste Management | **B-ES241T** | 30 | 2 | **6** |
| | | Theory | **Paper 2**: Biodiversity Conservation and Environmental Management | **B-ES242T** | 30 | 2 | |
| | | Practical | DSC Lab 4 : **Practical- IV** (Based on Paper 1 + Paper 2) | **B-ES243P** | 60 | 2 | |
| **B.Sc. /III** | **V** | Theory | Paper 1: Principles of Air & Noise Pollution | **B-ES351T** | 45 | 3 | **12** |
| | | Theory | Paper 2: Environmental Management | **B-ES352T** | 45 | 3 | |
| | | Practical | DSC Lab 5 : **Practical-V** (Based on Paper 1 + Paper 2) | **B-ES353P** | 90 | 3 | |
| | | Theory | Paper 3**:** Environmental Microbiology | **B-ES354T** | 30 | 2 | |
| | | Practical | DSC Lab 6 : **Practical – VI** (Based on Paper 3) | **B-ES355P** | 30 | 1 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **VI** | Theory | Paper 1: Water Pollution: Monitoring & Management | **B-ES361T** | 45 | 3 | **12** |
| | | Theory | Paper 2: Water Supply & Wastewater Treatment | **B-ES362T** | 45 | 3 | |
| | | Practical | DSC Lab 7 : **Practical VII**<br>(Based on Paper 1 + Paper 2) | **B-ES363P** | 90 | 3 | |
| | | Theory | Paper 3: Natural Resources and GIS | **BES364T** | 30 | 2 | |
| | | Practical | DSC Lab 8**: Practical - VIII**<br>(Based on Paper 3) | **B-ES365P** | 30 | 1 | |
| **B.Sc. /IV (Honors)** | **VII** | Theory | **Paper 1**: Environmental Chemistry | **B-ESH471T** | 60 | 4 | **14** |
| | | Theory | **Paper 2**:- Environmental Biology, Microbiology and Biotechnology | **B-ESH472T** | 60 | 4 | |
| | | Practical | **DSC Lab 9** : **Practical IX** ,<br>Environmental Chemistry, Microbiology and Biotechnology<br>(Based on Paper 1 + Paper 2) | **B-ESH475P** | 180 | 6 | |
| | **VIII** | Theory | **Paper 1**: Environmental Ecosystem and Biodiversity | **B-ESH481T** | 60 | 4 | **14** |
| | | Theory | **Paper 2**: Analytical Techniques for Environmental Monitoring | **B-ESH482T** | 60 | 4 | |
| | | Practical | **DSC Lab 10** : **Practical X**<br>Environmental Ecosystem and Analytical Techniques<br>(Based on Paper 1 + Paper 2) | **B-ESH485P** | 180 | 6 | |
| **B.Sc./ IV (Honors with Research)** | **VII** | Theory | **Paper 1**: Environmental Chemistry | **B-ESR471T** | 60 | 4 | **10** |
| | | Theory | Paper 2: Environmental Biology, Microbiology and Biotechnology | **B-ESR472T** | 60 | 4 | |
| | | Practical | DSC Lab 11 : **Practical XI**,<br>Environmental Chemistry, Microbiology and Biotechnology<br>(Based on Paper 1 + Paper 2) | **B-ESR475P** | 60 | 2 | |
| | **VIII** | Theory | **Paper 1**: Environmental Ecosystem and Biodiversity | **B-ESR481T** | 60 | 4 | **10** |
| | | Theory | Paper 2 : Analytical Techniques for Environmental Monitoring | **B-ESR482T** | 60 | 4 | |
| | | Practical | DSC Lab 12 : **Practical XII ,**<br>Environmental Ecosystem and Analytical Techniques<br>(Based on Paper 1+Paper 2) | **B-ESR485P** | 60 | 2 | |

# Institute of Science, Nagpur
**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science

**Semesterwise Details for FP/CEP/RM/RP/OJT available for Environmental Science as Major Subject in accordance to NEP**

| Course/Year | Semester | Theory / Practical | Name of Paper | Course Code | Total Period Hrs. | Credits | Total Credits |
|---|---|---|---|---|---|---|---|
| **B.Sc./II** | **III** | Practical | FP : Field Project (Related to DSC) | **B-ES239P** | 60 | 2 | **2** |
| | **IV** | Practical | CEP : Community Service | **B-ES249P** | 60 | 2 | **2** |
| **B.Sc./ III** | **V** | Practical | CEP : Community Service | **B-ES3511P** | 30 | 1 | **1** |
| | **VI** | Practical | OJT : Internship / Apprenticeship (Related to DSC) | **B-ES369P** | 120 | 4 | **4** |
| **B.Sc./ IV (Honors)** | **VII** | Theory | RM : Research Methodology | **B-ESH476T** | 60 | 4 | **4** |
| | **VIII** | Practical | OJT : Internship / Apprenticeship (Related to DSC) | **B-ESH486P** | 120 | 4 | **4** |
| **B.Sc. /IV (Honors with Research)** | **VII** | Theory | RM : Research Methodology | **B-ESR476T** | 60 | 4 | **8** |
| | | Practical | RP : Research Project / Dissertation (Core) | **B-ESR477P** | 120 | 4 | |
| | **VIII** | Practical | RP : Research Project / Dissertation 1 (Core) | **B-ESR486P** | 120 | 4 | **8** |
| | | Practical | RP : Research Project / Dissertation 2 (Core) | **B-ESR487P** | 120 | 4 | |

# Institute of Science, Nagpur

**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science

**Semesterwise Details of GE/OE Courses available for any Major subject other than faculty of Science and Technology (Offered by Department of Environmental Science) in accordance to NEP to be implemented from 2024-25**

**Basket for GE/OE**

| Course/Year | Semester | Theory / Practical | GE | Name of Paper | Course Code | Total Period Hrs. | Credits |
|---|---|---|---|---|---|---|---|
| B.Sc. /I | I | Theory | GE 1 | Earth and Its Evolution | **B-ES113T** | 30 | 2 |
| | | Theory | GE 2 | Global Atmosphere and Climate Change | **B-ES114T** | 30 | 2 |
| | II | Theory | GE 3 | Constituents of Oceanography | **B-ES123T** | 30 | 2 |
| | | Theory | GE 4 | Ecology and Biodiversity | **B-ES124T** | 30 | 2 |
| B.Sc. /II | III | Theory | GE 5 | Earth Resources and Management | **B-ES237T** | 30 | 2 |
| | IV | Theory | GE 6 | Fundamentals of Remote Sensing & Geographic Information System | **B-ES247T** | 30 | 2 |
| B.Sc. /III | V | - | - | - | - | - | - |
| | VI | - | - | - | - | - | - |

# Institute of Science, Nagpur
**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science

**Semesterwise Details of Vocational Skill Courses (VSC) available for Environmental Science as Major Subject (Offered by Department of Environmental Science) in accordance to NEP to be implemented from 2024-25**

**Basket for VSC**

| Course/Year | Semester | Theory / Practical | VSC | Name of Paper | Course Code | Total Period Hrs. | Credits |
|---|---|---|---|---|---|---|---|
| B.Sc. /I | I | Practical | VSC 1 | VSC Lab 1: Water Analysis (Related to Subject 1) | **B-ES115P** | 60 | 2 |
| | | - | - | - | - | - | - |
| | II | Practical | VSC 2 | VSC Lab 2: Air Analysis (Related to Subject 1) | **B-ES125P** | 60 | 2 |
| | | - | - | - | - | - | - |
| B.Sc. /II | III | - | - | - | - | - | - |
| | IV | - | - | - | - | - | - |
| B.Sc. /III | V | - | - | - | - | - | - |
| | VI | Practical | VSC 3 | VSC Lab 3: Inquisitive Examination in Environmental Science | **B-ES368P** | 60 | 2 |

# Institute of Science, Nagpur
**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science

**Semesterwise Details of Skill Enhancement Courses (SEC) available for any subject (other than Environmental Science) as Major Subject (Offered by Department of Environmental Science) in accordance to NEP to be implemented from 2024-25**

### Basket for SEC

| Course/Year | Semester | Theory / Practical | SEC | Name of Paper | Course Code | Total Period Hrs. | Credits |
|---|---|---|---|---|---|---|---|
| B.Sc. /I | I | - | - | - | - | - | - |
| | | - | - | - | - | - | - |
| | II | - | - | - | - | - | - |
| | | - | - | - | - | - | - |
| B.Sc./ II | III | Practical | SEC 1 | SEC Lab 1 : Laboratory Essentials in Environmental Science | **B-ES238P** | 60 | 2 |
| | IV | Practical | SEC 2 | SEC Lab 2 : Primordial Instrumentation in Environmental Science | **B-ES248P** | 60 | 2 |
| B.Sc./ III | V | Practical | SEC 3 | SEC Lab 3: Soil Analysis | **B-ES3510P** | 60 | 2 |
| | VI | - | - | - | - | - | - |

**Semesterwise Details of IKS available for Environmental Science as Major Subject and VEC available for any subject (other than Environmental Science) as Major Subject (Offered by Department of Environmental Science) in accordance to NEP to be implemented from 2024-25**

| Course/Year | Semester | Theory / Practical | Course Category | Name of Paper | Course Code | Total Period Hrs. | Credits |
|---|---|---|---|---|---|---|---|
| B.Sc. /I | I | Theory | VEC | Environmental Studies | **B-ES116T** | 30 | 2 |
| | I | Theory | IKS | Indian Knowledge System | **B-ES117T** | 30 | 2 |
| | II | Theory | IKS | Indian Knowledge System | **B-ES126T** | 30 | 2 |

# Institute of Science, Nagpur

**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science

**Semesterwise Details of Minor Subject : Environmental Science as a Minor Subject and any other subject as Major Subject (Offered by Department of Environmental Science) in accordance to NEP to be implemented from 2024-25**

**Basket for Minor Subject**

| Course/Year | Semester | Theory / Practical | Minor | Name of Paper | Course Code | Total Period Hrs. | Credits |
|---|---|---|---|---|---|---|---|
| **B.Sc. /I** | **I** | - | - | - | - | - | - |
| | **II** | - | - | - | - | - | - |
| **B.Sc. /II** | **III** | Theory | MI.T1 | **Paper 1**:- Introduction to Green Chemistry, Soil Pollution and Water Resources | **B-ES234T** | 30 | 2 |
| | | Theory | MI.T2 | **Paper 2**:- Environmental Biology | **B-ES235T** | 30 | 2 |
| | | Practical | MI.P1 | Minor Lab 1 : **Practical - I** (Based on Minor Paper 1 + Paper 2) | **B-ES236P** | 60 | 2 |
| | **IV** | Theory | MI.T3 | **Paper 1**:- Solid and Hazardous Waste Management | **B-ES244T** | 30 | 2 |
| | | Theory | MI.T4 | **Paper 2**:- Biodiversity Conservation and Environmental Management. | **B-ES245T** | 30 | 2 |
| | | Practical | MI.P2 | Minor Lab 2 : **Practical - II** (Based on Minor Paper 1 + Paper 2) | **B-ES246P** | 60 | 2 |
| **B.Sc. /III** | **V** | Theory | MI.T5 | **Paper 1**:- Environmental Microbiology | **B-ES358T** | 30 | 2 |
| | | Practical | MI.P3 | Minor Lab 3 : **Practical - III** (Based on Minor Paper 1) | **B-ES359P** | 30 | 1 |
| | **VI** | - | - | - | - | - | - |
| | | - | - | - | - | - | - |

# Institute of Science, Nagpur
**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science
**Semesterwise Details of DSE available for Environmental Science as Major Subject in accordance to NEP to be implemented from 2024-25**

| Course/Year | Semester | Theory / Practical | Elective | Name of Paper | Course Code | Total Period Hrs. | Credits |
|---|---|---|---|---|---|---|---|
| **B.Sc./ I** | **I** | - | - | - | - | - | - |
| | **II** | - | - | - | - | - | - |
| **B.Sc. /II** | **III** | - | - | - | - | - | - |
| | **IV** | - | - | - | - | - | - |
| **B.Sc. /III** | **V** | Theory | ELT1 | **Elective 1** :- Earth Evolution, Atmosphere and Climate Change | **B-ES356T** | 30 | 2 |
| | | Practical | ELP1 | **DSE Lab 1** : **Practical - I**<br>Earth Evolution, Atmosphere and Climate Change<br>(Based on Elective 1) | **B-ES357P** | 60 | 2 |
| | **VI** | Theory | ELT2 | **Elective 2**:- Earth Resources & Remote Sensing, GIS | **BES366T** | 30 | 2 |
| | | Practical | ELP2 | DSE Lab 2 : **Practical - II**<br>Earth Resources & Remote Sensing, GIS<br>(Based on Elective 2) | **B-ES367P** | 60 | 2 |
| **B.Sc. /IV (Honors)** | **VII** | Theory | ELT3<br>OR<br>ELT4 | **Elective 3** : Atmospheric Science & Climate Change<br>**OR**<br>**Elective 4**: Environmental Legislation And Policy | **B-ESH473T**<br>**OR**<br>**B-ESH474T** | 60 | 4 |
| | **VIII** | Theory | ELT5<br>OR<br>ELT6 | **Elective 5**: Environmental Sampling and Resource Management<br>OR<br>**Elective 6**: Environmental Impact Assessment and Audit | **B-ESH483T**<br>**OR**<br>**B-ESH484T** | 60 | 4 |
| **B.Sc. /IV (Honors with Research)** | **VII** | Theory | ELT7<br>OR<br>ELT8 | **Elective 3** : Atmospheric Science & Climate Change<br>**OR**<br>**Elective 4**: Environmental Legislation And Policy | **B-ESR473T**<br>**OR**<br>**B-ESR474T** | 60 | 4 |
| | **VIII** | Theory | ELT9<br>OR<br>ELT10 | **Elective 5**: Environmental Sampling and Resource Management<br>**OR**<br>**Elective 6**: Environmental Impact Assessment and Audit | **B-ESR483T**<br>**OR**<br>**B-ESR484T** | 60 | 4 |

## Credit Specifications:

a. Theory/Tutorial Courses: One hour/credit/week (a minimum of 15 hours of teaching per credit is required in a semester.
b. Laboratory/Performance-Based Courses: A minimum of 30 hours in laboratory or Performance Based activities is required in a semester. Performance-based activities include Workshop based activities, internships, Apprenticeships, Field-based learning, community engagement learning, etc.
c. Each semester will consist of at least 15 weeks of Academic Work equivalent to 90 actual teaching days.

## Assessment:

The assessment Plan will consist of Continuous Internal Evaluation (CIE) and End Semester Evaluation (ESE) for each course/subject taken together.

**(A) Continuous Internal Evaluation (CIE) will be based**

**(a)** Attendance of the student during a particular semester

**(b)** An assignment (min. two) based on curriculum to be assessed by the teacher concerned

**(c)** Subject-wise class test (min. two) or activities conducted by the teacher concerned with proper rubrics.

**(d)** Expected classroom activities shall consist of Group Discussions, Seminars, PowerPoint Presentations, Elocution, Debate, Role Play, Case Studies, Educational Games, etc. The teacher is expected to undertake a minimum of four of the aforesaid activity.

**(e)** The CIE marks will be communicated to the examination cell at the end of each semester, but before the semester end examinations / as instructed by the Examination Cell. These marks will be considered for the declaration of the results.

**(f)** The record of internal marks, evaluation & results should be maintained for a min. period of three years by the respective department for verification by the competent authority. Separate circular will be issued for detailed direction regarding **Continuous Internal Evaluation (CIE)**

**(B) Semester End Evaluation (SEE)**

**(a) Pattern of Theory Question Paper of 30 marks**

1. There will be four units in each paper.
2. Maximum marks for each theory paper will be 30.
3. Question paper will consist of five questions, each of 6 marks.
4. Four questions will be on four units with internal choice (One question on each unit).
5. Fifth question will be compulsory with eight question of one mark each. (Two questions from each of the four units). Students will have to choice to solve any six.

**(b) Pattern of Theory Question Paper of 45 marks**

1. There will be four units in each paper.
2. Maximum marks for each theory paper will be 45.
3. Question paper will consist of five questions, each of 9 marks.
4. Four questions will be on four units with internal choice (One question on each unit).
5. Fifth question will be compulsory with twelve question of one mark each. (Three questions from each of the four units). Students will have to choice to solve any nine.

**(c) Pattern of Theory Question Paper of 60 marks**

1. There will be four units in each paper.
2. Maximum marks for each theory paper will be 60.
3. Question paper will consist of five questions, each of 12 marks.
4. Four questions will be on four units with internal choice (One question on each unit).
5. Fifth question will be compulsory with questions from each of the four units having equal weightage and there will be no internal choice.

**Standard of Passing**

The scope of the course, percentage of passing in Theory and Project, and Internal Assessment will be governed as per the following rules:

**(i)** To pass the Bachelor of Science (B.Sc.) 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, and 8$^{th}$ Semester Examinations, an examinee shall obtain not less than 50 % marks in each theory course/paper, taking CIE & SEE together and also not less than 25 % marks in SEE. Whereas, for practical/performance-based examinations an examinee shall obtain not less than 50 % marks in each practical, taking CIE & SEE together.

**(ii)** An examinee who is unsuccessful at the examination shall be eligible for admission to the subsequent examinations on payment of a fee prescribed for the examination together with the conditions of the ordinance in force from time to time.

# INSTITUTE OF SCIENCE, NAGPUR

**(An Autonomous Institute of Government of Maharashtra)**


## Teaching and Examination Scheme/
## Pattern of Examination and Question Papers/Syllabus
## Of

**Four-Year Bachelor of Science (Honors/Research) Degree with a Semester Pattern in Environmental Science**

**(Faculty of Science & Technology)**

# SEMESTER I & II

**To be implemented from Academic Year 2024-25**

# INSTITUTE OF SCIENCE, NAGPUR

**(An Autonomous Institute of Government of Maharashtra)**

## Department of Environmental Science

**Teaching and Examination Scheme**

**Bachelor of Science (Honors/Research)**

**Four-Year (Eight Semester Degree Course)**

## B.Sc. Sem.-I (Environmental Science-Major, Minor from Basket)

| Sr. No. | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | | | | |
| | | | | | **Th.** | **Tu.** | **Pr.** | | Duration of Examination (**Hrs.**) | Semester End Evaluation (**SEE**) | Continuous Internal Evaluation (**CIE**) | Minimum Passing Marks |
| 1. | **4.5** | **DSC** (One will be major and the other minor in Semester III) | **Subject 1: Environmental Science Paper I** : Fundamentals of Environmental Science | **B-ES111T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSC Lab 1: Practical – I (Related to Subject 1)** | **B-ES112P** | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| | | | Subject 2 : | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | Subject 2 Lab : | -- | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| 2. | | **GE** | **Refer to GE Basket** | **B-ES113T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Refer to GE Basket** | **B-ES114T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 3. | | **VSEC** | **Refer VSC Basket (Related to Subject 1)** | **B-ES115P** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| | | | **Refer VSC Basket** (Related to Subject 2) | -- | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 4. | | **AEC** | English Compulsory | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 5. | | **VEC** | **Environmental Studies** | **B-ES116T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Office Automation** | -- | | | | | | | | |
| 6. | | **IKS** | **Indian Knowledge System** | **B-ES117T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 7. | | **CC** | NSS /NCC/Sports /Cultural | -- | -- | -- | 4 | 2 | -- | -- | 100 | 50 |
| | **Total** | | | | **14** | **--** | **16** | **22** | **--** | **390** | **360** | **--** |

## B.Sc. Sem.-II (Environmental Science-Major, Minor from Basket)

| Sr. No. | Level | Course Category | Name of the Course (Title of the Paper) | Course Code | Teaching Scheme (Hrs.) | | | Total Credit | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | Tutorial | Practical | | Duration of Examination (Hrs.) | Semester End Evaluation (SEE) | Continuous Internal Evaluation (CIE) | Minimum Passing Marks |
| | | | | | Th. | Tu. | Pr. | | | | | |
| 1. | 4.5 | DSC (One will be major and the other minor in Semester III) | **Subject 1**: **Environmental Science Paper I** : Monitoring of Water, Soil and Air | **B-ES121T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **DSC Lab 2 : Practical – II** (**Related to Subject 1**) | **B-ES122P** | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| | | | Subject 2 : | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | Subject 2 Lab : | -- | -- | -- | 2 | 1 | 4 | 30 | 20 | 25 |
| 2. | | GE | **Refer to GE Basket** | **B-ES123T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| | | | **Refer to GE Basket** | **B-ES124T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 3. | | VSEC | **Refer VSC Basket** (Related to Subject 1) | **B-ES125P** | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| | | | **Refer VSC Basket** (Related to Subject 2) | -- | -- | -- | 4 | 2 | 4 - 6 | 60 | 40 | 50 |
| 4. | | AEC | English Compulsory | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 5. | | VEC | Constitution of India | -- | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 6. | | IKS | **Indian Knowledge System** | **B-ES126T** | 2 | -- | -- | 2 | 2 | 30 | 20 | 25 |
| 7. | | CC | NSS /NCC / Sports / Cultural | -- | -- | -- | 4 | 2 | -- | -- | 100 | 50 |
| | **Total** | | | | **14** | **--** | **16** | **22** | **--** | **390** | **360** | **--** |

**Total Credits:**

1. **Three-Year UG Degree Program: 132**
2. **Four-Year UG Degree Program: 176**

**Abbreviations:** Generic/Open Electives: **OE**, Vocational Skills & Skill Enhancement Courses: **VSEC**, Vocational Skill Courses: **VSC**, Skill Enhancement Courses: **SEC**, Ability Enhancement Courses: **AEC**, Indian Knowledge Systems: **IKS**, Value Education Courses: **VEC**, On Job Training (Internship/Apprenticeship): **OJT**, Field Project: **FP**, Community Engagement & Service: **CEP**, Co-curricular Courses: **CC**, Research Methodology: **RM**, Research Project: **RP**

## SUBJECT: ENVIRONMENTAL SCIENCE
## B.Sc. - I Year, SEMESTER – I/II

### Marking Scheme

### Theory : Continuous Internal Evaluation (CIE)

| Sr. No. | Course Category | Total Marks | Theory : Continuous Internal Evaluation (CIE) shall be based on | | | | |
|---|---|---|---|---|---|---|---|
| | | | Attendance | Assignment | Class Test | Classroom Activity | Reciprocate in Class |
| 1. | **DSC** | 20 | 4 | 4 | 4 | 4 | 4 |
| 2. | **GE** | 20 | 4 | 4 | 4 | 4 | 4 |
| 3. | **VEC** | 20 | 4 | 4 | 4 | 4 | 4 |
| 4. | **IKS** | 20 | 4 | 4 | 4 | 4 | 4 |

### Practical/Laboratory : Continuous Internal Evaluation (CIE)

| Sr. No. | Course Category | Total Marks | Practical/Laboratory : Continuous Internal Evaluation (CIE) shall be based on | | | | |
|---|---|---|---|---|---|---|---|
| | | | Attendance | Reagent Preparation | Instrumentation | Result Interpretation | Practical Performance |
| 1. | **DSC** | 20 | 4 | 4 | 4 | 4 | 4 |
| 2. | VSEC : **VSC** | **40** | 8 | 8 | 8 | 8 | 8 |

### Practical/Laboratory : Semester End Evaluation (SEE)

| Sr. No. | Course Category | Total Marks | Practical/Laboratory : Semester End Evaluation (SEE) shall be based on | | | | |
|---|---|---|---|---|---|---|---|
| | | | Long Expt. (Any One) | Short Expt. (Any Two) | Viva-Voce | Visit Report | Practical Record |
| 1. | **1. DSC Lab: Practical** (Related to Subject 1) | **30 M** | **10** | **10** (5M Each) | **04** | **03** | **03** |
| | **2.** VSEC : **VSC Practical** | **60 M** | **20** | **20** (10M Each) | **08** | **06** | **06** |

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - I Year, SEMESTER – I/II**
**Theory Paper DSC/VEC/IKS/GE, Semester End Evaluation (SEE)**

**Question Paper Format (Total Marks-30 Marks)**

| | |
|---|---|
| **Q.1 Long Answer Type** | **6 Marks** |
| **A] Unit 1** | **6M** |
| **Or** | |
| **B] Unit 1** | **3M** |
| **C] Unit 1** | **3M** |
| **Q.2 Long Answer Type** | **6 Marks** |
| **A] Unit 2** | **6M** |
| **Or** | |
| **B] Unit 2** | **3M** |
| **C] Unit 2** | **3M** |
| **Q.3 Long Answer Type** | **6 Marks** |
| **A] Unit 3** | **6M** |
| **Or** | |
| **B] Unit 3** | **3M** |
| **C] Unit 3** | **3M** |
| **Q.4 Long Answer Type** | **6 Marks** |
| **A] Unit 4** | **6M** |
| **Or** | |
| **B] Unit 4** | **3M** |
| **C] Unit 4** | **3M** |
| **Q.5 Short Answer Type** | **6 Marks** |
| **a) Unit 1** | **1M** |
| **b) Unit 1** | **1M** |
| **c) Unit 2** | **1M** |
| **d) Unit 2** | **1M** |
| **e) Unit 3** | **1M** |
| **f) Unit 3** | **1M** |
| **g) Unit 4** | **1M** |
| **h) Unit 4** | **1M** |

# INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)

## SYLLABUS

Of

**Four Year (Eight Semesters) Bachelor of Science Degree Course**

## ENVIRONMENTAL SCIENCE
## B.Sc. - First Year

# SEMESTER I

**To be implemented from Academic Year 2024-25**

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-I**
**Name of the Course Category: DSC**
**Name of the Course: Fundamentals of Environmental Science**
**Course Code: B-ES111T**
**Paper I**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | **:** | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **2 Hrs.** |

**Objectives:** To make Students:

1. Understand the basic concept of Environmental Science and components of Environment.
2. Comprehend the Atmospheric Chemistry, Green House Effect and Acid Rain.
3. Recognize the Physico-chemical parameters in Aquatic Chemistry.
4. Extricate the Physico-chemical properties involved Soil Chemistry.

**Expected Learning Outcomes:** After Studying the course Students will be able to:

1. Explain the concept of Environmental Science and components of Environment.
2. Elucidate the fundamentals of Atmospheric Chemistry, Green House Effect and Acid Rain.
3. Reveal the estimation concepts of Physico-chemical parameters in Aquatic Chemistry.
4. Describe the various Physico-chemical properties involved Soil Chemistry.

**30M**

**Unit I: Basics of Environmental Science** **(8 Hrs.)**

A. **Introduction of Environmental Science:** Definition, Types, Classification, Characteristics, Components and principles of environment, Scope and Need for Environmental Science, Global Environment and its Segments.

B. **Environmental Education:** Goals, Objectives and Principles of Environmental Education, formal and non-formal environmental education, importance of environmental education, Environmental Awareness and days.

C. **Components of Environment:** Atmosphere-(Structure and Composition), Hydrosphere-Distribution of Water on Earth, Hydrological Cycle, Lithosphere-Internal structure of Earth, Formation of Rocks and its types.

**Unit II: Basics of Atmospheric Science** **(8 Hrs.)**

A. **Atmospheric Chemistry:** Structure of atmosphere based on temperature, temperature inversion and lapse rate, smog formation, types of smog (sulphur and photochemical smog), adverse effect of smog on human being.
B. **Green House Effect:** Greenhouse gases, Control of greenhouse gases (GHG's). Ozone depletion: chemistry of Ozone depletion & its consequences, Dobson Unit, ozone depleting substances (ODS), ozone hole, mitigation measures and international protocols.
C. **Acid Rain:** Chemistry of Acid Rain, Effect of acid rain on Ecosystem, control measures. Precipitation – Forms of precipitation (rain, drizzle, snow, sleet, and hail), types of precipitation (conventional, orographic, and cyclonic).

**Unit III: Aquatic Chemistry** **(7 Hrs.)**

A. **Characteristics of Water:** Physical properties of water (specific and latent heat, viscosity, salinity, transparency, and pressure), chemical properties- solubility of gases in water, $CO_2$, oxygen, Nitrogen and $H_2S$.
B. **Physical Parameter of Water:** Colour, Temperature, Taste and Odour, turbidity, Conductivity, pH, Total Solids.
C. **Chemical Parameter:** Alkalinity & Acidity, Hardness, Chlorides, Dissolved Oxygen (DO), principle and method of estimation, prescribed limit in potable water as per WHO guidelines.

**Unit IV: Soil Chemistry** **(7 Hrs.)**

A. **Soil:** Definition, Composition of Soil, Types of Soil, Soil formation, Soil Profile, Soil Structure.
B. **Physical Properties of Soil:** Soil density, porosity, soil texture, soil permeability, soil temperature, soil colour.
C. **Chemical Properties of Soil:** Soil Component (Inorganic & Organic) Soil pH, Humus & its Formation, Cation and Anion Exchange Reaction of Soil, Nitrogen, Phosphorus and Potassium (NPK) in Soil.

**References:**


**[1]** Text Book of Environment: K M Agrawal, P.K. Sikdar, and S.C. Deb, Mc'Millan Publication, Mumbai.

**[2]** Man and Environment: M.C. Dash and P.C. Mishra, Mc'Millan Publication, Mumbai.

**[3]** Environmental Science: S. C. Santra, New Central Book Pvt. Ltd, Kolkatta.

**[4]** Environmental Problems and Solution: D. K. Asthana, S. Chand Publication, New Delhi.

**[5]** Environmental Chemistry: S.S. Dara, S. Chand Publication, New Delhi.

**[6]** Environmental Chemistry: B.K. Sharma, Goel Publication, Meerut.

**[7]** Environmental Chemistry: A.K. Dey, New Age International Publishers,2001.

**[8]** Man and Environment: P.R. Trivedi and Gurdeep Raj, Akashdeep Publishing House, New Delhi.

**[9]** Fundamentals Concepts in Environmental Studies: Dr. D. D. Mishra , S. Chand Publication, New Delhi.

**[10]** Climatology: D. S. Lal, Sharda Pustak Bhavan, Allahabad ,2003.

**[11]** A Textbook of Environmental Studies: Dr. S. Satyanarayan, Dr. S. Zade, Dr. S. Sitre and Dr. P. U. Meshram, Allied Publishers, New Delhi.

**[12]** Environmental Biology: Biswarup Mukherjee, Tata McGraw-Hill Publishing Company Ltd, New Delhi,1996.

**[13]** Animal Ecology and Distribution of Animals: Veer Bala Rastogi, Rastogi Publication, Meerut (U.P).

**[14]** Ecology and Environment: P. D. Sharma, Rastogi Publication, Meerut (U.P).

**[15]** Fundamentals of Environmental Biology: S. Arora, Kalyani Publishers.

**[16]** Plant Ecology and Soil Science: R.S. Shukla and P.S. Chandel, S. Chand Publication, New Delhi.

**[17]** Animal Ecology and Environmental Biology: H.R Singh,Vishal Publication.

**[18]** Environmental Biology: P. S. Verma and V. K. Agrawal, S. Chand Publication, New Delhi.

**[19]** Environmental Biology: P.K.G. Nair, Himalaya Publication.

**[20]** Environmental Biology: K.C. Agrawal, Agro Botanical Publisher, Bikaner,1994.

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-I**
**Name of the Course Category: DSC**
**Name of the Course: DSC Lab 1**
**Course Code: B-ES112P**
**Practical - I**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **1** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **4 Hrs.** |

**Objectives: To make Students**:

1. Learn water sampling for ground and surface water and its storage techniques.
2. Acquire skills of estimating physico-chemical parameters of water and wastewater sample.
3. Study about determination of moisture content, bulk density, water holding capacity of soil.

**Expected Learning Outcomes:** After studying this course and performing the given experiments, the student will be able to:

1. Carry-out Water sampling for ground and surface water and its storage techniques.
2. Estimate Physico-chemical parameters of water and wastewater sample
3. Determine moisture content, bulk density, water holding capacity of soil.

**DSC: DSC Lab 1 (Based on Subject 1): Practical – I** **30M**

(**Minimum 70 % practical shall be conducted in each semester**)

**1]** Water sampling for Ground and Surface Water and its Storage Techniques.

**2]** Demonstration of multi parameter analyser for water analysis.

**3]** Estimation of Alkalinity of Water and Wastewater sample.

**4]** Estimation of Acidity of Water and Wastewater.

**5]** Estimation of free $CO_2$ of Water and Wastewater sample.

**6]** Estimation of Total solids, Dissolved Solids, Suspended Solids of Water and Wastewater Sample.

**7]** Estimation of Chloride of Water and Wastewater sample by Argentometric method.

**8]** Determination of Moisture Content of Soil

**9]** Determination of Bulk Density of Soil

**10]** Determination of Water Holding Capacity of Soil

**11]** Measurement of Rainfall by Rain gauge.

**12]** Determination of Soil by its colour using Munsell colour chart.

**Academic Visit:**

1. Visit to Water body to study Lake Ecosystem.
2. Visit to agricultural land to study soil characteristics.
3. Visit to regional meteorological department.

All students shall undertake field visits and submit study tour report certified by the HOD at the time of Semester End Practical Examination.

**Field Diary:**

The students shall prepare their field diary under the following heads:

1). Air Quality index of City/Town/Village.

2). Waterbodies in City/Town/Village and its importance.

3). Soil Pollution sources in City/Town/Village.

**References:**

**[1]** A Manual of Water and Wastewater Analysis: Dr D.S. Ramteke and Dr C.A. Moghe, Published by NEERI, Nagpur, 1996.

**[2]** Laboratory Manual of Environmental Chemistry: Dr Smita Hooda and Dr Sumanjeet Kaur, S. Chand and Co. Ltd. New Delhi.1997.

**[3]** Physico-chemical Examination of Water Industrial Effluents: N. Manivaskaram, Pragti Prakashan, Meerut (U.P) 1996.

**[4]** Chemical and Biological Methods of Water Pollution Studies: R.K. Trivedi and P.K. Goel, Enviro Media Publication.

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-I**
**Name of the Course Category: GE (Generic Elective)**
**Name of the Course: Earth and Its Evolution**
**Course Code: B-ES113T**
**Paper - I**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **2 Hrs.** |

**Course Objectives: To make Students**:

1. Learn the Historical story of Earth
2. Gain the Knowledge about Evolution of Earth
3. Understand the Earth System Process
4. Acquire the knowledge of Fields of Earth and Evolutionary Processes

**Expected Learning Outcomes:** After Studying the course Students will be able to:

1. Expound the History of Earth
2. Comprehend the Evolutionary Process of Earth
3. Interpret the processes of Earth System
4. Utilize the knowledge about Fields of Earth

**30M**

**Unit I: History of Earth** **(8 Hrs.)**

Solar system formation and Planetary differentiation; Formation of the Earth: Formation and Composition of Core, Mantle, Crust, Atmosphere and Hydrosphere; Chemical Composition of Earth.

**Unit II: Evolution of Earth** **(7 Hrs.)**

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.

**Unit III: Earth System Processes** **(7 Hrs.)**

Movement of Lithosphere Plates; Mantle convection and Plate Tectonics, Major Plates and Hot-spots, Plate boundaries; Sea floor spread; Earthquakes; Volcanic Activities; Orogeny; Isostasy.

**Unit IV: Fields of Earth and Evolutionary Processes** **(8 Hrs.)**

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.

**References:**


**[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 ($5^{th}$ 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. Blackwell Publishing.

**[8]** Pelletier, J. D. 2008. Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago.

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-I**
**Name of the Course Category: GE (Generic Elective)**
**Name of the Course: Global Atmosphere and Climate Change**
**Course Code: B-ES114T**
**Paper - II**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **2 Hrs.** |

**Course Objectives: To make Students**:

1. Gain the knowledge about Atmospheric Circulation on Earth.
2. Recognize the Meteorological parameters.
3. Understand the concept of Global Warming and its impact.
4. Acquire the knowledge of Climate Change and Protocol.

**Expected Learning Outcomes:** After Studying the course Students will be able to:

1. Expound about the Atmospheric Circulation.
2. Interpret the importance of Meteorological parameters.
3. Elucidate the Global Warming and its impact.
4. Utilize the knowledge about Climate Change and Protocol.

**30M**

**Unit I: Atmospheric Circulation** **(8 Hrs.)**

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; EI Nina and La Nina; tropical cyclone; Indian monsoon; Asian brown clouds, atmospheric windows.

**Unit II: Meteorology and Atmospheric Stability** **(7 Hrs.)**

Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion, Gaussian plume model.

**Unit III: Global warming** **(8 Hrs.)**

Earth's climate through ages; trends of global warming and climate change; drivers of global warming, Greenhouse gases (GHG's), Potential of different Green House Gases (GHGs) causing the Climate Change; Montreal Protocol 1987.

**Unit IV: Climate Change** **(7 Hrs.)**

Impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, International agreements; Kyoto protocol 1997, Convention on Climate Change; carbon credit and carbon trading.

**References**:


**[1]** Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.

**[2]** Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.

**[3]** Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.

**[4]** Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.

**[5]** Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.

**[6]** Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.

**[7]** Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.

**[8]** Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.

**[9]** Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-I**
**Name of the Course Category: VSEC**
**Name of the Course: Vocational Skill Course-Laboratory 1 (VSC Lab 1) : Water Analysis**
**Course Code: B-ES115P**
**Practical - I**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **60 Hrs. (4 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **100 (60+40)** |
| **Min. Passing Marks** | **:** | **50** |
| **Exam Duration** | **:** | **4-6 Hrs.** |

**Objectives: To make Students**:

1. Learn the analysis of colour, odour and transparency of water sample.
2. Gain the Knowledge about studying pH and EC of water sample.
3. Understand the analysis of Solids, Turbidity and chloride in water sample.
4. Acquire the knowledge of concentration of acidity, alkalinity and hardness of water sample.

**Expected Learning Outcomes:** After studying this course and performing the given experiments, the student will be able to:

1. Explicate the analysis of colour, odour and transparency of water sample.
2. Comprehend the pH and EC of water sample.
3. Interpret the processes of Solids, Turbidity and chloride analysis of water sample
4. Illustrate the knowledge about acidity, alkalinity and hardness of water sample.

**VSEC: VSC Lab 1 (Related to Subject 1): Practical – I, Water Analysis 60M**

(**Minimum 70 % practical shall be conducted in each semester**)

**1]** Introduction to the Laboratory Rules and Regulations.

**2]** Demonstration, Calibration and use of Burette & Pipette, micropipette,

**3]** Demonstration, Calibration and use of Volumetric Flask and Measuring Cylinder.

**4]** Demonstration and Calibration of Analytical Balance.

**5]** Determination of colour of water sample.

**6]** Determination of odour of water sample.

**7]** Determination of taste of water sample.

**8]** Determination of transparency of waterbody.

**9]** Determination of pH of water sample.

**10]** Determination of Electrical Conductivity of water sample.

**11]** Determination of Turbidity of water sample.

**12]** Determination of Chlorides in water Sample.

**13]** Determination of hardness of water sample.

**14]** Determination of dissolved oxygen in water sample.

**Academic Visit:**

**1)** Visit to drinking water treatment plant.

**2)** Visit to local natural water body.

**3)** Visit to waste water treatment plant.

All students are expected to undergo any one field visit and submit the visit report certified by the HOD at the time of Semester end Practical Examination.

**References:**


**[1]** Laboratory Manual on Water Analysis, National Environmental Engineering Research Institute Nehru Marg, Nagpur-440 020 June.5th 1987

**[2]** Water Quality Analysis Laboratory Methods, Dr. (Mrs.) Leena Deshpande, National Environmental Engineering Research Institute (NEERI), Nagpur Council of Scientific & Industrial Research, New Delhi, Govt. of India

**[3]** Guide Manual, Water and Wastewater Analysis, CPCB

**[4]** Baird, R., & Bridgewater, L. (2017). Standard methods for the examination of water and wastewater. 23rd edition. Washington, D.C.: American Public Health Association.

**[5]** Chemistry for Environmental Engineering and Science, Sawyer, Mc Carty and Parkin 5th Edition.

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-I**
**Name of the Course Category: Value Education Course (VEC)**
**Name of the Course: Environmental Studies**
**Course Code: B-ES116T**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **2 Hrs.** |

**Objectives:** To make Students**:**

1. Learn about the multidisciplinary nature of Environmental Studies.
2. Gain the Knowledge about Ecosystems and Natural Resources of Earth.
3. Understand the Biodiversity Conservation practices and Environmental Pollution.
4. Acquire practical knowledge about Environmental Assets and Polluted sites

**Expected Learning Outcomes:** After Studying the course Students will be able to :

1. Explicate the corelation of multidisciplinary nature of Environmental Studies
2. Comprehend about the Ecosystems and Natural Resources of Earth.
3. Elucidate the Biodiversity Conservation practices and Environmental Pollution.
4. Demonstrate the detailed documentation of Environmental Assets and Polluted sites

**Value Education Course (VEC) : Environmental Studies** **30M**

**Unit I: Environmental Heritage** **(7 Hrs.)**

**Ecosystem**: Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession.

**a**) Forest ecosystem

**b**) Grassland ecosystem

**c**) Desert ecosystem

**d**) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**Unit II: Equitable use of Resources** **(8 Hrs.)**

**Renewable and Non-renewable Resources**: Land resources and land use change; Land degradation, soil erosion and desertification, Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water. Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs.

**Unit III: Biodiversity and Conservation** **(8 Hrs.)**

**Levels of Biological Diversity**: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots; Endangered and endemic species of India, Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity, Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

**Unit IV: Ecological Degradation** **(7 Hrs.)**

**Environmental Pollution**: types, causes, effects and controls; Air, water, soil and noise pollution, Nuclear hazards and human health risks, Solid waste management: Control measures of urban and industrial waste.

**Academic Visit:**

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, grassland, etc.

All students are expected to undergo any one field visit and submit the visit report.

**References:**


**[1]** Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.

**[2]** Gadgil, M., & Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.

**[3]** Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.

**[4]** Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.

**[5]** Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.

**[6]** Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.

**[7]** McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29-64). Zed Books.

**[8]** McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.

**[9]** Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.

**[10]** Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.

**[11]** Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.

**[12]** Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.

**[13]** Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.

**[14]** Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.

**[15]** Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

**[16]** Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.

**[17]** Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.

**[18]** Warren, C. E. 1971. Biology and Water Pollution Control. WB Saunders.

**[19]** Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York: Norton.

**[20]** World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press.

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-I**
**Name of the Course Category: IKS**
**Name of the Course: Indian Knowledge System**
**Course Code: B-ES117T**
**Paper I**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **2 Hrs.** |

**Objectives:** To make Students:

1. Expound about Bharatavarsha-A Land of Rare Natural Endowments
2. Acquire knowledge of Sacred Ecology
3. Understand the concept of Water Management & Transportation
4. Recognize the concepts of Ecology and Environment

**Expected Learning Outcomes:** After Studying the course Students will be able to:

1. Interpret Bharatavarsha as A Land of Rare Natural Endowments.
2. Demonstrate knowledge of Sacred Ecology
3. Expound the concept of Water Management & Transportation
4. Utilise the concepts of Ecology and Environment

### IKS : Indian Knowledge System 30M

**Unit I: Bharatavarsha-A Land of Rare Natural Endowments (8 Hrs.)**

- Largest cultivable area in the world.
- Protected and nurtured by Himalayas.
- The Sindhu-Ganga plain and the great coastal plains.
- The great rivers of India-Abundant rains, sunshine and warmth, vegetation, animals and mineral wealth.
- Geography of Bharatvarsh, uniqueness of Indian culture and Civilizational Journey
- The Vedic Corpus. The Itihasas-Ramayana and Mahabharata, The Puranas.

**Unit II: Sacred Ecology** **(7 Hrs.)**

- Sacred Forest (Naimisaranya, Panchvati, Dandkaranya etc.)
- Sacred Groves (Aaramika, Devkunj, etc.)
- Rainwater Harvesting System: Vav, Kund, Talav etc,
- Sacred Hills and Mountains (Kailash, Vindhyachal, Sahyadri, Satrunjay, Goverdhan),
- Kumbha: assimilation of ritual, myth, symbology, and cosmology.

**Unit III: Water Management & Transportation** **(8 Hrs.)**

- Harappan and Traditional Water Management System of Gujarat
- Historical Sites- Sringeverpur, South Indian Water Management System, Western Ghats
- Cave- Kanheri, etc.
- Communities Involved in Water Management
- Modes of Transportations and Reforms
- Grand Trunk Road (Uttarapath & Dakshinapath)
- Development of Trading Techniques
- Boat & Ship Building

**Unit IV: Ecology and Environment** **(7 Hrs.)**

- Nakshatra Gyaan and Agriculture
- Solar and Lunar Eclipses
- Vernacular Architecture
- Forest Management and Urban Planning
- Agroforestry

**References:**

**[1]** Vatasyayan, Kapila. 1997. The Square and the Circle of the Indian Arts, Abhinav Publication.

**[2]** An Introduction to Indian Knowledge Systems: Concepts and Applications, B Mahadevan, V R Bhat, and Nagendra Pavana R N; 2022 (Prentice Hall of India).

**[3]** Indian Knowledge Systems: Vol I and II, Kapil Kapoor and A K Singh; 2005 (D.K. Print World Ltd).

**[4]** D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., A Concise History of Science in India, 2nd Ed., Universities Press, Hyderabad, 2010.

**[5]** K. Ramasubramanian, A. Sule and M. Vahia, Eds. History of Astronomy: A Handbook, S and HI, I.I.T Bombay and T.I.F.R., Mumbai, 2016.

**[6]** S. Balachandra Rao, Indian Astronomy-Concepts and Procedures, M.P. Birla Institute of Management, Bengaluru, 2014.

# INSTITUTE OF SCIENCE, NAGPUR

(An Autonomous Institute of Government of Maharashtra)


## SYLLABUS

Of

**Four Year (Eight Semesters) Bachelor of Science Degree Course**

## ENVIRONMENTAL SCIENCE
## B.Sc. - First Year

# SEMESTER II

**To be implemented from Academic Year 2024-25**

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-II**
**Name of the Course Category: DSC**
**Name of the Course : Monitoring of Water, Soil and Air**
**Course Code: B-ES121T**
**Paper I**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | **:** | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **2 Hrs.** |

**Objectives:** To make Students:

1. Understand the Basics of Environmental Science.
2. Recognize methods of Water Sampling and Analysis and monitoring.
3. Identify the Soil sampling methodology; site selection, in-field sampling technique, soil profile, site description and equipment.
4. Know Basics of Meteorology and Measurement of Meteorological Parameters.

**Expected Learning Outcomes:** After Studying the course Students will be able to:

1. Describe the Basics of Environmental Science.
2. Explain methods of Water Sampling and Analysis and monitoring.
3. Elucidate Soil sampling methodology; site selection, in-field sampling technique, soil profile, site description and equipment.
4. Expound the Measurement of Meteorological Parameters.

**30M**

**Unit I: Basics of Environmental Science** **(8 Hrs.)**

A. **Land Resources**: Significance of topmost layer, Soil erosion (definition and types), causes of soil erosion (water, wind, and biotic agencies), control measures of soil erosion.

B. **Water Sources**: Availability and quality of surface water (River, lake and dam) and ground water (Open well and Bore well), water requirement for domestic consumption, specification for drinking water (physical, chemical and bacteriological) by Bureau of Indian Standards.

C. **Conservation and Management of Water**: Traditional methods, Ground water recharge and Rainwater Harvesting, Concept of Watershed Management.

**Unit II: Water Sampling and Monitoring:** **(7 Hrs.)**

A. **Water Sampling and Analysis**: Necessity of analysis, water sampling, types of water samples, selection of sample sites, collection, handling, labelling and preservation of samples, presentation and interpretation of results.
B. **Water Sampling and Monitoring:** Water quality monitoring on-field test parameters, off-field parameters, tools/instruments used for water sampling, drinking water standard (IS 10500 and WHO).
C. **Environmental Analysis**: Theory, principle and working of pH meter, turbidity meter and conductivity meter. Application of pH meter, turbidity meter and conductivity meter in environmental analysis.

**Unit III: Soil Monitoring and Management** **(7 Hrs.)**

A. **Soil Monitoring**: Objectives of soil monitoring/testing, sampling and sample units (sample number, frequency and timing), sampling methodology; site selection, in-field sampling technique, site description and equipment used.
B. **Soil Analysis**: Important soil quality indicators: pH, Electrical Conductivity (EC), Total nitrogen(N), sodium and potassium, guidelines for handling and storage of soil samples.
C. **Soil Management**: Soil as a sink for waste disposal, remediation of contaminated soil, National Waste Land Development (NWLD), GIS-application for management of soil resources.

**Unit IV: Basics of Meteorology** **(8 Hrs.)**

A. **Meteorology**: Aims and objectives of meteorology, Primary meteorological parameters (temperature, wind direction, wind speed and wind patterns), Secondary meteorological parameters (humidity, precipitation, atmospheric pressure, and solar radiation), importance of meteorology.
B. **Measurement of Meteorological Parameters**: Relative humidity by Psychrometer, Wind speed by Anemometer and Atmospheric pressure by monometer and barometer. weather forecasting (methods and types), Role of satellite in weather forecasting.
C. **Climatology**: Definition, aim and objectives, sub-division of climatology, difference between meteorology and climatology, fog and clouds (definition types and classification)

**References:**


**[1]** Text Book of Environment: K M Agrawal, P. K. Sikdar, and S. C. Deb, Mc'Millan Publication, Mumbai.

**[2]** Man and Environment: M. C. Dash and P. C.Mishra, Mc'Millan Publication, Mumbai.

**[3]** Environmental Science: S. C. Santra, New Central Book Pvt. Ltd, Kolkatta.

**[4]** Environmental Problems and Solution: D.K. Asthana, S. Chand Publication, New Delhi.

**[5]** Environmental Chemistry: S. S. Dara, S. Chand Publication, New Delhi.

**[6]** Environmental Chemistry: B. K. Sharma, Goel Publication, Meerut.

**[7]** Environmental Chemistry: A. K. Dey, New Age International Publishers,2001.

**[8]** Man and Environment: P. R. Trivedi and Gurdeep Raj, Akashdeep Publishing House, New Delhi.

**[9]** Fundamentals Concepts in Environmental Studies: Dr. D. D. Mishra, S. Chand Publication, New Delhi.

**[10]** Climatology: D. S. Lal, Sharda Pustak Bhavan, Allahabad,2003.

**[11]** A Textbook of Environmental Studies: Dr S. Satyanarayan, Dr S. Zade, Dr S Sitre and Dr. P. U. Meshram, Allied Publishers, New Delhi.

**[12]** Environmental Biology: Biswarup Mukherjee, Tata McGraw-Hill Publishing Company Ltd, New Delhi,1996.

**[13]** Animal Ecology and Distribution of Animals: Veer Bala Rastogi, Rastogi Publication, Meerut (U.P).

**[14]** Ecology and Environment: P.D. Sharma, Rastogi Publication, Meerut (U.P).

**[15]** Fundamentals of Environmental Biology: S. Arora, Kalyani Publishers.

**[16]** Plant Ecology and Soil Science: R.S. Shukla and P.S. Chandel, S. Chand Publication, New Delhi.

**[17]** Animal Ecology and Environmental Biology: H.R Singh, Vishal Publication.

**[18]** Environmental Biology: P.S. Verma and V.K. Agrawal, S. Chand Publication, New Delhi.

**[19]** Environmental Biology: P.K.G. Nair, Himalaya Publication.

**[20]** Environmental Biology: K.C. Agrawal, Agro Botanical Publisher, Bikaner,1994.

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-II**
**Name of the Course Category: DSC**
**Name of the Course: DSC Lab 2**
**Course Code: B-ES122P**
**Practical - II**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **1** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **4 Hrs.** |

**Objectives:**

**To make Students**:

1. Learn determination of pH, Conductivity, Turbidity of water and wastewater sample.
2. Acquire skill to Estimate Hardness, Free chlorine, Dissolved Oxygen (DO) of water and wastewater sample.
3. Study the determination of pH, Electrical Conductivity (EC), Total hardness, of soil.
4. Analyse Relative humidity, Wind speed and wind direction.

**Expected Learning Outcomes:** After studying this course and performing the given experiments, the student will be able to:

1. Carry-out the determination of pH, Conductivity, Turbidity of water and wastewater sample.
2. Estimate Hardness, Free chlorine, Dissolved Oxygen (DO) of water and wastewater sample.
3. Determine pH, Electrical Conductivity (EC), Total hardness, of soil.
4. Determine Relative humidity, Wind speed and wind direction.

**DSC Lab 2 (Based on Paper 1) : Practical II** **30M**

**(Minimum 70 % practical shall be conducted in each semester)**

**1]** Determination of pH of water and wastewater sample.

**2]** Determination of Conductivity of water and wastewater sample.

**3]** Determination of Turbidity of water and wastewater sample.

**4]** Estimation of Hardness of water and wastewater sample by Complexometric method.

**5]** Estimation of Free chlorine of water and wastewater sample.

**6]** Estimation of Dissolved Oxygen (DO) of water and wastewater sample.

**7]** Determination of Electrical Conductivity (EC) of soil.

**8]** Determination of pH of soil.

**9]** Determination of Total hardness of soil.

**10]** Determination of Relative humidity by Psychrometer.

**11]** Determination of Wind speed and wind direction by Anemometer.

**12]** Measurement of Solar Constant.

**Academic Visit:**

1. Regional Meteorology Centre, Nagpur
2. National Park/Sanctuaries
3. Visit to Nearby Forest to study the flora and fauna in its Natural Environment.

All students shall undertake field visits and submit study tour report certified by the HOD at the time of Semester end Practical Examination.

**Field Diary:**

The students shall prepare their field diary under the following heads:

**1)** Case study on natural waterbody pollution.

**2)** Case study on industrial pollution in the surrounding.

**3)** Ecologically Sensitive Zone in neighbourhood.

**References:**

**[1]** A Manual of Water and Wastewater Analysis: Dr D.S. Ramteke and Dr C.A. Moghe, Published by NEERI, Nagpur, 1996.

**[2]** Laboratory Manual of Environmental Chemistry: Dr Snita Hooda and Dr Sumanjeet Kaur, S. Chand and Co. Ltd. New Delhi.1997.

**[3]** Physico-chemical Examination of Water Industrial Effluents: N. Manivaskaram, Pragati Prakashan, Meerut (U.P) 1996.

**[4]** Chemical and Biological Methods of Water Pollution Studies: R.K. Trivedi and P.K. Goel, Enviro Media Publication.

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-II**
**Name of the Course Category: GE (Generic Elective)**
**Name of the Course: Constituents of Oceanography**
**Course Code: B-ES123T**
**Paper - III**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **2 Hrs.** |

**Course Objectives: To make Students**:

1. Learn about the basics of Geological Oceanography
2. Understand the concepts of Physical Oceanography
3. Know the fundamentals of Chemical Oceanography
4. Gain Knowledge of Biological Oceanography

**Expected Learning Outcomes:** After Studying the course Students will be able to:

1. Interpret the basics of Geological Oceanography
2. Elucidate about concepts of Physical Oceanography
3. Expound the fundamentals of Chemical Oceanography
4. Utilize the knowledge of Biological Oceanography

.

**30M**

**Unit I: Geological Oceanography** **(8 Hrs.)**

Dimensions and morphological features of modern oceanic basins, their time evolution in response of plate tectonics; Dynamics of coastal environment and role of past sea level changes on its morphology; Marine sediments, their formation/degradation, spatial distribution and classification Roles of lysocline/CCD, ocean circulation.

**Unit II: Physical Oceanography** **(7 Hrs.)**

Features of the Ocean, Physical properties of seawater and their spatial distributions; Spatio-temporal scales and forcing mechanisms of oceanic motions; Surface water circulation by wind stress, tides, waves, gyres; Coriolis force and geostrophic currents; Indian Ocean dipole.

**Unit III: Chemical Oceanography** **(7 Hrs.)**

General chemistry and thermodynamics of seawater; Dissolved chemical constituents, their spatial distributions and measurements; Atmosphere–ocean coupling and exchange of gases; Penetration of anthropogenic $CO_2$; Alkalinity and ocean acidification.

**Unit IV: Biological Oceanography** **(8 Hrs.)**

Basics of an ecosystem; Autotrophs and higher trophic levels; Planktonic and benthic ecology; Classification and global distributions of marine productivity; Redfield ratios of nutrients/micronutrients, and HNLC regions; Fe, N, P limitations; Depths of habitats and gametogenesis of forminifera.

**References**:


**[1]** Talley, L. D., Pickard, G. L., Emery, W. J., Swift, J. H., 2005, Descriptive Physical Oceanography: An Introduction ($6^{th}$ revised Edition), Elsevier Academic Press.

**[2]** Fundamentals of ocean acoustics, 2003, L. M Brekhovskikh, Yu. P. Lysanov, Springer

**[3]** Emerson, S., and Hedges, J., 2008, Chemical Oceanography and the Marine Carbon Cycle (1st Edition), Cambridge University Press.

**[4]** Zeebe, R. E., and Wolf-Gladrow, D., 2001, CO2 in Seawater: Equilibrium, Kinetics and Isotopes ($1^{st}$ Edition), Elsevier Science.

**[5]** Turekian, K. K., Holland, H. D., and Elderfield, H., 2003, The Oceans and Marine Geochemistry: Treatise on Geochemistry ($1^{st}$ Edition), Pergamon.

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-II**
**Name of the Course Category: GE (Generic Elective)**
**Name of the Course: Ecology and Biodiversity**
**Course Code: B-ES124T**
**Paper - IV**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **2 Hrs.** |

**Course Objectives: To make Students**:

1. Learn about the concept of Biosphere and Indian Biogeography.
2. Understand the basic Essentials of Ecology.
3. Know the idea of Population and Community Ecology.
4. Recognize the Biodiversity and Threats to it.

**Expected Learning Outcomes:** After Studying the course Students will be able to:

1. Explicate the association of Biosphere and Indian Biogeography.
2. Interpret the view about Essentials of Ecology.
3. Expound the Population and Community Ecology.
4. Utilize the knowledge of Biodiversity to prevent from Threats.

.

**30M**

**Unit I: Biosphere and Indian Biogeography** **(8 Hrs.)**

Geographical zones of the earth; Earth's planetary motions-rotation and revolution, seasonality, solstices and equinoxes. Concept and evolution of life; Types of Biomes and their distribution, temperature, wind pattern, soil, precipitation, flora and fauna, Phytogeographic realms (10 zones from tropic, temperate, subarctic and arctic regions) and Zoogeographic realms - 8 zones; Bio-geographical classification of India (10 zones); major forests in India - 16 Forest type groups - salient features.

**Unit II: Essentials of Ecology** **(7 Hrs.)**

Introduction to Ecology- Definition, principles and scope of ecology. Types of Ecology Ecological factors- climatic, topographic and biotic, Biogeochemical cycles- Definition, types and Importance, Global Hydrological cycles, Gaseous (carbon, oxygen, and nitrogen), Sedimentary (phosphorous and Sulfur).

**Unit III: Population and Community Ecology** **(8 Hrs.)**

Population Ecology: Definition, characteristic (natality, mortality, age structure, growth curve, dispersal, population size and density, biotic potential, Community Ecology: Definition, characteristics-species diversity, growth form, structure and dominance, Habitat Ecology Concepts, features and adaptations of Aquatic: Freshwater – lentic, lotic; Marine - neritic, estuarine - mangrove, intertidal, tidal flats, seagrass bed, coral bed; Oceanic – pelagic, benthic; Terrestrial habitat - major terrestrial biomes.

**Unit IV: Biodiversity and Threats** **(7 Hrs.)**

Basic concepts, importance and conservation needs, Genetic, species and ecosystem diversity, Biological and phylogenetic species concept, Basic concepts of speciation, species extinction. Biodiversity hot spots (Global, Indian), IUCN categories of species, Endangered and endemic species of India, Values of biodiversity, Threats to biodiversity-HIPPO- Habitat loss, Invasive species, population, pollution and over exploitation;

**References**:


**[1]** Principles of Environmental Biology-P. K. G. Nair, Himalaya Publ.

**[2]** Ecology and Environment- P. D. Sharma, Rastogi Publ.

**[3]** Plant Ecology and Soil Science- R. S. Shukla, P. S. Chandel, S Chand& company.

**[4]** Communities and Ecosystem- Witalkar.

**[5]** Manual of Field Ecology- R. Mishra.

**[6]** Concept of Ecology- E. J. Koromondy, Principal Hall.

**[7]** Modern Concept of Ecology- H. D. Kumar.

**[8]** Text book of Plant Ecology- R. S. Ambusth.

**[9]** Elements of Ecology- Brijgopal and Bharadwaj.

**[10]** Elements of Ecology- P. L. Kochar.

**[11]** Environmental Biology- K. C. Agrawal.

**[12]** A Text book of Ecology and Environment by P.C. Joshi and Namita Joshi, Himalaya

**[13]** Environment & Ecology by- Vaishali Anand, Mc Graw Hill

**[14]** Environmental Ecology and Natural Resources by Awdhutwar and Kute

**[15]** Fundamental of Ecology and Environment by Pranav Kumar

**[16]** Environment and Ecology by K. K. Agrawal

**[17]** Environment, Ecology, Bio-diversity, Climate Change and Disaster Management by – Ravi, Agrahari (Mc Graw Hill)

**[18]** Fundamentals of Ecology by E.P. Odum.

**[19]** Fundamentals of Ecology- M.C. Dash, Tata McGraw Hill Pub.

**[20]** Environmental Science - Van Cunninghnn, Tata McGraw Hill Pub.

**[21]** Ecology by Weiver and Climents

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-II**
**Name of the Course Category: VSEC**
**Name of the Course: Vocational Skill Course-Laboratory 2 (VSC Lab 2) : Air Analysis**
**Course Code: B-ES125P**
**Practical - II**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **60 Hrs. (4 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **100 (60+40)** |
| **Min. Passing Marks** | **:** | **50** |
| **Exam Duration** | **:** | **4-6 Hrs.** |

**Objectives: To make Students**:

1. Learn about measurement of temperature, humidity and wind speed of ambient air.
2. Gain the Knowledge of analysis of Rainfall, solar radiation and dust.
3. Understand the analysis of SPM in ambient air.
4. Acquire the knowledge of Bioaerosol-microorganisms present in the indoor and outdoor environment.

**Expected Learning Outcomes:** After studying this course and performing the given experiments, the student will be able to:

1. Evaluate the temperature, humidity and wind speed of ambient air
2. Comprehend the concentration of Rainfall, solar radiation and dust.
3. Interpret the quality of ambient air on the basis of SPM.
4. Utilize the knowledge Bioaerosol-microorganisms present in the indoor and outdoor environment.

**VSEC: VSC Lab 2 (Related to Subject 1 : Practical – II, Air Analysis** **60M**

**(Minimum 70 % practical shall be conducted in each semester)**

**1)** Measurement of maximum and minimum temperature at different times of day.

**2)** Determination of Humidity in ambient air.

**3)** Determination of Pressure in ambient air.

**4)** Determination of Wind speed in ambient air.

**5)** Study of wind direction in ambient air.

**6)** Measurement of Rainfall/precipitation.

7) Measurement of solar radiation/Intensity and its effect on growth of plants.
8) To estimate the amount dust (particulate matter) deposition on the leaves of roadside plants.
9) Analysis of Atmospheric Air particle (dust) by Dust Fall Jar Apparatus.
10) Measurement of Suspended Particulate Matter (SPM) by High Volume Sampler.
11) Measurement of Respirable Suspended Particulate Matter (RSPM) by Respirable Dust Sampler.
12) Assessment of Bioaerosol-microorganisms present in the indoor environment.
13) Assessment of Bioaerosol microorganisms present in the outdoor environment.
14) Assessment of Bioaerosol microorganisms present at the source of industrial pollution.

**Academic Visit:**

1) Visit to Weather display station.
2) Visit to MPCB, Nagpur.
3) Visit to regional meteorology department.

All students are expected to undergo any one field visit and submit the visit report certified by the HOD at the time of Semester end Practical Examination.

**References:**


[1] Stern A.C (1986) Air Pollution VoI. I-VII, Academic press.
[2] Parker H.W (1977). Air Pollution.
[3] Lodge (1994). Methods of air sampling and analysis
[4] R.K Trivedy and Goel P.K (1995) An Introduction to air pollution, Techno Science Publications Jaipur.
[5] Kudesiav. P. (1993). Air Pollution, Pragati Prakashan, New Delhi.
[6] Daniel Vallero. Fundamentals of Air Pollution, 5th Edition. 2014. Academic Press. Elsevier
[7] Sharma, N., Agarwal, A.K., Eastwood, P., Gupta, T., Singh, A. P. Air Pollution and Control 1st Edition. 2018. Springer
[8] Sportisse, Bruno. Fundamentals in Air Pollution. 1st Edition. 2010. Springer
[9] Susanne M. Charlesworth Colin A. Booth. Urban Pollution: Science and Management. 2018. John Wiley & Sons Ltd.

## Syllabus for Four Year (Eight Semesters) Degree Course

**SUBJECT: ENVIRONMENTAL SCIENCE**
**B.Sc. - First Year: Semester-II**
**Name of the Course Category: IKS**
**Name of the Course: Indian Knowledge System**
**Course Code: B-ES126T**
**Paper: II**

| | | |
|---|---|---|
| **Number of Credits** | **:** | **2** |
| **Total Hours (Per week)** | **:** | **30 Hrs. (2 Hrs.)** |
| **Total Marks (SEE+CIE)** | : | **50 (30+20)** |
| **Min. Passing Marks** | **:** | **25** |
| **Exam Duration** | **:** | **2 Hrs.** |

**Objectives:** To make Students:

1. Explicate about Fundamentals of IKS.
2. Acquire knowledge of Metallurgy, Textile Chemistry& Pyro Technology
3. Understand the concept of Mathematics & Astronomy
4. Recognize the importance of Ancient Indian Art and Architecture

**Expected Learning Outcomes:** After Studying the course Students will be able to:

1. Construe Fundamentals of IKS.
2. Demonstrate knowledge of Metallurgy, Textile Chemistry& Pyro Technology.
3. Expound the concept of Mathematics & Astronomy
4. Utilise the importance of Ancient Indian Art and Architecture.

### IKS: Indian Knowledge System 30M

#### Unit I: Fundamentals of IKS (8 Hrs.)

- Concept of building and testing hypothesis using the methods of tantrayukti.
- Introduction to pramanas and their validity, upapatti
- Standards of argumentation in the vada traditions (introduction to concepts of vaada, samvaada, vivaada, jalpa, vitanda)
- Concept of poorvapaksha, uttarapaksha,
- An overview of Indian contributions to technology, Technological Innovations

**Unit II: Metallurgy, Textile Chemistry& Pyro Technology (7 Hrs.)**

- Arthaśāstra as the earliest text describing gold, silver
- Copper/Bronze/Zinc: Important Mines (Zawar, Khetri mines)
- Iron and Wootz Steel Technology
- Textile and Dyeing- Indian Specialities (Kutchi Embroidery, Cotton Textile etc.)
- Ceramic Technology, Stone (Lapidary), Shell, Ivory, Faience & Glass Technology

**Unit III: Mathematics & Astronomy (7 Hrs.)**

- Mathematics contained in the Sulbasutra.
- Weaving Mathematics into Beautiful Poetry- Bhaskaracharya.
- The Evolution of Sine Function in India
- The Discovery of Calculus by Kerala Astronomers
- Vedanga Jyotish & Measuring Time & Calendar

**Unit IV: Ancient Indian Art and Architecture (8 Hrs.)**

- Geography of Bharatvarsh and Civilizational Journey,
- Origin of Sthapatyaveda,
- Concept of Space and Time,
- Vedic Yajna: Recreating the microcosmos, Vastu Purusha, Six Limbs of Indian Art and Architecture
- Harappan Town Planning, Early Historical Cities and Early Text (Arthshastra),
- Mud Forts of Chhattisgarh,

**References:**


**[1]** An Introduction to Indian Knowledge Systems: Concepts and Applications, B Mahadevan, V R Bhat, and Nagendra Pavana R N; 2022 (Prentice Hall of India).

**[2]** Indian Knowledge Systems: Vol I and II, Kapil Kapoor and A K Singh; 2005 (D.K. Print World Ltd).

**[3]** The Beautiful Tree: Indigenous India Education in the Eighteenth Century, Dharampal, Biblia Impex, New Delhi, 1983. Reprinted by Keerthi Publishing House Pvt Ltd., Coimbatore, 1995.

**[4]** R.M. Pujari, Pradeep Kolhe, N. R. Kumar, 'Pride of India: A Glimpse into India's Scientific Heritage', Samskrita Bharati Publication.

**[5]** Indian Contribution to science', compiled by Vijnana Bharati.

**[6]** Dr. Subhash Kak , Computation in Ancient India,Mount, Meru Publishing (2016)

**[7]** Robert Kanigel, The Man Who Knew Infinity: A Life of the Genius Ramanujan, Abacus, London, 1999

**[8]** Alok Kumar, Sciences of the Ancient Hindus: Unlocking Nature in the Pursuit of Salvation, CreateSpace Independent Publishing, 2014

**[9]** B.V. Subbarayappa, Science in India: A Historical Perspective, Rupa, New Delhi, 2013

**[10]** S. Balachandra Rao, Indian Mathematics and Astronomy: Some Landmarks, Jnana Deep Publications, Bangalore, 3rdedn, 2004

**[11]** S. Balachandra Rao, Vedic Mathematics and Science in Vedas, Navakarnataka Publications, Bengaluru, 2019

**[12]** Bibhuti bhushan Datta, Ancient Hindu Geometry: The Science of the Śulba, 1932, repr. Cosmo Publications, New Delhi, 1993

**[13]** Bibhuti bhushan Datta & Avadhesh Narayan Singh, History of Hindu Mathematics, 1935, repr. Bharatiya Kala Prakashan, Delhi, 2004

**[14]** Coomaraswamy, Ananda K. 2002. Early Indian Architecture: Cities and City-Gates, Munshiram Manoharlal Publishers.

**[15]** Vatasyayan, Kapila. 1997. The Square and the Circle of the Indian Arts, Abhinav Publication.