

**KAVAYITRI BAHINABAI CHAUDHARI  
NORTH MAHARASHTRA UNIVERSITY,  
JALGAON**



'A' Grade  
NAAC Re-Accredited  
(3<sup>rd</sup> Cycle)

**SYLLABUS STRUCTURE OF**  
**B. Sc. [Environment Science]**  
**T. Y. B. Sc.**

**UNDER CHOICE BASED CREDIT SYSTEM (CBCS)**

**[2020-21]**

## PREAMBLE

The syllabus has been prepared anticipating the requirements of B.Sc. Environment Science students under Choice Based Credit System (CBCS) Program. The contents have been drawn to accommodate the widening horizons of the Environment Science discipline and reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

The course curriculum outlined here is designed in an inclusive and interdisciplinary manner and draws content from various allied disciplines. Ideally, an undergraduate programme in environmental science should focus equally on theory and practice so that students are able to pick up necessary skills enabling them to find gainful employment at the job market. Therefore, a number of skill-based courses have been identified and made a part of the curriculum. Attention was also paid to structuring various core courses so as to make them appealing from a practitioner's point of view. It is hoped that a student with a B.Sc. Environmental Science (Hons.) degree, after having read the courses outlined here, should feel adequately equipped to meet the challenges of career development. At the same time, there is sufficient content for those who wish to continue academic life at the university beyond undergraduate level. That said, due care has been taken to maintain necessary academic rigor and depth in the course content so that the learning outcomes from these courses will lead to intellectual growth of a student.

The present syllabus is restructured anticipating the future needs of Environment Science with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Environment Science.

Hence, Board of Studies in Environmental Science through online consultation resolved to accept the revised syllabus for T. Y. B. Sc. (Environmental Science) based on Choice Based Credit System (CBCS) of UGC guidelines.

## Scheme of B. Sc. program (Faculty of Science and Technology)

	First Year				Second Year				Third Year				Total Credit value	
	Semester I		Semester II		Semester III		Semester IV		Semester V		Semester VI			
	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses		
<b>1</b>	<b>Core courses (16)</b>													
	(i) Theory	4	4	4	4	4	3	4	3					4 X14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2X14=28
<b>2</b>	<b>Ability enhancement compulsory course(AECC) (2)</b>													
		2	1	2	1									2X2=04
<b>3</b>	<b>Skill Enhancement Course (SEC) (4)</b>													
					2	1	2	1	2	1	2	1		2 X4= 16
<b>4</b>	<b>Discipline Specific Elective DSE (6)</b>													
	(i) Theory									4	3	4	3	4X6=24
	(ii) Practical									2	3	2	3	2X6 =12
	<b>Total Credit value (Credit x No. of Courses )</b>		<b>26</b>	<b>26</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>132</b>	

### ➤ Course Structure:

**Duration:** The duration of B.Sc. (Environment Science) degree program shall be three years.

**Medium of instruction:** The medium of instruction for the course shall be **English**.

The present syllabus has been prepared to:

- i. Accommodate the advanced topic on the Environment Science discipline
- ii. Build the basic science knowledge at the level of first year of Environment Science
- iii. Reflect the changing needs of the students. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Environment Science. For this purpose, more focus on relevant experimentation on the topics is included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of Environmental Microbiology. The relevant practical are included to enrich their knowledge.

At third year under-graduation, six theory and three practical papers each for two semesters are included to uncover all applied areas of Environment Science.

The courses codes and titles for the courses are as given below: **T. Y. B. Sc. Envi-Environment Science.**

➤ **Discipline Specific Elective [DSE]**

(Six Theory and Three Practical Papers each semester)

Sem	DSE	Paper Code	Paper Name	Paper Code	Paper Name	Practical Paper Code	Practical Paper Name
V	A I	Envi-501	Environmental Pollution – I	Envi-502	Biodiversity and its Conservation – I	Envi-503	Laboratory Course based on Theory Paper-V
	A II	Envi-504	Basic Concept in Environmental Toxicology – I	Envi-505	Remote Sensing & GIS – I	Envi-506	Laboratory Course based on Theory Paper-VI
	A III	Envi-507	Instrumental Techniques in Environmental Analysis –I	Envi-508	Environmental Biotechnology – I	Envi-509	Laboratory Course based on Theory Paper-VII
VI	A IV	Envi-601	Environmental Pollution – II	Envi-602	Biodiversity and its Conservation – II	Envi-603	Laboratory Course based on Theory Paper-VIII
	A V	Envi-604	Basic Concept in Environmental Toxicology – II	Envi-605	Remote Sensing & GIS – II	Envi-606	Laboratory Course based on Theory Paper-IX
	A VI	Envi-607	Instrumental Techniques in Environmental Analysis –II	Envi-608	Environmental Biotechnology – II	Envi-609	Laboratory Course based on Theory Paper-X

➤ **More Options to Discipline Specific Elective**

DSE	Paper I	Paper II	Practical Paper
DSE 4	Environmental Chemistry	Fundamentals of Ecology & Ecosystem	Practical Paper
DSE 5	Water & water Resources	Soil Conservation & Management	Practical Paper
DSE 6	Industrial Safety & Hygiene	Environmental Management System	Practical Paper
DSE 7	Dissertation		

➤ **Skill enhancement courses (SEC) (any Four):**

Student has choice to study any one course from respective semester subject to the availability of particular course at respective college

Semester	SEC	Course Title	SEC	Course Title
V	SEC V	Air Monitoring Techniques	SEC VI	Water Monitoring Techniques
VI	SEC VII	Noise & Illumination Monitoring Techniques	SEC VIII	Laboratory Hazard & Safety Measures

**Scheme of T. Y. B. Sc. (Environment Science)**

Semester	CORE COURSE				Skill Enhancement Course (SEC)		
	DSE		Credits	Hours		Credits	Hours
V	DSE- 1 A: Core Course I: <b>Environment Science (Sp)</b>	Paper I (Envi-501)	4	30	<b>SEC 1</b>	2	30
		Paper II (Envi-502)	4	30			
		Practical Paper (Envi-507)	2	60			
	DSE- 2 A: Core Course II	Paper I (Envi-503)	4	30			
		Paper II (Envi-504)	4	30			
		Practical Paper (Envi-508)	2	60			
	DSE- 3 A: Core Course III	Paper I (Envi-505)	4	30			
		Paper II (Envi-506)	4	30			
		Practical Paper (Envi-509)	2	60			
VI	DSE- 1 A Core Course IV: <b>Environment Science (Sp)</b>	Paper I (Envi-601)	4	30	<b>SEC 2</b>	2	30
		Paper II (Envi-602)	4	30			
		Practical Paper (Envi-607)	2	60			
	DSE- 2 A Core Course V	Paper I (Envi-603)	4	30			
		Paper II (Envi-604)	4	30			
		Practical Paper (Envi-608)	2	60			
	DSE- 3 A: Core Course VI	Paper I (Envi-605)	4	30			
		Paper II (Envi-606)	4	30			
		Practical Paper (Envi-609)	2	60			

➤ **Duration of lecture:** 30 Lectures of 60 minutes or 36 Lectures of 50 min or 60 Lectures of 30 minutes.

➤ **Examination Pattern**

Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination.

- **External Examination:** Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
  - Question 1 (12 marks): a) MCQ solve any 6 out of 8    b) Definitions solve any 3 out of 5
  - Question 2 (12 marks): Answer in one sentence, solve any 6 out of 8
  - Question 3 (12 marks): Answer in short, solve any 4 out of 6
  - Question 4 (12 marks): Explain or Short notes, solve any three out of 5
  - Question 5 (12 marks): Broad answer questions, solve any 2 out of 3
- **Internal examination (40 marks each semester):** Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.
- **Practical Examination:** Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5 – 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date. There shall be 5 marks for laboratory log book and well written journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

➤ **Equivalence for T.Y. B.Sc. (Environment Science) is furnished in the following table:**

<b>Old Syllabus (w. e. f. June 2017) (Semester pattern 60:40)</b>	<b>New Syllabus (w. e. f. June 2020) CBCS pattern (Semester pattern 60:40)</b>	<b>Remark, If any</b>
Envi- 311: Environmental Pollution – I	Envi- 501: Environmental Pollution – I	Code of the Paper change
Envi- 312: Biodiversity and its Conservation – I	Envi- 502: Biodiversity and its Conservation – I	Code of the Paper change
Envi-313: Basic Concept in Environmental Toxicology – I	Envi-503: Basic Concept in Environmental Toxicology – I	Code of the Paper change
Envi-314: Remote Sensing & GIS – I	Envi-504: Remote Sensing & GIS – I	Code of the Paper change
Envi-315: Instrumental Techniques in Environmental Analysis –I	Envi-505: Instrumental Techniques in Environmental Analysis –I	Code of the Paper change
Envi-316: Environmental Biotechnology – I	Envi-506: Environmental Biotechnology – I	Code of the Paper change
Envi- 317: Practical Course Based On Theory Papers	Envi- 507: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 318: Practical Course Based On Theory Papers	Envi- 508: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 319: Practical Course Based On Theory Papers	Envi- 509: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 321: Environmental Pollution – II	Envi- 601: Environmental Pollution – II	Code of the Paper change
Envi- 322: Biodiversity and its Conservation – II	Envi- 602: Biodiversity and its Conservation – II	Code of the Paper change
Envi-323: Basic Concept in Environmental Toxicology – II	Envi-603: Basic Concept in Environmental Toxicology – II	Code of the Paper change
Envi-324: Remote Sensing & GIS – II	Envi-604: Remote Sensing & GIS – II	Code of the Paper change
Envi-325: Instrumental Techniques in Environmental Analysis –II	Envi-605: Instrumental Techniques in Environmental Analysis –II	Code of the Paper change
Envi-326: Environmental Biotechnology – II	Envi-606: Environmental Biotechnology – II	Code of the Paper change
Envi- 327: Practical Course Based On Theory Papers	Envi- 607: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 328: Practical Course Based On Theory Papers	Envi- 608: Practical Course Based On Theory Papers	Code of the Paper change
Envi- 329: Practical Course Based On Theory Papers	Envi- 609: Practical Course Based On Theory Papers	Code of the Paper change

## SEMESTER –V

### DSE A-I: Paper I

#### Envi- 501: Environmental Pollution – I (Theory)

TOTAL HOURS: 30

CREDITS: 4

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of pollution, pollutants, also about air, water and marine pollution		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand the basic concept in pollution, pollutants, their types and effects.</li><li>• Understand air pollution with sources, causes and effects on biotic community.</li><li>• Understand water pollution with sources, causes and effects on biotic community.</li><li>• Understand Marine pollution with sources, causes and effects on biotic community</li><li>• Aware about their control strategies of different types of pollutions.</li></ul>		
<b>I</b>	<b>Introduction to Environmental Pollution</b>	<ul style="list-style-type: none"><li>• Definition of pollution</li><li>• Pollutants</li><li>• Factors of pollution, Types of pollutants</li><li>• Levels and Movement of pollutants, Effects of pollution.</li></ul>	<b>6</b>
<b>II</b>	<b>Air pollution</b>	<ul style="list-style-type: none"><li>• Meaning and definition of air pollution</li><li>• Sources and Types of air pollutants</li><li>• Air pollution in India</li><li>• Adverse effects of air pollution</li><li>• Smog and Acid rains, Control of air pollution.</li></ul>	<b>8</b>
<b>III</b>	<b>Water pollution</b>	<ul style="list-style-type: none"><li>• Definition of water pollution</li><li>• Sources and Types of water pollutants</li><li>• Nature and types of water pollution</li><li>• Surface water pollution, Ground water pollution</li><li>• Ganga pollution and its control measures</li><li>• Waste water treatment technology in industries</li><li>• Primary, Secondary and Tertiary treatment of Sewage Treatment Plants.</li></ul>	<b>10</b>
<b>IV</b>	<b>Marine pollution</b>	<ul style="list-style-type: none"><li>• Introduction, Sources and nature of pollutants sea water pollution</li><li>• Industrial waste and sewage sludge</li><li>• Disposal of plastic litters, Oil pollution and Marine biota,</li><li>• Petrochemicals in the sea, Coral reefs and pollution.</li></ul>	<b>6</b>



## DSE A-I: Paper II

### Envi- 502: Biodiversity and its Conservation - I (Theory)

TOTAL HOURS: 30

CREDITS: 4

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of bioethics and importance of biodiversity, information about different species and environmental movements		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand the concept of biodiversity, their types, classification and their social, ethical and optional values.</li><li>• Aware about bioethics, habitat destruction, fragmentation, degradation and pollution.</li><li>• Aware about endangered and endemic species in the world and in the India.</li><li>• Aware for the conservation of biodiversity through In-situ and Ex-situ.</li><li>• Study of major environmental movements (case study) associated with environment and biodiversity conservation.</li></ul>		
<b>I</b>	<b>Introduction to Biodiversity</b>	<ul style="list-style-type: none"><li>• Introduction, Definition, Genetic, Species and Ecosystem diversity</li><li>• Bio-geographical classification of India</li><li>• India as Mega-diversity Nation, Value of biodiversity</li><li>• Consumptive and Productive use</li><li>• Social, Ethical and Optional values</li></ul>	<b>9</b>
<b>II</b>	<b>Bioethics and Conservation</b>	<ul style="list-style-type: none"><li>• Key ethical arguments, Causes of extinction</li><li>• Habitat destruction, Habitat fragmentation, Habitat degradation &amp; Pollution</li><li>• Introduction of exotic species, diseases, over exploitation, shifting and jhum cultivation.</li></ul>	<b>8</b>
<b>III</b>	<b>Endangered and Endemic species</b>	<ul style="list-style-type: none"><li>• In India and in World countries</li><li>• Conservation of biodiversity</li><li>• In-situ and Ex-situ conservation</li><li>• Hotspot biodiversity.</li></ul>	<b>6</b>
<b>IV</b>	<b>Major Environmental movements</b>	<ul style="list-style-type: none"><li>• Chipko movement</li><li>• Silent Valley Movement</li><li>• Appiko movement</li><li>• Narmada Bachao Andolan,</li><li>• Tehri Dam conflicts and ideological trends in Indian environmentalists</li></ul>	<b>7</b>

## DSE A-II: Paper III

### Envi- 503: Basic Concepts in Environmental Toxicology – I (Theory)

TOTAL HOURS: 30

CREDITS: 4

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of basics in environmental toxicology		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understands the concept of toxicology, toxicants, their exposure with time and dose, concept of carcinogen and mutagen.</li><li>• Study the mechanism of bioaccumulation, biomagnifications, acute and chronic toxicity.</li><li>• Understand the factors affecting the toxicity</li><li>• Study the toxicity of gaseous pollutants like CO, NO<sub>x</sub>, SO<sub>x</sub> and petroleum solvents.</li></ul>		
<b>I</b>	<b>Basic Principles of Toxicology</b>	<ul style="list-style-type: none"><li>• Pollutants, Responses to toxic exposure</li><li>• Duration and frequency of exposure</li><li>• Dose response relationship</li><li>• Carcinogens</li><li>• Mutagens</li><li>• Natural defense mechanism</li></ul>	<b>9</b>
<b>II</b>	<b>Toxic substances</b>	<ul style="list-style-type: none"><li>• Environmental toxicant</li><li>• Bioaccumulation</li><li>• Bio magnification</li><li>• Toxic residues</li></ul>	<b>7</b>
<b>III</b>	<b>Toxicity</b>	<ul style="list-style-type: none"><li>• Factors affecting toxicity of chemicals</li><li>• Evaluation of toxicity</li><li>• Bio assay test, Acute and Chronic toxicity</li></ul>	<b>8</b>
<b>IV</b>	<b>Toxicology of gaseous pollutants</b>	<ul style="list-style-type: none"><li>• Carbon monoxide</li><li>• Oxides of Nitrogen</li><li>• Sulphur dioxides</li><li>• Petroleum and Solvents</li></ul>	<b>6</b>

## DSE A-II: Paper IV

### Envi- 504: Remote Sensing and GIS – I (Theory)

**TOTAL HOURS: 30**

**CREDITS: 4**

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of fundamental of RS, sensors, satellite and GIS		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"> <li>• Understand the fundamental of remote sensing and their use in environment segments.</li> <li>• Study of different sensors with their principles and working.</li> <li>• Understand the construction and working of satellites with different resolution.</li> <li>• Interpreted the image using different visual and digital recognition elements.</li> <li>• Understand the concept of GIS, data using in GIS, scanning, digitization and use of GPS.</li> </ul>		
<b>I</b>	<b>Fundamentals of Remote Sensing</b>	<ul style="list-style-type: none"> <li>• Definition, concept and history of remote sensing</li> <li>• Electro-magnetic radiation, Energy interaction with atmosphere, interaction with Earth's surface materials</li> <li>• Spectral reflectance curve, Spectral signatures</li> <li>• Concept of atmospheric window</li> </ul>	<b>7</b>
<b>II</b>	<b>Sensors</b>	<ul style="list-style-type: none"> <li>• Introduction and types-active and passive sensors</li> <li>• Along track and across track scanners</li> <li>• Optical sensor, Microwave sensor</li> <li>• Thermal sensor and hyper spectral sensor</li> <li>• Sensor resolution- spectral, spatial, radiometric, temporal</li> <li>• Platforms: Introduction and types -Ground based, air borne and space borne platforms</li> </ul>	<b>8</b>
<b>III</b>	<b>Satellites</b>	<ul style="list-style-type: none"> <li>• Satellites types, satellite orbit: geosynchronous and sun synchronous satellites</li> <li>• Indian remote sensing program Characteristics of IRS-P6</li> <li>• High resolution satellites: IKONOS and Quick Bird.</li> <li>• Image analysis: visual and digital, Recognition elements: Tone, Texture, Pattern, Shape, Size, Shadow and Association</li> </ul>	<b>7</b>
<b>IV</b>	<b>Introduction to Geographic Information Systems</b>	<ul style="list-style-type: none"> <li>• Definition, components of GIS</li> <li>• Concept of map, Map scale and Types of Maps</li> <li>• Data: spatial and non-spatial data, raster and vector data, GIS file formats:, Shapefile and GRID File</li> <li>• Scanning, Digitization, Geometric transformation</li> <li>• Topology: introduction, relationships and topological errors, attribute data query, spatial data query</li> <li>• Global Positioning system (GPS) – Introduction</li> </ul>	<b>8</b>

## DSE A-III: Paper V

### Envi- 505: Instrumental Techniques in Environmental Analysis - I (Theory)

TOTAL HOURS: 30

CREDITS: 4

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of instrumental methods, elementary electronics, EMR and sampling techniques		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand the use of instruments for environmental analysis, classification of instruments, detection limits and errors associated with instruments techniques.</li><li>• Study of basic of elementary electronics of instrumentations.</li><li>• Study of EMR and its interactions with property of wave, particles.</li><li>• Understand the concept of polarization absorption and emission.</li><li>• Understanding the process of sampling, concept of standard solution, normalities, and oxidation numbers.</li></ul>		
<b>I</b>	<b>Instrumental methods of Analysis</b>	<ul style="list-style-type: none"><li>• Introduction, Classification of instrumental methods</li><li>• Components of instruments</li><li>• Confidence intervals, Detection limit</li><li>• Precision and accuracy</li><li>• Constant errors and proportionate errors</li></ul>	<b>7</b>
<b>II</b>	<b>Elementary Electronics</b>	<ul style="list-style-type: none"><li>• Semiconductors</li><li>• Properties of Silicon and Germanium Semiconductor</li><li>• Semiconductor diodes</li><li>• Transistors, bipolar, Amplifiers, Filters</li><li>• Voltage regulators, Readout devices</li></ul>	<b>7</b>
<b>III</b>	<b>Electromagnetic Radiation and its Interaction</b>	<ul style="list-style-type: none"><li>• Properties of electromagnetic radiation</li><li>• Wave properties, Particle properties of radiation,</li><li>• Energy units, Electromagnetic spectrum</li><li>• Polarization of radiation, Absorption of radiation</li><li>• atomic absorption and molecular absorption</li><li>• Emission radiation</li></ul>	<b>8</b>
<b>IV</b>	<b>Sampling and Basic Concepts in Chemical Analysis</b>	<ul style="list-style-type: none"><li>• Basis of sampling, Sampling procedures</li><li>• Sampling statistics, Hazards in sampling</li><li>• Standard solutions, Preparation of standards</li><li>• Equivalentents</li><li>• Normality and oxidation numbers</li><li>• Titrimetric Analysis, Gravimetric analysis</li></ul>	<b>8</b>

## DSE A-III: Paper VI

### Envi- 506: Environmental Biotechnology - I (Theory)

TOTAL HOURS: 30

CREDITS: 4

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of environmental biotechnology, biomass, biomass energy and bioremediation		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understanding the concept of environmental biotechnology and its global impacts on different field like agriculture, health care and environment.</li><li>• Study the composition of biomass and its types.</li><li>• Study the biomass energy gain from petroleum plants, hydrocarbon, liquid fuel and biogas.</li><li>• Understand the concept of bioremediation with different micro-organisms.</li></ul>		
<b>I</b>	<b>Introduction of Environmental Biotechnology</b>	<ul style="list-style-type: none"><li>• Scope and importance</li><li>• Global impact of biotechnology Healthcare, Agriculture</li><li>• Environment, Biotechnology in India</li><li>• Need for future development</li><li>• Ban on genetic food</li><li>• Gene bank and Plant conservation.</li></ul>	<b>9</b>
<b>II</b>	<b>Biomass</b>	<ul style="list-style-type: none"><li>• Biomass as an energy source</li><li>• Composition of biomass</li><li>• Terrestrial biomass, Aquatic biomass</li><li>• Saline water hyacinth</li><li>• Waste as a renewable source of energy,</li><li>• enzymatic digestion.</li></ul>	<b>7</b>
<b>III</b>	<b>Biomass energy</b>	<ul style="list-style-type: none"><li>• Petroleum plants</li><li>• Hydrocarbon from higher plants</li><li>• Alcohol the liquid fuel</li><li>• Biogas</li></ul>	<b>6</b>
<b>IV</b>	<b>Bioremediation</b>	<ul style="list-style-type: none"><li>• In situ bioremediation</li><li>• Intrinsic bioremediation</li><li>• Ex-situ bio remediation</li><li>• Bioremediation of hydrocarbons – use of mixture of bacteria</li><li>• Use of genetically engineered bacterial strains</li></ul>	<b>8</b>

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## DSE A-I: Practical Paper VII

### Envi- 507: Practical Course Based On Theory Papers (Practical)

**TOTAL HOURS: 60**

**CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understanding the concept of sampling and its preservations</li><li>• Demonstrate on pH and EC meter for monitoring the pH and electrical conductivity of water and soil samples.</li><li>• Analyse the water with different parameters like solids, available &amp; residual chlorine, and phosphate for determining its quality.</li><li>• Understand and study of water quality criteria for drinking as well as for waste water.</li></ul>	
1	Study of Safety Instructions	4
2	Collection & Preservation of Water Sample	4
3	Determination of Colour of Industrial effluents	4
4	To study principles, component & working operation of pH & EC Meter	4
5	To study principles, component & working operation of Turbidity Meter	4
6	To study principles, component & working operation of DO Meter	4
7	Determination of pH & Conductivity of water sample	4
8	Determination of Volatile Solids from soil sample	4
9	Determination of Phosphate from the water	4
10	Determination of Dissolved oxygen by DO meter	4
11	Determination of Residual chlorine from water sample	4
12	Determination of Available chlorine from water sample	4
13	Determination of the total solids from water sample	4
14	Study of Quality criteria of Water for Drinking Purpose	4
15	Study of Quality criteria of Water for Industrial and other Purpose	4

**Note: Mandatory to perform at least 12 practicals**

## DSE A-II: Practical Paper VIII

### Envi- 508: Practical Course Based On Theory Papers (Practical)

**TOTAL HOURS: 60**

**CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand and study of Air and Noise quality criteria for determining the pollution level.</li><li>• Demonstrate on RDS sampler for monitoring of oxides of nitrogen, oxides of sulphur, SPM and RSPM.</li><li>• Analyse the chlorophyll contents for estimation of pollution load.</li><li>• Understand and study of adaptations of some plants as a pollution resistant.</li></ul>	
1	Study of quality criteria of Air and Noise pollutions	4
2	To study principle, components and working operation of respirable dust sampler	4
3	Determination of NO <sub>x</sub> from ambient air	4
4	Determination of SO <sub>x</sub> from ambient air	4
5	Determination of SPM from ambient air	4
6	Determination of RSPM from ambient air	
7	Study of effect of Sulphur dioxide on plants	4
8	Study of effect of Hydrogen sulphide on plants	4
9	Determination of Noise level	4
10	Ecological adaptations of Xerophytes	4
11	Determination of Leaf extract pH of a given plant leaf.	4
12	Determination of Chlorophyll- <i>a</i> content of a given sample.	4
13	Determination of Relative Water Contents (RWC) of a given plant leaf.	4
14	Determination of Density, Abundance and Frequency of component species in a Grassland community.	4
15	Determination of requisite size and number of quadrants to be laid down for studying vegetation.	4

**Note: Mandatory to perform at least 12 practicals**

## DSE A-III: Practical Paper IX

### Envi- 509: Practical Course Based On Theory Papers (Practical)

**TOTAL HOURS: 60**

**CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand and study of metal digestion and analysis.</li><li>• Demonstrate on instruments which are used in environmental analysis like Spectrophotometer, flame photometer, gas chromatography.</li><li>• Analyse the selected metal for estimation of pollution load.</li><li>• Understand and study of construction and working of ETP for waste water treatment.</li></ul>	
1	Nitric acid digestion for metal analysis	4
2	Nitric acid and Hydrochloric acid digestion for metal analysis	4
3	Nitric acid perchloric acid digestion for fluoride analysis	4
4	Nitric acid sulphuric acid digestion for metal analysis	4
5	Study and demonstration of Atomic Absorption Spectrophotometer	4
6	Study and Demonstration of UV-visible spectrophotometer	4
7	Study and demonstration of Flame Photometer	4
8	Estimation of Sodium by Flame Photometer from the provided sample.	4
9	Estimation of Potassium by Flame Photometer from the provided sample.	4
10	Study on molarity, normality and buffers	4
11	Determination of Chlorides from water sample	4
12	To study the construction and working of Effluent Treatment Plant	4
13	Estimation of chromium in water.	4
14	Estimation of Zinc from the provided sample	4
15	Estimation of Mercury from the provided sample	4

**Note: Mandatory to perform at least 12 practicals**



## SEMESTER –VI

### DSE A-IV: Paper I

#### Envi- 601: Environmental Pollution – II (Theory)

TOTAL HOURS: 30

CREDITS: 4

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of noise, solid waste, thermal and radioactive pollution		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand Noise pollution with sources, causes and effects on biotic community.</li><li>• Understand Solid waste pollution with sources, causes and effects on biotic community.</li><li>• Understand Thermal pollution with sources, causes and effects on biotic community.</li><li>• Understand Radioactive pollution with sources, causes and effects on biotic community.</li><li>• Aware about their control strategies of different types of pollutions.</li></ul>		
<b>I</b>	<b>Noise Pollution</b>	<ul style="list-style-type: none"><li>• Definition of Sound and Noise</li><li>• Measurement of noise level, Sources of noise pollution</li><li>• Noise pollution level in India</li><li>• Effects of noise pollution, Concept of sound, Noise and hearing problems, Measurement of noise pollution</li><li>• Noise mapping</li></ul>	<b>8</b>
<b>II</b>	<b>Solid Waste</b>	<ul style="list-style-type: none"><li>• Introduction, History and origin of solid waste</li><li>• Methods of solid waste collection</li><li>• Classification of solid waste</li><li>• Solid waste treatment methods- Pyrolysis, Incineration, Microbial treatment</li></ul>	<b>7</b>
<b>III</b>	<b>Thermal Pollution</b>	<ul style="list-style-type: none"><li>• Introduction, Source and effects of thermal pollution on ecosystem</li><li>• Hazardous effects, Long term impacts</li><li>• Process of mixing heated effluents with receiving water</li><li>• Thermal effects on marine life and bacteria</li><li>• Effect on water quality, man and its environment</li></ul>	<b>8</b>
<b>IV</b>	<b>Radioactive Pollution</b>	<ul style="list-style-type: none"><li>• Radioactivity, Natural radioactivity</li><li>• Characteristics of alpha, beta and gamma rays</li><li>• Radiochemistry, Types of radiochemistry</li><li>• Radioactive substances</li><li>• Classification of radioactive isotopes</li><li>• Case study of radioactive pollution, Chernobyl and Three mile island</li></ul>	<b>7</b>

## DSE A-IV: Paper II

### Envi- 602: Biodiversity and its Conservation - II (Theory)

TOTAL HOURS: 30

CREDITS: 4

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of importance of biodiversity conservation through forest and wild life protection		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand the international agreements associated with environmental awareness.</li><li>• Understand and study of forest and their types, relation between forest and global warming, carbon sink, nature pollution indicators.</li><li>• Understand and study the forest conservation through laws.</li><li>• Concept of forest fire, forest population heavy loss of green belt and forest research in India.</li><li>• Understand the strategies for wildlife conservation through study of depletion of wildlife and their effects.</li></ul>		
<b>I</b>	<b>Environmental Movement</b>	<ul style="list-style-type: none"><li>• Genesis of global environmental movement</li><li>• environmental resolution- Public Participation</li><li>• Politics of green movements.</li></ul>	<b>6</b>
<b>II</b>	<b>International Agreements and Environmental Awareness</b>	<ul style="list-style-type: none"><li>• Earth Summit</li><li>• Convention of Biodiversity</li><li>• United Nations Convention on Climate Change</li><li>• Biodiversity Act (2002)</li></ul>	<b>7</b>
<b>III</b>	<b>Protection of Forest</b>	<ul style="list-style-type: none"><li>• Introduction, Importance of forest</li><li>• Forest and Global warming, Forest are carbon sink and sources of carbon</li><li>• Nature's pollution indicators -Forest</li><li>• India's forests, Types of forest, National Forest Policy</li><li>• Forest conservation through laws, Preservation or Conservation strategies</li><li>• Forest fire, Forest and Indian population</li><li>• Heavy loss of green belt, Forest research in India</li></ul>	<b>9</b>
<b>IV</b>	<b>Strategies for Wild life</b>	<ul style="list-style-type: none"><li>• Introduction, Importance of wild life to man</li><li>• Reasons for depletion of wildlife</li><li>• Effects of wildlife depletion, Reasons for wildlife conservation</li><li>• Categories of Indian wild life, Endangered species, Protected wild life of India</li><li>• Biosphere research program</li><li>• Wild life research in India</li><li>• Wild life education and training</li></ul>	<b>8</b>

## DSE A-V: Paper III

### Envi- 603: Basic Concepts in Environmental Toxicology – II (Theory)

TOTAL HOURS: 30

CREDITS: 4

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of soil , air, water toxicology with bio-transformation		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand the basics of soil toxicology.</li><li>• Study of toxic elements of air and water like Lead, Mercury, Arsenic, Chromium, Cadmium, Nickel, Bismuth, Zinc, Copper, Manganese, etc.</li><li>• Aware about toxicity of pesticides and their effects.</li><li>• Understand the concept of eco-toxicology, public health, animals in relation to human health.</li></ul>		
<b>I</b>	<b>Soil toxicology</b>	<ul style="list-style-type: none"><li>• Organic chemicals in the soil environment</li><li>• Inorganic chemicals in the soil environment</li></ul>	<b>6</b>
<b>II</b>	<b>Effect of Toxic elements for Air and Water</b>	<ul style="list-style-type: none"><li>• Lead</li><li>• Mercury</li><li>• Arsenic</li><li>• Chromium</li><li>• Cadmium</li><li>• Nickel</li><li>• Bismuth</li><li>• Thallium, Vanadium</li><li>• Zinc</li><li>• Copper</li><li>• Manganese</li></ul>	<b>8</b>
<b>III</b>	<b>Toxicity of Pesticides</b>	<ul style="list-style-type: none"><li>• Introduction</li><li>• Classification of pesticides</li><li>• Pesticide and human health</li></ul>	<b>8</b>
<b>IV</b>	<b>Bio transformation Phase I and Phase II</b>	<ul style="list-style-type: none"><li>• Chemical toxicants</li><li>• Industrial and Agricultural wastes</li><li>• Eco-toxicology</li><li>• Public health, Animals in relation to human health</li><li>• Ecological change and diseases</li><li>• Water relation to human health</li><li>• Urbanization stress and health</li></ul>	<b>8</b>

## DSE A-V: Paper IV

### Envi- 604: Remote Sensing and GIS – II (Theory)

**TOTAL HOURS: 30**

**CREDITS: 4**

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of Vector and raster data use in RS & GIS, applications of RS & GIS in different field		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"> <li>• Understand the analysis of vector data using buffering.</li> <li>• Study the analysis of raster data using overlay features.</li> <li>• Understand and study of applications of RS and GIS in agriculture field.</li> <li>• Understand and study of applications of RS and GIS in social science &amp; Geo- disaster management field.</li> <li>• Understand and study of applications of RS and GIS in forestry, ecology, and watershed &amp; water resource management.</li> </ul>		
<b>I</b>	<b>Vector Data Analysis</b>	<ul style="list-style-type: none"> <li>• Buffering – Variations in Buffering</li> <li>• Overlay- Feature Type and overlay</li> <li>• concept of Distance measurement</li> <li>• concept of Pattern analysis</li> </ul>	<b>7</b>
<b>II</b>	<b>Raster Data Analysis</b>	<ul style="list-style-type: none"> <li>• Data Analysis Environment</li> <li>• Concept of Local Operations</li> <li>• Concept of Physical distance Measurement Operations</li> <li>• Comparison of Vector- and Raster- Based Data Analysis</li> </ul>	<b>8</b>
<b>III</b>	<b>Applications of RS and GIS in Agriculture, Soil Sciences and Drought Management</b>	<ul style="list-style-type: none"> <li>• <b>Agriculture:</b> Introduction – Agriculture Ecosystems, Yield parameters, identification of crops and acreage estimation, disease identification</li> <li>• <b>Soil Sciences:</b> Introduction –Soil classification, Spectral response curve of soils, soil mapping, mapping and monitoring of degraded land</li> <li>• <b>Drought Management:</b> Introduction, Types of drought, consequences, drought management</li> </ul>	<b>7</b>
<b>IV</b>	<b>Applications of RS and GIS in Forestry and Ecology and Watershed and Water Resource Management</b>	<ul style="list-style-type: none"> <li>• <b>Forestry and Ecology:</b> Introduction - forest density, Forest type mapping, inventory of forests, delineation of degraded forests, damage assessment, Landscape characterization, Biomass assessment</li> <li>• <b>Watershed and Water Resource Management:</b> Sustainable watershed management, Spectral response of pure water, Water pollution detection, Salinity and waterlogged area mapping</li> </ul>	<b>8</b>

## DSE A-VI: Paper V

### Envi- 605: Instrumental Techniques in Environmental Analysis -II (Theory)

TOTAL HOURS: 30

CREDITS: 4

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of principles and working operation of different environmental instruments, chromatography, spectro-photometry and environmental statistics		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand the use of different instruments like pH meter, EC meter, Turbidity meter, Flame photo meter, Bomb Calorimeter, etc.</li><li>• Study of spectrophotometer using UV-visible and Atomic Absorption Spectrophotometer.</li><li>• Study of chromatography techniques using column chromatography, Ion exchange chromatography, Thin layer chromatography, Gas chromatography and HPLC.</li><li>• Understand the concept of environmental statistics through mean, mode, median and variance.</li></ul>		
<b>I</b>	<b>Principle and Applications of Instruments</b>	<ul style="list-style-type: none"><li>• pH meter,</li><li>• Potentiometry</li><li>• Conductometry</li><li>• Turbidimetry</li><li>• Flame Photometry</li><li>• Bomb Calorimeter</li><li>• Neutron Activation Analysis</li><li>• Isotope Dilution Analysis.</li></ul>	<b>6</b>
<b>II</b>	<b>Spectrophotometry</b>	<ul style="list-style-type: none"><li>• Introduction - UV-visible spectrophotometer</li><li>• Single beam/Double beam, Radiation sources, Wavelength selection, Sample containers, Detectors</li><li>• Atomic absorption spectrophotometer-Introduction, Radiation sources, Wavelength selection, Sample containers, Detectors</li><li>• Introduction to Inductively Coupled Plasma Optical Emission Spectroscopy (ICPOES).</li></ul>	<b>9</b>
<b>III</b>	<b>Chromatography</b>	<ul style="list-style-type: none"><li>• An introduction of chromatography</li><li>• Classification of separation methods</li><li>• Classification of chromatography</li><li>• Qualitative and quantitative analysis</li><li>• Column chromatography</li><li>• Liquid-liquid Partition chromatography</li><li>• Ion exchange, Thin layer, Paper, Gas Chromatography</li><li>• HPLC, Electrophoresis</li></ul>	<b>7</b>

<b>IV</b>	<b>Environmental Statistics</b>	<ul style="list-style-type: none"> <li>• Fundamental of Statistics</li> <li>• Mean</li> <li>• Mode</li> <li>• Median</li> <li>• Variance</li> </ul>	<b>8</b>
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## DSE A-VI: Paper VI

### Envi- 606: Environmental Biotechnology - II (Theory)

**TOTAL HOURS: 30**

**CREDITS: 4**

Unit No.	Title	Topics	Lectures
<b>Course Objective</b>	To acquaint students with basic concepts of bioremediation, bioleaching and hazards of environmental engineering		
<b>Learning outcome</b>	On completion of the course, students are able to: <ul style="list-style-type: none"> <li>• Understanding the concept of toxicity of bioremediation through metal and dyes.</li> <li>• Study the concepts of xenobiotics.</li> <li>• Study the process of bioleaching using different micro-organisms</li> <li>• Understand the hazards in environmental engineering through growth inhibition and replacement of natural strains.</li> </ul>		
<b>I</b>	<b>Bioremediation Toxicity</b>	<ul style="list-style-type: none"> <li>• Bioremediation of heavy metals, Bioremediation of dyes</li> <li>• Genetic modification in industrial effluents</li> <li>• Wastewater treatment technology</li> <li>• Role of microbes in effluents</li> </ul>	<b>7</b>
<b>II</b>	<b>Bioremediation</b>	<ul style="list-style-type: none"> <li>• Xenobiotics</li> <li>• Gene manipulation of pesticides regarding microorganisms</li> </ul>	<b>7</b>
<b>III</b>	<b>Bioleaching</b>	<ul style="list-style-type: none"> <li>• Introduction, Definition</li> <li>• Types of leaching- Direct &amp; Indirect leaching</li> <li>• Microorganism used in leaching</li> <li>• Leaching of Copper</li> <li>• Leaching of Uranium</li> <li>• Leaching of Gold and Silver</li> </ul>	<b>8</b>
<b>IV</b>	<b>Hazards of Environmental engineering</b>	<ul style="list-style-type: none"> <li>• Survival of gene modified microorganisms in the environment</li> <li>• Adaptive mutagenesis</li> <li>• Effect of environmental factors on gene transfer</li> <li>• Ecological impacts of gene modified microorganisms released in the environment</li> <li>• Growth inhibition of natural strains</li> <li>• Replacement of natural strains</li> </ul>	<b>8</b>

## DSE A-IV: Practical Paper VII

### Envi- 607: Practical Course Based On Theory Papers (Practical)

**TOTAL HOURS: 60**

**CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Determine different parameters like ammonia, nitrates and sulphate from water samples to describe its quality.</li><li>• Demonstrate on turbidity meter to determine the water turbidity.</li><li>• Analyse the soil for measuring the chlorides for determining its quality.</li><li>• Understand and study of water quality criteria for drinking as well as for sewage waste water through BOD and COD.</li></ul>	
1	Determination of pH & Conductivity of sewage water sample	4
2	Determination of pH & Conductivity of soil sample	4
3	Determination of Nitrate from the water.	4
4	Determination of Sulphate from the water.	4
5	Determination of Ammonia from the water	4
6	Estimation of coliform bacteria from water by MPN test (2 days required)	4
7	Determination of Turbidity by Turbidity meter	4
8	Determination of Ca & Mg Hardness of given water sample	4
9	Determination of Calcium & Magnesium ions from given water sample	4
10	Determination of soil moisture	4
11	Determination of chlorides from soil sample	4
12	Determination of DO of sewage water sample	4
13	Determination of BOD of sewage water sample	4
14	Determination of COD of sewage water sample	4
15	Determination of MPN of water sample	4

**Note: Mandatory to perform at least 12 practicals**

## DSE A-V Practical Paper VIII

### Envi- 608: Practical Course Based On Theory Papers (Practical)

**TOTAL HOURS: 60**

**CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand and study of physical characteristics of soil like bulk density, water holding capacity, organic carbon, organic matter etc.</li><li>• Study and determining the atmospheric fungi for its effects on human</li><li>• Analyse the chlorophyll contents for estimation of pollution load.</li><li>• Understand and study of adaptations of different plant and animal species for survival in the environment.</li></ul>	
1	Estimation of Primary productivity	4
2	Determination of soil bulk density	4
3	Determination WHC of soil	4
4	Estimation of Organic carbon	4
5	Demonstration of Spirometer for use in occupational health	4
6	Demonstration of Audiometer for use in occupational health	4
7	Assessment of Atmospheric Fungi using Petri plate method (2 days required)	4
8	Ecological adaptations of Mesophytes	4
9	Ecological adaptations of Hydrophytes	4
10	Determination of Sludge Volume Index	4
11	Determination of Oil & grease from given water sample	4
12	To study and analyze the Physical parameters of solid waste	4
13	To study and analyze the Chemical parameters of solid waste	4
14	Study on noise pollution in flourmills	4
15	Study on dust pollution in flourmills	4

**Note: Mandatory to perform at least 12 practicals**



## DSE A-VI: Practical Paper IX

### Envi- 609: Practical Course Based On Theory Papers (Practical)

**TOTAL HOURS: 60**

**CREDITS: 2**

Sr. No.	Title of the Practical	Hours
Course Objective	To acquaint with various laboratory techniques used in Environmental Science	
Learning Outcome	On completion of the course, students are able to: <ul style="list-style-type: none"><li>• Understand and study of satellite images using different characteristic like tone, texture, pattern, shape and size.</li><li>• Demonstrate on instruments which are used in environmental analysis like Bomb calorimeter and HPLC.</li><li>• Computation of environmental statistics through mean, mode, median and variance.</li><li>• Understand and study of determination of selected metal for their toxicological effects.</li></ul>	
1	Study and Demonstration of Bomb calorimeter	4
2	Estimation of Chlorophyll content by TLC method	4
3	Study and Demonstration of Gas Chromatography	4
4	Computation of Mean, Median, Mode and Variance of the given environmental data set	4
5	Use of excel program for calculating mean, standard deviation.	4
6	Use of excel program for preparation of chart and graphs.	4
7	Use of MS-Word for creating document, tables and graphs.	4
8	Study of Satellite Image	4
9	Study of Thematic Map	4
10	Demonstration on the use of GPS	4
11	Marked the latitude and longitude and preparation of location map using GPS	4
12	Use of GIS software for environment studies	4
13	Estimation of Iron from the provided sample	4
14	Estimation of Lead from the provided sample	4
15	Estimation of Cadmium from the provided sample	4

**Note: Mandatory to perform at least 12 practicals**

## Reference Books for Semester V & VI (T. Y. B. Sc. – Environment Science)

### ❖ Envi-501 & 601 - Environmental Pollution - I & II

1. Environmental chemistry by B. K. Sharma, Goel publication house, Meerut, Sixth revised edition – 2001.
2. Environmental geography by Savindra Singh, Prayag Pustak Bhavan, Allahabad. Revised edition – 2002.
3. Ecology and environment by P. D. Sharma, Rastogi publications, Meerut. Seventh edition – 2004.
4. Environmental studies by S. T. Ingle and S. R. Thorat, Prashant publications, Pune, First edition – 2005.

### ❖ Envi- 502 & 602 - Biodiversity and its Conservation – I & II

1. Environmental chemistry by B. K. Sharma, Goel publication house, Meerut, Sixth revised edition – 2001.
2. Environmental geography by Savindra Singh, Prayag Pustak Bhavan, Allahabad. Revised edition – 2002.
3. Ecology and environment by P. D. Sharma, Rastogi publications, Meerut. Seventh edition – 2004.
4. Environmental studies by S. T. Ingle and S. R. Thorat, Prashant publications, Pune, First edition – 2005.

### ❖ Envi-503 & 603 – Basic Concepts in Environmental Toxicology – I & II

1. Environmental Toxicology and Chemistry by Donald D Crosby. First edition– 2001.
2. Toxicology principle and methods, M. A. Subramaniam, MJP publishers, Chennai. First edition – 2003.
3. Environmental toxicology – Satake and Mido Discovery publishing home. New Delhi, Second edition – 2005.
4. Toxicology by Sumitro Ghosh, Dominant publishers, New Delhi. First edition– 2005.

### ❖ Envi-504 & 604 – Remote Sensing and GIS – I & II

1. Textbook of Remote sensing and geographical information systems, M. Anji Reddy (2006), B.S. Publications, Hyderabad.
2. Remote sensing Principles and applications, Dr. B. C. Panda (2005), Viva books Private New Delhi.
3. Elements of Photogrammetry, Paul R. Wolf, McGraw-Hill, 2000.
4. Remote sensing and Image interpretation, Lillesand and Keifer, John Wiley and Sons, 1987.
5. Introduction to Geographical Information System, Kang- Tsung – Chang, 2002, McGrawHill.
6. Geographic Information System- an introduction, 3rd edition, Tor Bernhardsen, Wiley Pub.

7. Geographic Information Systems and Science (2nd ed.), 2005, Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind, John Wiley & Sons, Ltd.
8. Concepts and techniques of Geographic Information System, C.P.Lo & Albert K.W. Yeung, 2002, Prentice Hall, India.
9. Introduction of Geographic Information Systems and Science, Paul A. Lonfley, Michel Goodchild, D.J.Maguire & D.W. Rhind, 2002, John Wiley & Sons Ltd.

❖ **Envi-505 & 605 – Instrumental Techniques in Environmental Analysis – I & II**

1. Environmental Science by S. C. Santra, Central Publishing, New Delhi. First edition 2000.
2. Environmental Toxicology and Chemistry by Donald D Crosby. First edition – 2001.
3. Toxicology principle and methods, M. A. Subramaniam, MJP publishers, Chennai. First edition – 2003.
4. Toxicology by Sumitro Ghosh, Dominant publishers, New Delhi. First edition – 2005.
5. Vogel's Textbook of Chemical Analysis, EIBS publisher, Third edition –2005.
6. Instrumental Methods of Chemical Analysis – Willard and Merritt, CBS publisher. Second edition – 2001.

❖ **Envi-506 & 606 – Environmental Biotechnology – I & II**

1. Fundamentals of Biotechnology by Purohit, Discovery Publishing House. First edition – 2003.
2. Biotechnology by RC Dubey S. Chand Publications, New Delhi. Second edition – 2003.
3. Advance in Biotechnology by S. N., Jogdand. Himalaya Publishing, India. First edition – 2001.
4. Biotechnology fundamentals and applications - Agrobotanical Publishers, India. First edition – 2005.
5. Environmental Science by S. C. Santra, Central Publishing, New Delhi. First edition – 2000.

❖ **Envi-507, 508, 509 & 607, 608, 609 – Practical Course Based On Theory Papers**

1. Waste Water Engineering: Metcalf & Eddy, Tata Mc-Graw Hill Publishers, III Edition (1995)
2. Water Supply and Sanitary Engineering: S. C. Rangwala, Charotar publishing house, Anand (1992)
3. Water and Wastewater Technology: Mark J Hammer & Mark J Hammer Jr., Prentice Hall of India, IV Edition (2002)
4. Environmental Pollution Control Engineering: C.S.Rao, New Age International (P) Ltd. (1991)
5. Sewage Disposal and Air pollution engineering: S. K. Garg, Khanna publishers, New Delhi (1998)
6. Air Pollution and Control: Mowli and Subbayya, Divyajyoti Prakashan, Jodhpur (1989)
7. Air Pollution: V.P. Kudesia, Pragati Prakashan, New Delhi (1997)
8. Noise Pollution and Management: G. Gaur, Sarup and Sons, New Delhi (1997)