



UNDER - GRADUATE  
PROGRAMME  
IN  
ENVIRONMENTAL SCIENCES

Courses of study, Schemes of Examinations & Syllabi  
(Choice Based Credit System)

SYLLABUS 2023  
Onwards

DEPARTMENT OF  
ENVIRONMENTAL SCIENCES

BISHOP HEBER COLLEGE

(AUTONOMOUS)

Affiliated to Bharathidasan University  
Nationally reaccredited with 'A' Grade by NAAC  
Recognized by UGC as "College of Excellence"  
"Star College" Status Awarded by the DBT  
DST-FIST Sponsored College

Tiruchirappalli – 620 017  
Tamil Nadu, India



**TANSICHE - B.Sc. ENVIRONMENTAL SCIENCE - 2023 ONWARDS**  
**Programme Structure**

Sem	Part	Course	Course Code	Course Title	Credits	Hrs./week	Marks		
							CIA	ESA	Total
I	1	Language I	U23TM1L1	<b>பொதுத்தமிழ் I</b>	3	6	25	75	100
	2	English I	U23EG1L1	Prose and Short Stories	3	6	25	75	100
	3	Core Theory I	U23ES101	Fundamentals of Ecology	5	5	25	75	100
		Core Practical I	U23ES1P1	Basic Field Ecology	3	3	40	60	100
		Allied Theory - I	U23ES1Y1	Environmental Botany	3	3	25	75	100
	4	Allied Practical - I	U23ESPY1	Allied Practical - Environmental Botany	2	3	40	60	100
		SEC I (NME)	U23ES1E1	Vermicomposting	2	2	40	60	100
FC		U23ES1N1	Fundamentals of Environmental sciences	2	2	CIA -100			
					<b>23</b>	<b>30</b>			
II	1	Language II	U23TM2L2	<b>பொதுத்தமிழ் II</b>	3	6	25	75	100
	2	English II	U23EG2L2	Poetry and Shakespeare	3	6	25	75	100
	3	Core Theory II	U23ES202	Environmental Microbiology and Biotechnology	5	5	25	75	100
		Core Practical II	U23ES2P2	Practical in Environmental Microbiology and Biotechnology	3	3	40	60	100
		Allied Theory - II	U23ES2Y2	Environmental Zoology	3	3	25	75	100
	4	Allied Practical - II	U23ESPY2	Environmental Zoology Practical	2	3	40	60	100
		SEC II	U23ES2E2	NMEC II- Paper Recycling	2	2	40	60	100
SEC III		U23ES2S3	Biodiversity Assessment	2	2	40	60	100	
					<b>23</b>	<b>30</b>			
III	1	Language III	U23TM3L3	<b>பொதுத்தமிழ் III</b>	3	6	25	75	100
	2	English III	U23EG3L3	One Act Plays and Abridged Novel	3	6	25	75	100
	3	Core Theory - III	U23ES303	Environmental Pollution	5	5	25	75	100
		Core Practical - III	U23ES3P3	Air & Noise Analysis	3	3	40	60	100
		Allied Theory - III	U23ES3Y3	Allied Chemistry- I	3	3	25	75	100
	4	Allied Practical - III	U23ESPY3	Allied Chemistry- Practical	2	3	40	60	100
		SEC IV	U23ES3S4	Entrepreneurship on Mushroom Cultivation	1	1	CIA-100		
SEC V (SBEC II)		U23ES3S5	Environmental Monitoring and Assessment	2	2	CIA-100			
5	E.V.S	U23EST41	Environmental Studies	-	1	-	-	-	
						<b>22</b>	<b>30</b>		
IV	1	Tamil IV	U23TM4L4	<b>பொதுத்தமிழ் Iv</b>	3	6	25	75	100
	2	English IV	U23EG4L4	Language through Literature	3	6	40	60	100
	3	Core Theory - IV	U23ES404	Energy Resources	5	5	25	75	100
		Core Practical - IV /SEC	U23ES4P4	Environmental Audit	3	3	40	60	100
		Allied Theory - IV	U23ES4Y4	Chemistry for Environmental Sciences	3	3	25	75	100
	4	Allied Practical - IV	U23ESPY4	Allied Chemistry Practical	2	2	40	60	100
		SEC VI	U23ES4S6	Life Skills	2	2	CIA 100		
SEC VII		U23ES4S7	SL- Vermicomposting	2	2	CIA 100			
5	EVS	U23EST41	Environmental Studies	2	1	25	75	100	
						<b>22</b>	<b>30</b>		
V	3	Core V	U23ES505	Biodiversity and Conservation	4	5	25	75	100
		Core VI	U23ES506	Tools and Techniques for Environmental sciences	4	5	25	75	100
		Core Prac. V	U23ES5P5	Water Quality analysis	4	6	40	60	100
		Core Project	U23ES5PJ	Project work	4	4	40	60	100
		Elective I	U23ES5:A	Remote sensing and GIS	3	4	25	75	100
		Elective II	U23ES5:B	Environmental Legislation	3	4	25	75	100
	4	VLO	U23VLO51	Abundant Life	2	2	CIA-100		
		U23VLO52	Human values						
5	Summer Internship	U23ES5I1	Industrial process and pollution control	2		CIA-100			
						<b>26</b>	<b>30</b>		
VI	3	Core VIII	U23ES607	Statistics for Environmental Sciences	4	6	25	75	100
		Core IX	U23ES608	Environmental Management and Sustainable Development	4	6	25	75	100
		Core Prac. VI	U23ES6P6	Soil Analysis	4	6	40	60	100
		Elective III	U23ES6:A	Global Warming and climate change	3	5	25	75	100
		Elective IV	U23ES6:B	Industrial and Ecosystem Exposure	3	5	40	60	100
	4	Extension	U23ETA61	Extension Activity	1		CIA-100		
		Professional competency Skill	U23ES6G1	Professional Competency Skill- Institutional Environmental Audit	2	2	CIA-100		
					<b>21</b>	<b>30</b>			
<b>Total Credits</b>					<b>140</b>				

# CORE THEORY I - FUNDAMENTALS OF ECOLOGY

Semester: I  
Credits: 5

Course Code: U23ES101  
Hours/Week: 5

## 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	To describe, recognize and relate the components of ecosystem.	K1	I
CO2	To explain and illustrate the structure, function and concepts of an ecosystem	K2	II
CO3	To summarize and theorize the attributes and concepts of an ecosystem	K3	III
CO4	To distinguish, categorize and conclude the concepts of habitat ecology	K4	IV
CO5	To execute the ecological tools in the field	K3	V
CO6	To analyze and interpret the data.	K4	V

## 2. A. Syllabus

### Unit I Ecosystem and its Components

Importance and scope of ecology; Ecosystem and its components - Abiotic factors - climate - temperature - light - humidity - edaphic - wind and biotic factors - predation, parasitism, competition, disease.

### Unit II Structure and Function of the Ecosystem

Structure of the ecosystem- food chain - herbivorous and detritus food chains - trophic levels and food web; Function of ecosystem- Energy flow in an ecosystem- productivity - biogeochemical cycle in an ecosystem - N, P, C and O cycles.

### Unit III Attributes of Ecosystem

Population Ecology: Definition, Characteristics of Population: density - natality - mortality, growth form- biotic potential - carrying capacity- population fluctuations-population equilibrium population regulation, population distribution, age distribution, dispersal. Biotic interactions: inter-specific and intra-specific. Community Ecology: Characteristics of a Community - species diversity, growth form and structure, dominance, self-reliance, relative abundance, trophic structure, guild, niche, Ecosystem ecology: Ecological pyramid and ecological succession.

### Unit IV 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 V Ecological Tools

Census and sampling estimates; Sampling methods in ecology: Sampling vegetation, sampling phytoplankton; sampling animal populations-mammals, birds, insects. Diversity scales - Alpha, Beta and Gamma Diversity. Quantitative assessment of diversity - density, frequency, relative frequency, richness, abundance. Diversity indices - Shannon Wiener Index and Evenness

## B. Text Books

1. Sharma, P. D. Ecology and Environment. 13<sup>th</sup> Edition (Reprint), Rastogi Publications, Meerut, India. ISBN 978-93-5078-122-7,2019.
2. Singh, J. S., Singh, S.P and Gupta, S. R. Ecology, Environment and Resource Conservation. Anamaya Publ., New Delhi. 688Pp,2006.
3. Verma P. S and Agarwal, V. K. Environmental Biology: Principles of Ecology. Chand & Company Pvt. Ltd.
4. Odum, E. P. Fundamentals of Ecology. 5<sup>th</sup> ED., Brooks/Cole, 2004; ISBN:978-0534420666.

## C. Reference Books

1. Agarwal, K. C. Environmental Biology. Agro Botanica,1999. ISBN: 978-8187167174.
2. Beck, W.S., Liem, K. F and Simpson, G. G. Life - Introduction to Biology. Harper Collins Publications,1991, ISBN: 9780155507098.
3. Chapman, J. L and Reiss, M. J. Ecology - Principles and Applications. Cambridge University Press, 1995; ISBN: 978- 0521588027.
4. Dash, M. C. Fundamentals of Ecology. Tata McGraw-Hill Publishing Co., 2001; ISBN: 9780070421479.
5. Kormondy, E. J. Concepts of Ecology. Prentice Hall of India,1996; ISBN: 9780131660090.
6. Ricklefs, R. E and Miller. Ecology. 4<sup>th</sup>Ed. W.H. Freeman and Co.,1999; ISBN:978-0716728290.
7. Raven, P. H. and Johnson, G. B. Biology. 11<sup>th</sup>ed. Wm. C. McGraw-Hill Education, 2016; ISBN: 978-1259188138.
8. Smith, T. M and Smith, R. L. Elements of Ecology. 9<sup>th</sup>ed. Pearson Education, 2015; ISBN: 9780321934185.
9. Taylor, T. J., Green, N. P. O and Stout, G.W. Biological Science. Soper, R (Ed.). Cambridge University Press,1998; ISBN: 978- 0521684170.
10. Wallace, R.A. Biology-The World of Life. Harper Collins Publications, 1990; ISBN: 978-0673464804.

## D. Web links

1. <https://projects.ncsu.edu/cals/course/fw353/Estimate.htm#:~:text=In%20practice%2C%20population%20estimates%20are,%2C%20and%20mark%2Drecapture%20methods>
2. <https://www.questia.com/library/science-and-technology/environmental-and-earth-sciences/ecology>
3. <https://biologydictionary.net/ecological-pyramid/>
4. <https://nptel.ac.in/courses/109/103/109103123/>
5. <https://nptel.ac.in/content/storage2/courses/122103039/pdf/mod6.pdf>

## CORE PRACTICAL I -BASIC FIELD ECOLOGY

Semester: I  
Credits: 3

Course Code: U23ES1P1  
Hours/Week: 3

### Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Experiments
CO1	Identify the plant species, record and memorize the herbal vegetation	K1	1 & 5
CO2	analyze and interpret the data	K4	2
CO3	Assess and interpret the herbal plants by quantitative methods	K2	2
CO4	Estimate the species diversity of plants	K4	3
CO5	Measure the height and girth of trees	K4	4
CO6	Identify the butterflies	K4	6 & 7

### 2. A. Syllabus

#### List of Experiments

1. Study of herbal vegetation by quadrat method
2. Quantitative assessment of herbal plants - Estimation of density, frequency, frequency class, abundance, relative abundance and species richness
3. Estimation of species diversity by Shannon - Wiener diversity index method.
4. Tree height, girth measurement
5. Preparation of 5 herbarium sheets
6. Insect survey - with special reference to butterflies
7. Insect box preparation

#### B. Text Books

1. Sharma, P.D. Ecology and Environment. 13<sup>th</sup> Ed. (Reprint), Rastogi Publications, Meerut, India. ISBN 978-93-5078-122-7, 2019.
2. Rina Majumdar and Renuka Kashyap. Practical Manual of Ecology and Environment Science. 2019.

#### C. Reference Books

1. Daisy, A. Butterfly of Bishop Heber College. Heber Au Sable Institute of Environmental Studies, Trichy, ISBN 978 - 81 - 906267 - 9 -8, 2010.
2. Prema Michael. Ecological Methods for Field and Laboratory Investigations. Tata McGraw Hill, 404 pages, ISBN 0074517651, 9780074517659, 1984.
3. Relton, A. Bird of Bishop Heber College. Heber Au Sable Institute of Environmental Studies, Trichy, ISBN 978 - 93 - 80767 - 00 - 0, 2010.
4. Shailaja Ravindranath and Sudha Premnath. Biomass Studies - Field Methods for Monitoring Biomass. Centre for Environmental Education, Southern Regional Cell, Bangalore, ISBN-81-2-4-1113- 4, 1997.

#### D. Web links

1. <https://www.wiley.com/en-us/Practical+Field+Ecology%3A+A+Project+Guide-p-9780470694282>
2. <https://projects.ncsu.edu/cals/course/fw353/Estimate.htm#:~:text=In%20practice%2C%20population%20estimates%20are,%2C%20and%20mark%2Drecapture%20methods>

**ALLIED THEORY I:**

**Semester: I**  
**Credits: 3**

**Course Code:U23ES1Y1**  
**Hours/Week: 3**

**ALLIED PRACTICAL I:**

**Semester: I**  
**Credits: 2**

**Course Code:U23ES1PY1**  
**Hours/Week: 3**

## SEC (NME- I) - VERMICOMPOSTING

Semester: I  
Credits: 2

Course Code: U23ES1E1  
Hours/Week: 2

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcomes	K-Level	Unit
CO1	To learn the technique of Vermicomposting	K1	I
CO2	To develop entrepreneurship skills in establishing vermiculture unit.	K2	II
CO3	Exposure On Vermicomposting Technology		

### UNIT I: INTRODUCTION

**Vermiculture** - definition, scope and importance; common species for culture; Environmental parameters; culture methods - wormery - breeding techniques; indoor and outdoor cultures - monoculture and polyculture - merits and demerits. **Morphology & Anatomy** Earthworms - Taxonomic position, external features- shape, size, colour, segmentation, setae & clitellum. Body wall, coelom, locomotion, digestive, circulatory, respiratory, excretory & nervous system.

### UNIT II: VERMICOMPOSTING TECHNOLOGY

Vermicomposting of wastes in field pits, ground heaps, tank method, roof shed method, static pile windrows, top fed windrows, wedges & bin method, harvesting the compost, storage, Vermi Wash-Preparation, and application. Site Selection, Species selection, Vermibed, Feed stock, Inoculation of earthworms, Feeding & Maintenance, Harvesting methods.

### UNIT III: ENTREPRENEURSHIP IN VERMICOMPOSTING

Business model, Opportunities, Challenges, Financial guidance, Cost - Benefit Analysis, Economic importance of Earthworms: In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food.

### UNIT IV: FIELD VISIT

Visit to vermiculture unit

### UNIT V: REPORT

Report writing and submission on field visit.

### REFERENCE BOOKS

1. Edwards, C.A and P.J. Bohlen, **Ecology of Earthworms**, 3<sup>rd</sup>Edn , Chapman and Hall,1996.
2. Gupta P.K. **Vermicomposting**, Agrobios, India, 2003.
3. Ismail, S.A. Vermicology, **The biology of earthworm**, Orient Longman, London,1970.
4. Lee, K.E, **Earthworms-their ecology and relationship with soil and land use**, Academic press, Sydney, 1985.



**FOUNDATION COURSE  
FUNDAMENTALS OF ENVIRONMENTAL SCIENCES**

**Semester: I  
Credits: 2**

**Course Code: U23ES1N1  
Hours/Week: 2**

**1. Course Outcomes**

On completion of this course, the students will be able to:

CO No.	Course Outcomes	K-Level	Unit
CO1	Recognize the physical environment encompassing atmosphere, hydrosphere, lithosphere and biosphere.	K1	I
CO2	Relate the variations in radiation-balance and temperature with latitude and seasonal changes of the earth	K2	II
CO3	Categorize the spheres of atmosphere based on their physical attributes and processes	K2	II
CO4	Illustrate the hydrological cycle, ocean currents and lithosphere	K2	III & IV
CO5	Justify the variations in biomes based on atmospheric, hydrological and geological differences	K5	V
CO6	Classify the living organisms based on their geographical distribution based on climatic, edaphic, and hydrological factors	K2	V

**2. A. Syllabus**

**Unit I Environment and Components of Environment**

Importance, scope, and principles of environmental sciences; Atmosphere, hydrosphere, biosphere, lithosphere and their interrelationships.

**Unit II Structure and Composition of Atmosphere**

Vertical Stratification – Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere; Physical properties - pressure and thickness, temperature and speed of sound, density and mass. Optical properties - scattering, absorption, emission, refractive index.

**Unit III Hydrosphere**

Sources and importance of water; Distribution of water and hydrologic cycle. Humidity and Condensation: Precipitation: Forms and types of precipitation. Oceanic dynamics – concepts and implications of waves, circulation, tides, current, gyres, upwelling, oceanic landforms, and plate tectonics.

**Unit IV Lithosphere**

Earth's layer and internal structure of the earth; Different types of rocks and different types of soils; Process of soil formation and soil profile.

**Unit V Biosphere**

Types of Biomes and their distribution - Phytogeographic realms (10 zones from tropic, temperate, subarctic and arctic regions) and Zoogeographic realms – 8 zones.

## B. Topics for Self-study

- **Folding and faulting**  
([http://www.geo.hunter.cuny.edu/~fbuon/GEOL\\_231/Lectures/Fold-Fault%20Landforms.pdf](http://www.geo.hunter.cuny.edu/~fbuon/GEOL_231/Lectures/Fold-Fault%20Landforms.pdf))
- **Ocean relief** (<https://byjus.com/free-ias-prep/ncert-notes-geography-minor-relief-of-ocean-floor/>)
- **Ocean deposits** (<https://www.yourarticlelibrary.com/geography/oceanography/types-of-ocean-deposits-terrigenous-and-pleagic-deposits/32228>)
- **Global atmospheric circulation**  
(<https://www.bbc.co.uk/bitesize/guides/zpykxsg/revision/1>)

## C. Text Books

1. Sharma, P. D. Ecology and Environment. Seventh Edition, Rastogi Publication, Meerut, 2004.
2. Santra, S. C. Environmental Science. Second Edition, New Central Book Agency (P) Ltd., Kolkata, 2010.
3. De Blij, H. J and Muller, P. O. Physical Geography of the global Environment. John Wiley & Sons, Inc, New York,1993.
4. Misra, S. P and Pandey, S. N. Essential Environmental Studies, Second Edition, Ane Books Pvt. Ltd., Chennai, 2010.

## D. Reference Books

1. Botkin, D.B. and Keller, E.A. Environmental Science: Earth as a Living Planet. John Wiley and Sons, New Delhi, 2011.
2. Cunningham, W. P. and Saigo, B.W. Environmental Science – A Global Concern. Eighth Edition. WCB/McGraw Hill, New York, 2007.
3. McKinney, M.L., Schoch, R. and Yonavjak, R.M. Environmental Science Systems and Solutions. Jones & Bartlett Publishing Inc., Delhi, 2007.
4. Joseph, K. and Nagendran, R. Essentials of Environmental Studies. Pearson Education Publisher, Delhi, 2004.
5. Purohit, S.S., Shammi, Q.J. and Agarwal, A.K. A Textbook of Environmental Science. Students Edition, Jodhpur, 2004.
6. Reddy, A.M. Textbook of Environmental Science and Technology. BSP Books Pvt. Ltd., Hyderabad, 2005.
7. Anjaneyulu, Y. Introduction to Environmental Science. BSP Books Pvt. Ltd., yderabad, 2009.
8. Lal, D.S. Climatology. Sharda Pustak Bhawan, Allahabad, 2003.
9. Chapin III, F.S., Matson, P.A and Vitousek, P.M. Principles of Terrestrial Ecosystem Ecology. Springer, New Delhi, 2012.
10. Bloom, A.L. Geomorphology – A Systematic Analysis of Late Cenozoic Landforms. Third Edition, Pearson Education, Singapore, 2003.
11. Dayal, P. A Textbook of Geomorphology. Shukla Book Depot, Patna, 2001.
12. Singh, S. Environmental Geography. Prayag Pustak Bhawan, Allahabad, 2002

## E. Web links

1. <https://climate.ncsu.edu/edu/Structure>
2. <https://www.ess.uci.edu/~yu/class/ess5/Chapter.1.composition.all.pdf>
3. <https://www.elsevier.com/books/principles-of-environmental-physics/monteith/978-0-12-386910-4>

## CORE THEORY II - ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Semester: II  
Credits: 4

Course Code: U23ES202  
Hours/Week: 5

### 1. Course Outcomes

On completion of the course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	Illustrate the microbial growth curve and kinetics	K2	I
CO2	Distinguish the various types of microbial growth and methods of microbial growth estimation	K2	II
CO3	Recall the microbial ecology and relate their interactions	K1	III
CO4	Explain the principles in bioprocess technology	K2	IV
CO5	Identify the primary and secondary metabolites	K1	IV
CO6	Determine the biotechnologically intracellular products and Importance of molecular techniques in environmental management	K3	V

### 2. A. Syllabus

#### Unit I Environmental Microbiology

History and discovery of microorganisms - Spontaneous generation - Germ Theory of disease, Prokaryotic and Eukaryotic cell structure of bacteria, virus, fungi, yeast and algae, Growth and reproduction of bacteria and virus. COVID-19 Pandemic: Origin, Transmission, Morphology, Characteristics, Symptoms, Prevention, Clinical Diagnosis and Current Scenario.

#### Unit II Microorganisms in Industry

Sterilization-physical and chemical methods; Culture Techniques- Types of media; Environmental Determinants- Temperature, Radiation, Pressure, Salinity, pH and Water Activity; Microorganisms in Industry -Microorganisms in food: milk, fruits, egg and Fish-Principles of food spoilage and food preservation; Microorganisms and sanitation.

#### Unit III Microorganism in Atmosphere

Air borne Infections - Causative Microbes - Control Measures; Sick Building Syndrome; Droplet infection. Aquatic Microbiology: Water-borne Diseases Disinfection of water for potable purposes. Soil Microbiology: Rhizosphere and Rhizoplane Microflora - Composting.

#### Unit IV Environmental Biotechnology

Concepts and scope of environmental biotechnology; Biofertilizers-use of Rhizobium, Azolla, Mycorrhiza; Vermiculture. Production of lactic acid, Amino acid, Alcohol fermentation, Penicillin Production.

#### Unit V Principles of various Biotechnological Methods

Plasmid isolation; restriction, digestion; PCR; RAPD; RFLP. Genetically Modified Crops; Genetically Engineered species and pest control; salient features of Guidelines and policy of GMOs in India

### B. Topics for Self-study

- **Food borne intoxications** (<https://onlinelibrary.wiley.com/doi/10.1002/9781119237860.ch10>)
- **Biopesticides** (<https://thebiologynotes.com/biopesticides/>)
- **Bioluminescence** (<https://byjus.com/biology/bioluminescence/>)
- **Recombinant DNA Techniques** (<https://microbenotes.com/recombinant-dna-technology-steps-applications-and-limitations/>)

### C. Text Books

1. Michael J. Pelczar. Microbiology. Tata McGraw-Hill, 2010.
2. L. E Casida, JR, Industrial Microbiology. NewAge International, PJ Limited, Publisher,2015
3. Reed, G. Prescott and Dunn's Industrial Microbiology. CBS Publisher and Distributor,2004
4. Gerand J. Tortora, Berdell R. Funke, Christine L. Case, Microbiology. Pearson, 2014
5. Satyanarayana, U. Text Book of Biotechnology. Books & Allied (P) Ltd.-Kolkata,2005

### D. Reference Books

1. Atlas, R. M. and Bartha, R. Microbial Ecology - Fundamentals and Applications. Benjamin/Cummings Science Publishing,1998.
2. Baker, K. H. and Herson,D. S. Bioremediation. McGraw-Hill Inc.,1994.
3. Mitchel, R. (Ed.) Environmental Microbiology. Wiley-Liss Inc., 1992.
4. Pelczar, M.J., Chan, E. C. Sand Krieg, N. R. Microbiology- Concepts and Applications. McGraw-Hill Book Co., 1993.
5. Murugesan, A.G and Rajakumari, C. Environmental Science and Biotechnology. MJP Publishers, Chennai,2006.
6. Gupta, P. K. Elements of Biotechnology. Rastogi Publications, Meerut, 2007.
7. Abbasi, S. A and Ramasami, E. Biotechnological Methods of Pollution Control. University Press, Hyderabad,1999.

### E. Web Links

1. <http://www.eolss.net/Sample-chapters/C10/E5-12-02.pdf>
2. <https://www.toppr.com/guides/biology/biotechnology-principles-and-process/tools-of-biotechnology/>
3. [https://fire.biol.wvu.edu/cmoyer/zztemp\\_fire/biol346\\_W06/labman\\_week4.pdf](https://fire.biol.wvu.edu/cmoyer/zztemp_fire/biol346_W06/labman_week4.pdf)
4. <https://www.lamission.edu/lifesciences/lecturenote/mic20/Chap06Growth.pdf>
5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7150350/>
6. <https://www.ncbi.nlm.nih.gov/books/NBK208345/>

**CORE PRACTICAL II -  
ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY LAB**

**Semester: II**  
**Credits: 3**

**Course Code: U23ES2P2**  
**Hours/Week: 3**

**1. Course Outcomes**

On completion of the course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	Demonstrate the principles of Microscope	K2	1
CO2	Explain the techniques of gram staining of Bacteria and Methylene Blue Reductase Test	K2	2 & 3
CO3	Acquire the expertise in Identification of Fungi and Isolation of Fungi from Soil	K2	4 & 5
CO4	Estimate Coliform Group of Bacteria with the help of MPN Technique	K4	6 & 7
CO5	Demonstrate the Gel Electrophoresis and PCR	K2	8
CO6	Describe the Blood Serum Separation and Blood Grouping	K2	9 & 10

**2. A. Syllabus**

**List of Experiments**

1. Demonstration of Microscope
2. Gram staining of Bacteria
3. Methylene Blue Reductase Test
4. Identification of Fungi – Lactophenol Cotton Blue Staining.
5. Isolation of Fungi from Soils – Pour Plate Method.
6. Isolation of Bacteria from Water/Wastewater – Serial Dilution Technique.
7. Estimation of Coliform Group of Bacteria – MPN Technique- Presumptive Test.
8. Demonstration of Gel Electrophoresis and PCR
9. Blood Serum Separation
10. Blood Grouping

**C. Text Books**

1. Srivastava, M. L. Environmental Microbiology. Shree Publisher & Distributors, 2008. ISBN: 978-8183292603.
2. Raina, M., Pepper, I. and Gerba, C. Environmental Microbiology.
3. Academic Press, New York, 2000. ISBN: 978-0124975705.
4. Jemba, P. K. Environmental Microbiology, Science Publishers, New Hampshire, 2004.
5. Abbasi, S.A. and Ramasami, E. Biotechnological Methods of Pollution Control. University Press, Hyderabad, 1999. ISBN: 978- 8173710988.

**D. Reference Books**

1. Aneja, K. R. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. WishwaPrakashan, 1996.
2. Benson, H. J. Microbiological Applications – Laboratory Manual in General Microbiology. McGraw-Hill Publications, 1998.
3. Bhattacharyya, B. N. Experiments with Microorganisms. Emkay Publications, 1993.
4. APHA. Standard Method for Examination of Water and Wastewater. APHA- AWWA, WPCF, 1989.
5. APHA. Standard Method for Examination of Water and Wastewater. APHA –AWW, WEF, 1998.

**E. Web Link**

1. [https://www.wpiinc.com/media/wysiwyg/pdf/PZMIV\\_IMs.pdf](https://www.wpiinc.com/media/wysiwyg/pdf/PZMIV_IMs.pdf)
2. [https://www.who.int/water\\_sanitation\\_health/resourcesquality/wqmchap10.pdf](https://www.who.int/water_sanitation_health/resourcesquality/wqmchap10.pdf)

3. [https://www.who.int/bloodsafety/transfusion\\_services/sop-bts\\_bangladesh.pdf](https://www.who.int/bloodsafety/transfusion_services/sop-bts_bangladesh.pdf)

**ALLIED THEORY - II**

**Semester: II**  
**Credits: 3**

**Course Code: U23ES2Y2**  
**Hours/Week: 3**

**ALLIED PRACTICAL - II:**

**Semester: II**  
**Credits: 2**

**Course Code:U23ES2PY2**  
**Hours/Week: 3**



## SEC (NME- II) PAPER RECYCLING

Semester: II  
Credits: 2

Course Code: U23ES2E2  
Hours/Week: 2

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	To develop awareness about entrepreneurship	K1	1
CO2	Develop and entrepreneurial mind-set by learning key skills such as design personal selling and communication	K1	2 & 3
CO3	Develop skills towards paper recycling and its process	K5	4

### 2. A. Syllabus

#### Unit I : Introduction to Entrepreneurship

Meaning and concepts of Entrepreneurship, the history of entrepreneurship, development, role of entrepreneurship in economic development, Myths about entrepreneurs, agencies in entrepreneurship management and future of entrepreneurship and Types of entrepreneurs, entrepreneurial success stories.

#### Unit II : Waste paper Management

Paper waste - Definition; types, sources, effects and Management strategies - Collection and segregation -answer sheets- Xerox papers - Books and Magazines - colour papers - colour cards, files - carton box - waste recyclable materials, storage, collection, transportation, recycling and reuse.

#### Unit II : Paper Recycling Process

Waste Paper - Chopping - Cleansing & Soaking - Pulping & blending - Lifting & Couching - Pressing & Water Removal - Drying - Calendaring - Cutting - Recycled paper products

#### Unit IV : Production of value added products

Tag file, Box file, Tag Folders and files, visiting cards, Tags for shirts, Greeting cards, cover varieties, different varieties of paper carry bags, Pouch folders, Programme folder, Document folders, Spring clip file, pen holders, photo stand, Daily sheet calender, Cake base box, Jewel box, Dress hangers, Mouse traps etc.,

#### Unit V : Marketing strategies

Product - Price - Place/Distribution - Promotion/ advertisement - People - Process - Physical evidence

### C. Text Books

1. Bajpai, P. (2014) Management of Pulp and Paper Mill Waste. Springer International Publishing, Switzerland.

### D. Reference Books

1. Rogoff, M. J. (2013). Solid waste recycling and processing: planning of solid waste recycling facilities and programs. Elsevier
2. Vaughn, J Waste management: A Reference handbook, 1<sup>st</sup> Edition. ABC-CLIO. ISBN:10:1598841513. ISBN-13:9781598841510

## SEC III – BIODIVERSITY ASSESSMENT

Semester: II  
Credits: 2

Course Code: U23ES2S3  
Hours/Week: 2

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	Develop the skill to map an area	K3	1
CO2	Prepare the list and describe some flora including trees, shrubs, herbs and grasses and vines	K1	2 & 3
CO3	Assess the fauna of the campus including butterflies, reptiles, birds and mammals	K5	4
CO4	Assess the fauna of the neighborhood including butterflies, reptiles, birds and mammals	K5	5
CO5	Create Peoples Biodiversity Register	K6	6
CO6	Demonstrate Participatory Rural Appraisal	K2	7

### 2. A. Syllabus

#### List of Activities

1. **Introduction to PS**  
Plant habitat categories with diagrams and description
2. **Know your Environment -campus**
  - a. Area Mapping - Mapping of the campus
  - b. Assessment of flora in campus (Description of any five species in each category)
    - i. Trees
    - ii. Shrubs
    - iii. Herbs and grasses;
    - iv. Vines
3. **Know your Domestic Environment**
  - a. Area Mapping - Mapping of the neighbour-hood
  - b. Assessment of flora in neighbour-hood
    - i. Trees;
    - ii. Shrubs;
    - iii. Herbs and grasses;
    - iv. Vines
4. **Know your environment**
  - a. Assessment of fauna of the campus - Identification and Methods
    - i. Butterflies;
    - ii. Birds;
    - iii. Reptiles and
    - iv. Mammals
5. **Know your Domestic environment**
  - a. Assessment of fauna of the neighbour-hood - Identification and Methods
    - i. Butterflies;
    - ii. Birds;
    - iii. Reptiles and
    - iv. Mammals

6. **Peoples Biodiversity Register**
  - a. Flora:
    - i. Trees;
    - ii. Shrubs;
    - iii. Herbs;
    - iv. Medicinal plants;
    - v. Agricultural Crops;
    - vi. Recently lost/ changes of flora
  - b. Fauna
    - i. Wild animals;
    - ii. Vertebrate mammals, birds, reptiles, others;
    - iii. Domestic Animals;
    - iv. Recently lost/ changes of fauna
7. **Participatory Rural Appraisal**
  - a. Introduction to PRA
  - b. Village profile
  - c. Transect walk outcome
    - i. Resource mapping;
    - ii. Assets mapping;
    - iii. Social mapping
  - d. Management plan
  - e. Conclusion

#### C. Text Books

2. Canter, L. W. Environmental Impact Assessment. 2<sup>nd</sup> Ed., McGraw Hill Book co., New York, 1977. ISBN:978-0070097674.

#### D. Reference Books

3. Rao, M. N and Rao, H. V. N. Air Pollution. Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2017. ISBN:978-0074518717.
4. Cunningham, A. B. Professional Ethics and Ethnobotanical Research. In: Alexiades M, editor. Selected guidelines for ethnobotanical research: a field manual. Bronx: New York Botanical Garden; 1996. p. 19-51. ISBN:978-0893274047.
5. April Smith. Campus Ecology - A Guide to Assessing Environmental Quality and Creating Strategies for Change. Living Planet, Los Angeles, 1993. ISBN:9781879326194.

#### E. Web links

1. <http://www.fao.org/3/w2352e/W2352E06.htm>
2. <http://ecologicalfootprint.com/>
3. [http://nbaindia.org/uploaded/pdf/PPT\\_PBRs\\_Guidelines.pdf](http://nbaindia.org/uploaded/pdf/PPT_PBRs_Guidelines.pdf)

## CORE THEORY III - ENVIRONMENTAL POLLUTION

Semester: III  
Credits: 5

Course Code: U23ES303  
Hours/Week: 5

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	List out different types of pollution.	K1	I
CO2	Classify the different types of pollutants.	K2	II
CO3	Identify the types of pollutants with regard to air, water and soil.	K3	II & IV
CO4	Analyze the impacts of pollution on Environment	K4	III
CO5	Relate the disaster to the types of Pollution.	K2	V
CO6	Explain the pollutants and its impacts	K2	V

### 2. A. Syllabus

#### Unit I Air Pollution

Introduction – structure and composition of atmosphere; classification of air pollutants – primary and secondary, particulate and gaseous; Sources of air pollution - vehicular pollution; Effects of air pollution on – Man, Plants and Materials; greenhouse effect – global warming – ozone depletion; acid rain. Indian air quality standards. Bhopal Gas disaster.

#### Unit II Water Pollution

Introduction – sources – point and non- point; Oxygen demanding waste, industrial effluents and domestic sewage and its effects; Eutrophication, Bioaccumulation, Bio- magnification; Classification: Ground water – Surface water; Causes of waterborne diseases; Water Quality standards; Water treatment (Theory only) – physical, chemical and biological. Indian water quality standards. Mina Meta disaster.

#### Unit III Soil pollution

Soil texture, structure, physical, chemical and biological properties; Sources and Effects of soil pollution; Pesticides in soil environment and their effects; Biological magnification, pollution through mining; Control of soil pollution.

#### Unit IV Thermal and Oil pollution

Introduction; sources of thermal pollution – Nuclear power plants, Hydro electrical power plants, coal power plants; Effects of thermal pollution. Oil pollution – sources and effects on flora and fauna.

#### Unit V Noise pollution

Sources – natural and manmade; Characteristics of sound – frequency, intensity, time of exposure, Intermittence; Effects of noise pollution – Man and materials; Control of noise pollution. Indian noise level standards.

### B. Topics for Self-study

- **Air Pollution Modelling** (<http://home.iitk.ac.in/~anubha/Modeling.pdf>, <https://www.intechopen.com/books/air-quality-models-and-applications/urban-air-pollution-modeling>)
- **Case Study Water Pollution** ([https://www.who.int/water\\_sanitation\\_health/resourcesquality/wpccasestudy1.pdf](https://www.who.int/water_sanitation_health/resourcesquality/wpccasestudy1.pdf))
- **Soil Profile, soil pollution and layers** ([https://www.ctahr.hawaii.edu/mauisoil/a\\_profile.aspx](https://www.ctahr.hawaii.edu/mauisoil/a_profile.aspx))
- **Thermal Pollution & Oil Pollution** <https://www.nrel.gov/docs/fy18osti/70881.pdf>)

### **C. Text Books**

1. Kumaraswamy, K., Alagappa Moses, A and Vasanthi, M. Environmental Studies, Bharathidasan University, Tiruchirappalli, 2004.
2. Kannan, K. Fundamentals of Environmental Pollution. S. Chand and Co., Delhi, 1991.
3. Sharma, B. K and Kaur, H. Soil and Noise Pollution. GOEL Publishing House, Meerut, 1994.

### **D. Reference Books**

1. De, A. K. Environmental Chemistry. Wiley Eastern Ltd., New Delhi, 1987.
2. Rao, M. N and Rao, H.V.N., Air Pollution. Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1989.
3. Sharma, B, K and Kaur, H., Water Pollution. Goyal Publishing House, Meerut, 1994.
4. Brady, N.C. The Nature and Properties of Soils. Tenth Edition. Mac Millan Publishing Co., New York, 1990.
5. Stanley E. Manahan. Environmental Science and Technology: A Sustainable Approach to Green Science and Technology. CRC Press, 2006.
6. Kumaraswamy, K., Alagappa Moses, A and Vasanthi, M. Environmental Studies. Bharathidasan University, Tiruchirappalli, 2004.

### **E. Web links**

1. [https://nptel.ac.in/content/storage2/courses/105102089/air%20pollution%20\(Civil\)/Module-1/3.htm](https://nptel.ac.in/content/storage2/courses/105102089/air%20pollution%20(Civil)/Module-1/3.htm)
2. <http://www.indiaenvironmentportal.org.in/files/file/Air%20Quality%20Index.pdf>
3. <https://www.tropmet.res.in/~lip/Publication/RR-pdf/RR-127.pdf>

## CORE PRACTICAL III - AIR AND NOISE ANALYSIS

Semester: III  
Credits: 2

Course Code: U23ES3P3  
Hours/Week: 3

### 1. Course outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Experiment
CO1	Explain the collection, handling and preservation of the environmental samples	K2	I
CO2	Assess the PM <sub>10</sub> in the ambient air	K5	I
CO3	Demonstrate SO <sub>2</sub> and NO <sub>x</sub> in the ambient air	K2	I
CO4	Measure the ambient noise level.	K5	I
CO5	Analyze the physico- chemical parameters of soil	K4	II
CO6	Compare the results with the standards	K5	II

### 2. A. Syllabus

#### List of Experiments

##### I Air Analysis

Estimation of PM<sub>10</sub> in the ambient air

1. Demonstration of SO<sub>2</sub> in the ambient air
2. Demonstration NO<sub>x</sub> in the ambient air

##### II Noise Analysis

Measurement of Noise at different locations

- a. Urban zone
- b. Rural zone
- c. Residential zone
- d. Industrial zone
- e. Silent zone

### C. Text Books

1. Trivedy, R K., Goel, P. K and Trisal, L. Practical Methods in Ecology and Environmental Sciences. Environmental Publications, Karad, 1987.
2. Howard S. Peavy., Donald R. Rowe and George Tchobanoglous, Environmental Engineering. Indian Edition, 2017
3. Sawyer, C. N. and McCarty, P. L. Chemistry for Environmental Engineering, McGraw Hill International, 1978.

### D. Reference Books

1. Margesin R and Schinner. Manual of Soil Analysis – Monitoring and Assessing Bioremediation. Springer –Verlag BerlinHeidelberg, 2005.
2. James P. Lodge. Methods of Air Sampling and Analysis. Inter Society Committee Publication, 1988.
3. APHA. Standard Method for Examination of Water and Wastewater. APHA –AWWA –WPCF, 1989.
4. APHA. Standard Method for Examination of Water and Wastewater. APHA –AWWA –WEF, 1998.

### E. Web Links

1. [http://moef.gov.in/wp-content/uploads/2019/05/NCAP\\_Report.pdf](http://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf)
2. <http://kspcb.gov.in/NAAQSMannualVolumeI.pdf>
3. <https://www.youtube.com/watch?v=zXvEmlFqicw>

**ALLIED THEORY III:**

**Semester: III**  
**Credits: 3**

**Course Code: U23ES3Y3**  
**Hours/Week: 3**

**ALLIED PRACTICAL III:**

**Semester: III**  
**Credits: 2**

**Course Code: U23ESPY3**  
**Hours/Week: 3**



## SEC IV - ENTREPRENEURSHIP ON MUSHROOM CULTIVATION

Semester: III  
Credits: 1

Course Code: U23ES3S4  
Hours/Week: 1

### 1. Course Outcomes

On completion of the course, the students will be able to:

CO	Course Outcomes	K-level	Unit
CO1	Relate the basic of mushroom cultivation	K2	I-V
CO2	Infer the methods of cultivation	K3	

### 2. A. Syllabus

#### Unit 1: Introduction

Introduction to Mushroom Cultivation, History and importance of mushroom cultivation Overview of different mushroom species, Nutritional and medicinal value of mushrooms, Mushroom Life Cycle and Growth Requirements; spore germination, mycelium formation, fruiting body development Environmental factors affecting mushroom growth: temperature, humidity, and light.

#### Unit 2: Methods

Mushroom Cultivation Methods, Substrate selection and preparation, Sterilization techniques: steam sterilization, chemical sterilization, inoculation methods: grain spawn, liquid culture, agar culture Growing Environment Management; Temperature and humidity control Ventilation and air exchange Light requirements for different mushrooms.

#### Unit 3: Cultivation Techniques for Specific Mushroom Species

Cultivation techniques for selected mushroom species (e.g., *Agaricus bisporus*, *Pleurotus spp.*, *Lentinula edodes*) Casing and pinning techniques, Troubleshooting common cultivation issues. Disease and Pest Management: Identification and prevention of common mushroom diseases integrated pest management techniques fungal competitors and their control.

#### Unit 4: Harvesting and Post-Harvest Handling

Harvesting techniques and timing, Handling and packaging of harvested mushrooms, Storage techniques for short-term and long-term preservation.

#### Unit 5: Marketing and Business Opportunities

Market analysis and identification of target customers, Packaging and branding considerations, Business planning and feasibility analysis for mushroom cultivation.

### C. Reference Books

1. Organic Mushroom Farming and Mycoremediation: Simple to Advanced and Experimental Techniques for Indoor and Outdoor Cultivation" by Tradd Cotter.

### D. Text Books

1. Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home" by Tavis Lynch.
2. Mycelium Running: How Mushrooms Can Help Save the World" by Paul Stamets.
3. Mushroom Grower's Handbook 1: Oyster Mushroom Cultivation" by MushWorld.

## SEC V - ENVIRONMENTAL MONITORING AND ASSESSMENT

Semester: III  
Credits: 2

Course Code: U23ES3S5  
Hours/Week: 2

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Activities
CO1	Observe and collect data on Micro-Meteorological parameters	K2	1
CO2	Conduct environmental monitoring with regard to air, noise, water and land environment	K2	2
CO3	Develop the skills on assess the overall environmental setting of a developmental activity	K2	3
CO4	Apply standard methods for examination of environmental parameters	K2	
CO5	Identify the different types of Soil.	K2	4
CO6	Describe the geological and geo-referencing techniques	K3	5

### 2.A. Syllabus

#### List of Activities

1. Environmental Monitoring of Micro-Meteorological parameters: Temperature, humidity, atmospheric pressure, wind velocity, wind direction, sunshine.
2. Ambient Air/Indoor and Noise Quality monitoring: Principles of sampling; analysis and instrumentation for air quality-Particulates; Gases and Noise.
3. Water Quality Monitoring Protocol 2006 and Sampling techniques of water: Preservation of water samples for the analysis of various parameters; Standard methods for the Examination of water and wastewater; Water quality standards.
4. Soil Identification: Type, Structure, Classification, Texture; Standard Classification - India (IS 1498 - 1970), USDA soil taxonomy and FAO (1974 - 1978).
5. Geology: Geological Time Scale; Weathering and its classification; Fossils and Mineral Deposits; Archaeological Evidences/sites; Slope, Terrain, Drainage system and Contour, Map Projections; Georeferencing and Area Calculation using GIS techniques.

#### B. Reference Books

1. Padmanabhamurty, B. Environmental Meteorology, I.K. International Pvt. Ltd., New Delhi. 2004. ISBN: 81-88237-10-8.
2. APHA- Standard Methods for the Examination of Water and Waste Water, 2018. American Public Health Association, Washington, DC. 1992
3. Trivedy, R.K. and Goel, P.K. Chemical and biological methods for water pollution studies. EM International, Pune.1986
4. Gupta, Anand. (2014). Hand Book of Water, Air and Soil Analysis. International E Publication, 2014. ISBN: 978-93-83520-91-4
5. Trivedi, P.R. Environmental Water and Soil analysis, Akash Deep Publishing House, Delhi. 2007. ISBN -10:8171582613.
6. Richard, H. Groshong, Jr. 3-D Structural Geology A Practical Guide to Quantitative Surface and Subsurface Map Interpretation. Springer-Verlag Berlin Heidelberg, Netherlands2006.

#### C. Web Links

1. [http://environmentclearance.nic.in/writereaddata/Online/TOR/0\\_0\\_31\\_Oct\\_2014\\_1615420501AdditionalInformation.pdf](http://environmentclearance.nic.in/writereaddata/Online/TOR/0_0_31_Oct_2014_1615420501AdditionalInformation.pdf)
2. [http://www.indiaairquality.info/wp-content/uploads/docs/2003\\_CPCB\\_Guidelines\\_for\\_Air\\_Monitoring.pdf](http://www.indiaairquality.info/wp-content/uploads/docs/2003_CPCB_Guidelines_for_Air_Monitoring.pdf)
3. [https://pubs.usgs.gov/twri/twri9a4/twri9a4\\_Chap4\\_v2.pdf](https://pubs.usgs.gov/twri/twri9a4/twri9a4_Chap4_v2.pdf)

## COURSE: ENVIRONMENTAL STUDIES

Semester: III  
Credits:

Course Code: U20EST41  
Hours/Week: 1

### 1. Course Outcomes

On completion of this course the students will be able to:

CO No.	Course Outcomes	K-Level	Unit
CO1	Outline the importance for the Environmental studies	K2	I
CO2	Extend their understanding about various resources	K4	II
CO3	Recall the ecosystems and how they are interacting	K4	III
CO4	Classify how the diverse organisms are distributed across various geographical, physiological realms	K5	IV
CO5	Identify the causes, analyze the impacts of various environmental pollutions	K5	V
CO6	Summarize the concept of sustainability and relate various current environmental issues	K5	VI
CO7	Analyze how the environmental problems of recent times are related to population	K4	VII
CO8	Create documents on environmental resources, ecosystems etc.	K6	VIII

### 2. A. Syllabus

#### Unit I The Multidisciplinary nature of Environmental Studies

Definition, Scope and Importance. Need for Public awareness

#### Unit II Natural Resources

Renewable and Non-renewable resources; Natural resources and associated problems a) Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case Studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources of sustainable lifestyles.

#### Unit III Ecosystems

Concept of an ecosystem, Structure of an ecosystem, Producers, consumers, decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristics features, structure and function of the following ecosystem: a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (Ponds, streams, lakes, rivers, oceans, estuaries)

#### Unit IV Biodiversity and its Conservation

Introduction-definition: Genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: Consumptive use, productive use, social ethical, aesthetic and option values, Biodiversity at global, National and local level, India as a megadiversity nation, Hot-spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity In-situ conservation of biodiversity.

#### Unit V Environmental Pollution

Definition, Causes, effects and control measures of: Air Pollution; Water Pollution; Soil Pollution; Marine Pollution; Noise Pollution; Thermal Pollution; Nuclear Hazards; Solid Waste Management:

Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies. Disaster management: Floods, earthquake, cyclone and landslides.

#### **Unit VI Social Issues and the Environment**

From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Case studies, Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies, Wasteland reclamation, Consumerism and waste products Environment Protection Act, Air (Prevention and Control of Pollution) Act, Forest (Conservation) Act, Issues involved in enforcement of environmental legislation, Public awareness.

#### **Unit VII Human Population and the Environment**

Population growth, variation among nations, Population explosion-family welfare programme environment and human health, human rights, value education, HIV/AIDS, women and child welfare, role of information technology in environment and human health, case studies.

#### **Unit VIII Field Visit**

Field visit to document environmental assets-river/ forest/ grassland/hill/mountain, visit to a local polluted site -Urban/Rural/Industrial/ Agricultural, study of common plants insects, birds, study of simple ecosystems-pond, river, hill slopes, etc.

#### **C. Text Books**

1. Kumaraswamy K, Alagappa Moses A and Vasanthi M, 2017. Environmental Studies- a text book for all undergraduate courses. 16<sup>th</sup> Edition. Bharathidasan University, Tiruchirappalli.

#### **E. Web links**

1. <https://nptel.ac.in/courses/120/108/120108004/>
2. <https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf>
3. <https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf>

## CORE THEORY IV - ENERGY RESOURCES

Semester: IV  
Credits: 5

Course Code: U23ES404  
Hours/Week: 5

### Course Outcomes

On completion of this course the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	Acquire basic knowledge on energy concepts and categorizes the energy sources	K3	I
CO2	Explain the thermodynamic Concepts	K2	II
CO3	Realize the importance of carrier and conversion forms of energy	K2	II
CO4	Describe the harnessing methods of Solar, wind, tidal and geothermal energy	K4	III
CO5	Demonstrate the energy from biomass. Relate and criticize the nuclear power generation	K3	IV
CO6	Evaluate the usage of energy	K6	V

### 2. A. Syllabus

#### Unit I Fundamentals and Types of Energy

Energy - Law of Conservation of energy - Energetics - Energy transformation - Energy condition - Energy transition - Energy level - Energy system - Mass - Mass-energy equivalence. Kinetic - Internal - Thermal - Potential - Gravitational - Mechanical - Interatomic potential - Electrical - Magnetic.

#### Unit II Thermodynamic Concepts

Power - Thermodynamics - Laws of thermodynamics - Thermodynamic system - Thermodynamic state - Thermodynamic potential - Thermodynamic equilibrium - Thermal equilibrium - Thermodynamic temperature - Isolated system - Entropy - Free entropy - Entropic force - Negentropy - Work - Energy - Enthalpy

#### Unit III Energy resources and carriers

Resources: Primary energy - Secondary energy - Renewable Energy Source - Non-renewable Energy Source - Fossil fuel - Coal - Petroleum - Natural gas - Nuclear fuel - Natural uranium - Radiant energy - Solar - Wind - Hydropower - Marine energy - Geothermal - Bioenergy - Gravitational energy. Carriers: Conduction - convection - Radiation - Enthalpy - Fuel - fossil fuel - Heat - Latent heat - Work - Electricity - Battery - Capacitor

#### Unit IV Energy system components

Energy engineering - Electric power - Fossil fuel power station - Nuclear power - Nuclear power plant - Radioisotope thermoelectric generator - Solar power - Photovoltaic system - Concentrated solar power - Solar thermal energy - Solar power tower - Solar furnace - Wind power - Wind farm - Airborne wind energy - Hydropower - Hydroelectricity - Wave farm - Tidal power - Geothermal power - Biomass

#### Unit V Measurement, Use and Supply of Energy

Fundamentals of energy and measurements: -- Units of expressions - (Joule, Kelvin, Joule/Kelvin, calorie kilo calorie, watt, watt/second, kilowatt - kilowatt hour) -carbon cycle- Carbon Emission - Carbon footprint. Use and supply: Energy consumption - Energy storage - World energy consumption - Energy security - Energy conservation -Efficient energy use -Transport - Agriculture - Renewable energy - Sustainable energy - Energy policy - Energy development - Worldwide energy supply.

## **B. Text Books**

1. Rai, G. D. Non-conventional Energy Sources. Khanna Publishers, New Delhi, 2001. ISBN 9788174090737
2. Vijai Gupta, Maria Tuohy, Christian Kubicek, Jack Saddler and Feng Xu. Bioenergy Research: Advances and Applications. 1<sup>st</sup> Edition, 2014, Elsevier, ISBN:9780444595614
3. Raymond Murray and Keith E. Holbert. Nuclear Energy –An Introduction to Concepts, Systems and Applications of Nuclear Processes. 7<sup>th</sup> Edition, Butterworth-Heinemann, 2014, ISBN-13:978-0124166547
4. Sukhatme, S. P. Solar Energy. 2<sup>nd</sup> Edition, Tata McGraw Hill publishing company Ltd., New Delhi, 1996, ISBN:0-07-462453-9.

## **C. Reference Books**

1. Richard F. Wilson. Energy, Ecology Environment and Society. 1<sup>st</sup> Edition, Academic Press New Delhi, 1974, eBook ISBN:9780323153898.
2. Dunn, P. D. Appropriate Technology. Macmillan Education Limited, 1979, ISBN:10-0333242076
3. Johnson Gary L, Wind Energy System. Prentice Hall Inc., New Delhi, 1985, ISBN:978-0139577543
4. Trivedi, P. R and Sudarshan, K. N. Environment and Natural Resources Conservation. Common Wealth Publishers, New Delhi, 1994. ISBN: 8171692796
5. Nathanson, J.A. Basic Environmental Technology: Standards media. 2000, ISBN: 013082626X
6. Vijai Gupta, Maria Tuohy, Christian Kubicek, Jack Saddler and Feng Xu. Bioenergy Research: Advances and Applications. 1<sup>st</sup> Edition, Elsevier, ISBN:9780444595614

## **D. Web links**

1. <https://personal.ems.psu.edu/~radovic/Chapter2.pdf>
2. <https://beeindia.gov.in/sites/default/files/1Ch2.pdf>
3. <https://nptel.ac.in/courses/112/105/112105266/>
4. <https://nptel.ac.in/courses/112/105/112105051/>

## PS/CORE PRATICAL IV - ENVIRONMENTAL AUDIT

Semester: IV  
Credits: 3

Course Code: U23ES4P4  
Hours/Week: 3

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcomes	K-Level	Activities
CO1	Formulate the methodology for study of the domestic / campus environment.	K2	1-4
CO2	Develop skill to audit water utility	K3	1
CO3	Develop skill to audit domestic energy usage	K3	2
CO4	Develop skill to audit waste in a domestic environment	K3	3
CO5	Develop skill to calculate domestic carbon footprint	K3	4
CO6	Assess the environmental audit in a domestic / campus environment.	K6	1-4

### 2. A. Syllabus

#### Lit of Activities

1 **Water Audit**-Importance and objectives-Methodology-Assessment-Result and inference-Conservation measures

2 **Energy Audit**-Importance and objectives-Methodology-Assessment-Result and inference-Conservation measures

3 **Waste Audit**- Importance and objectives-Methodology Assessment-Result and inference-Conservation measures

4 **Carbon footprint**- Carbon footprint calculation; Result and inference; Carbon offset measures

#### C. Text Books

1. Canter, L. W. Environmental Impact Assessment. McGraw Hill Book Co., New York,1977.

#### B. Reference Books

2. April Smith. Campus Ecology - A Guide to Assessing Environmental Quality and Creating Strategies for Change. Living Planet, LosAngeles,1993.
3. Rao, M. N and Rao, H. V. N. Air Pollution. Tata McGraw Hill Publishing Co. Ltd., New Delhi,1989.
4. Cunningham, A. B. Professional Ethics and Ethnobotanical Research. In: Alexiades M, Editor. Selected guidelines for Ethnobotanical Research: a field manual. Bronx: New York Botanical Garden; 1996.p.19-51.

#### C. Web Link

1. [http://old.cwc.gov.in/main/downloads/DraftGuideline\\_Water\\_Audit.pdf](http://old.cwc.gov.in/main/downloads/DraftGuideline_Water_Audit.pdf)
2. <https://www.adb.org/sites/default/files/publication/28555/estimating-carbon-footprints-road-projects.pdf>
3. <https://nptel.ac.in/content/storage2/courses/105103025/pdf/pdf3.pdf>

**ALLIED THEORY IV-**

**Semester: IV**  
**Credits: 3**

**Course Code: U23ES4Y4**  
**Hours/Wee: 3**



**ALLIED PRACTICAL IV:**

**Semester: IV**  
**Credits: 2**

**Course Code:U23ES4PY4**  
**Hours/Week: 3**

## SEC VII SERVICE LEARNING - VERMICOMPOSTING

Semester: IV  
Credits: 2

Course Code: U23ES4S7  
Hours/Week: 2

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcomes	K-Level	Unit
CO1	To learn the technique of Vermicomposting	K1	I
CO2	To develop entrepreneurship skills in establishing vermiculture unit.	K2	II
CO3	Exposure On Vermicomposting Technology		
CO4	To develop skills on vermicomposting		

### GENERAL OBJECTIVES

- To learn the techniques of vermicomposting
- To develop entrepreneurship skills in establishing vermiculture unit.

### UNIT I: INTRODUCTION

Relevance and Significance of Vermicomposting – Advantages - Nutrient contents of Vermicompost Vs Others - Impacts and Sustainability - Economic, Social, Ecological, Vermicomposting in India

### UNIT II: VERMICOMPOSTING TECHNOLOGY

Site Selection, Species selection, Vermibed, Feed stock, Inoculation of earthworms, Feeding & Maintenance, Harvesting methods

### UNIT III: ENTREPRENEURSHIP IN VERMICOMPOSTING

Business model, Opportunities, Challenges, Financial guidance, Cost – Benefit Analysis,

### UNIT IV: PROPOSAL PREPARATION

### UNIT V: PROJECT

### REFERENCE BOOKS

1. Edwards, C.A and P.J. Bohlen, **Ecology of Earthworms**, 3<sup>rd</sup>Edn , Chapman and Hall, 1996.
2. Gupta P.K. **Vermicomposting**, Agrobios, India, 2003.
3. Ismail, S.A. Vermicology, **The biology of earthworm**, Orient Longman, London, 1970.
4. Lee, K.E, **Earthworms-their ecology and relationship with soil and land use**, Academic press, Sydney, 1985.

## COURSE: ENVIRONMENTAL STUDIES

Semester: IV  
Credits: 2

Course Code: U23EST41  
Hours/Week: 1

### 1. Course Outcomes

On completion of this course the students will be able to:

CO No.	Course Outcomes	K-Level	Unit
CO1	Outline the importance for the Environmental studies	K2	I
CO2	Extend their understanding about various resources	K4	II
CO3	Recall the ecosystems and how they are interacting	K4	III
CO4	Classify how the diverse organisms are distributed across various geographical, physiological realms	K5	IV
CO5	Identify the causes, analyze the impacts of various environmental pollutions	K5	V
CO6	Summarize the concept of sustainability and relate various current environmental issues	K5	VI
CO7	Analyze how the environmental problems of recent times are related to population	K4	VII
CO8	Create documents on environmental resources, ecosystems etc.	K6	VIII

### 2. A. Syllabus

#### Unit I The Multidisciplinary nature of Environmental Studies

Definition, Scope and Importance. Need for Public awareness

#### Unit II Natural Resources

Renewable and Non-renewable resources; Natural resources and associated problems a) Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, change4s caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case Studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual I conservation of natural resources. Equitable use of resources of sustainable lifestyles.

#### Unit III Ecosystems

Concept of an ecosystem, Structure of an ecosystem, Producers, consumers, decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristics features, structure and function of the following ecosystem: a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (Ponds, streams, lakes, rivers, oceans, estuaries)

#### Unit IV Biodiversity and its Conservation

Introduction-definition: Genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: Consumptive use, productive use, social ethical, aesthetic and option values, Biodiversity at global, National and local level, India as a megadiversity nation, Hot-spots of biodiversity, Threats to biodiversity : habit los, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity In-situ conservation of biodiversity.

#### Unit V Environmental Pollution

Definition, Causes, effects and control measures of: Air Pollution; Water Pollution; Soil Pollution; Marine Pollution; Noise Pollution; Thermal Pollution; Nuclear Hazards; Solid Waste Management:

Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies. Disaster management: Floods, earthquake, cyclone and landslides.

#### **Unit VI Social Issues and the Environment**

From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Case studies, Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies, Wasteland reclamation, Consumerism and waste products Environment Protection Act, Air (Prevention and Control of Pollution) Act, Forest (Conservation) Act, Issues involved in enforcement of environmental legislation, Public awareness.

#### **Unit VII Human Population and the Environment**

Population growth, variation among nations, Population explosion-family welfare programme environment and human health, human rights, value education, HIV/AIDS, women and child welfare, role of information technology in environment and human health, case studies.

#### **Unit VIII Field Visit**

Field visit to document environmental assets-river/ forest/ grassland/hill/mountain, visit to a local polluted site -Urban/Rural/Industrial/ Agricultural, study of common plants insects, birds, study of simple ecosystems-pond, river, hill slopes, etc.

#### **C. Text Books**

2. Kumaraswamy K, Alagappa Moses A and Vasanthi M, 2017. Environmental Studies- a text book for all undergraduate courses. 16<sup>th</sup> Edition. Bharathidasan University, Tiruchirappalli.

#### **E. Web links**

4. <https://nptel.ac.in/courses/120/108/120108004/>
5. <https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf>
6. <https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf>

## CORE THEORY V - BIODIVERSITY AND CONSERVATION

Semester: V  
Credits: 4

Course Code: U23ES505  
Hours/Week: 5

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcomes	K-Level	Unit
CO1	Define biodiversity and its different levels	K1	I
CO2	Compare the Bio geographical classification of India	K2	II & III
CO3	Plan the Strategies of Conservation	K3	II & IV
CO4	Explain the importance of traditional knowledge and sacred groves.	K2	IV
CO5	List Sustainable wildlife management	K4	V
CO6	formulate the Laws and policies pertaining to conservation	K6	V

### 2. A. Syllabus

#### Unit I Introduction to Biodiversity

Levels of biodiversity; Biodiversity at Global, National and local levels; the mega-biodiversity countries of the world; Hot spots of biodiversity; IUCN categories of species - Red list; Endangered and endemic species of India. Values and threats of biodiversity: Values - consumptive use - productive use - social-ethical -aesthetic and optional values; Threats to biodiversity-HIPPO - Habitat loss, Invasive species, population, pollution and over exploitation;

#### Unit II Indian Biogeography

Bio geographical classification of India (10 zones); major forests in India - 16 Forest type groups - salient features.

#### Unit III Strategies of Conservation

In-situ conservation-IUCN conservation categories; Conservation approach: Strategic Species approach - key stone species, flagship species, umbrella species; Ecosystem approach. Ex-situ conservation of plants and animals - Botanical gardens, Arboretum, Seed banks, Gene banks, zoos, aquaria, inter specific pregnancy

#### Unit IV Sustainable Management

Concept and importance of traditional knowledge and sacred groves. Sustainable wildlife management- Principles and techniques; Management of forest fire, human animal conflict, invasive alien species; Concept of sustainable hunting; sustainable grazing, ecotourism;

#### Unit -V Biodiversity Conservation Regulations

Laws and policies pertaining to conservation: Salient features of the laws Indian Forest Act, 1927; Wildlife Protection Act, 1972; Forest Conservation Act, 1980, Biological diversity Act, 2002; Salient features of National Forest Policy 1988 - Joint Forest Management, 1990; Social forestry. Conservation Efforts: Objectives and activities - Major conservation agencies - WWF, IUCN, Conservation International, WCMC; International Conventions: Out comes - Conventions on Biological Diversity (CBD), CITES, CMS, Ramsar convention

### B. Topics for Self-study

- **Tiger reserves in India** (<https://affairscloud.com/list-of-tiger-reserves-in-india/>)
- **Forest Laws and Acts** ([https://mpforest.gov.in/img/files/Handbook\\_FC\\_Act\\_2019](https://mpforest.gov.in/img/files/Handbook_FC_Act_2019))
- **Conservation Act** ([https://en.wikipedia.org/wiki/Conservation\\_Act\\_1987](https://en.wikipedia.org/wiki/Conservation_Act_1987))
- **Conservation Strategies** (<https://www.slideshare.net/resgmasheikh/conservation-strategies>)

### C. Text Books

1. Sharma, P.D. Ecology and Environment. 13<sup>th</sup> Edition (Reprint), Rastogi Publications, Meerut, India. ISBN 978-93-5078-122-7, 2019.
2. Verma, P. S and Agarwal, V.K. Environmental Biology (Principles of Ecology). S Chand & Company; New edition ISBN-10: 8121908590, ISBN-13: 978-8121908597, 2000.
3. Clarke GL, Elements of Ecology. John Wiley, London,2003.
4. Odum, E. P. Fundamentals of Ecology. W.B., Saunders Co, Philadelphia and London,1971.
5. Krishnamurthy, K.V. An Advanced Textbook on Biodiversity: Principles and Practice. Oxford and IBH. Publ. Co. New Delhi. 260p, 2004.
6. Krishnamurthy, K.V. An Advanced Textbook on Biodiversity: Principles and Practice. Oxford and IBH. Publ. Co. New Delhi. 260Pp, 2004.

### D. Reference Books

1. Chapman, J. Land Reiss, M.J. Ecology-Principles and Applications. Cambridge University Press (Low price edition), 1995.
2. Melchias, G. Biodiversity and Conservation. Oxford IBH. New Delhi. 236Pp, 2001.
3. Groombridge, B. Editor. Global Biodiversity– Status of the Earth’s living resources. Chapman & Hall, London,1994.
4. Levin, S. A. Encyclopedia of Biodiversity: Second Edition. Academic Press 5 Vol, 2000.
5. Singh, J. S., Singh, S. P and Gupta, S. R. Ecology, Environment and Resource Conservation. Anamaya Publ., New Delhi. 688 Pp, 2006.

### E. Web links

1. <http://www.iucnredlist.org/https://www.unenvironment.org/>
2. <https://cpb.ucdavis.edu/news/resources-teaching-ecology-and-evolution>
3. <https://www.esa.org/programs/ecology-education/#gsc.tab=0>
1. <https://www.ugc.ac.in/oldpdf/modelcurriculum/Chapter4.pdf>
2. [http://www.keralabiodiversity.org/images/pdf/book\\_english.pdf](http://www.keralabiodiversity.org/images/pdf/book_english.pdf)
3. <http://www.fao.org/3/i6855en/I685>

## CORE THEORY VI - TOOLS AND TECHNIQUES FOR ENVIRONMENTAL SCIENCES

Semester: V  
Credits: 4

Course Code: U23ES506  
Hours/Week: 5

### 1. Course Outcomes

On completion of this course the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	Explain the monitoring of micro-meteorological and environment parameters	K2	I
CO2	Explain the water quality monitoring and sampling techniques	K2	II
CO3	Identify the Impact of developmental activities	K1	III
CO4	Identify the Environmental / Baseline /Setting and Identification of impacts	K1	IV
CO5	Analyze the impacts of a mining/industrial/developmental activity	K4	IV
CO6	Predict the impacts and prepare Environmental Impact Statement	K3	V

### 2. A. Syllabus

#### Unit I Environmental Monitoring of Micro-Meteorological parameters

Temperature, humidity, Atmospheric pressure, wind velocity, wind direction, sunshine. Ambient Air: Particulates PM2.5, PM10. Gaseous contaminants: SO<sub>2</sub>, H<sub>2</sub>S, NO<sub>x</sub>, CO, CO<sub>2</sub>. Ambient Noise levels. National standards for air quality and noise

#### Unit II Environmental Monitoring of Hydrological parameters

Water Quality Monitoring Protocol 2006 and Sampling techniques of water; Preservation of water samples for the analysis of various parameters. Standard methods for the Examination of water and wastewater. Water quality standards

#### Unit III Impact of Developmental Activity

Category A and B projects as per EIA Notification, 2006 (Assessment based on EIA reports of projects cleared by MoEFCC and SEIAA). Mining extraction of natural resources and Power generation; Primary processing units; Material production; Material processing; Manufacturing/Fabrication; Service Sectors; Physical Infrastructure including services; Construction - Township/Commercial complexes/Housing.

#### Unit IV Environmental Impact Assessment and Statement

Environmental / Baseline /Setting; Identification of impacts; Prediction of impacts and Preparation of Environmental Impact Statement.

#### Unit V Environmental Management Plan

Air, Water, Land, Socio-economic, Ecology and Biodiversity.

### B. Topics for Self-study

- **Air Quality Management Process** (<https://www.epa.gov/air-quality-management-process>)
- **Water Technology and Innovation** (<https://blogs.worldbank.org/water/future-water-how-innovations-will-advance-water-sustainability-and-resilience-worldwide>)
- **EIA legislation** (<https://www.cseindia.org/eia-legislation-402>)
- **Environmental management plan roles and responsibilities** ([https://www.westerncape.gov.za/Text/2005/7/deadp\\_emp\\_guideline\\_june05\\_5.pdf](https://www.westerncape.gov.za/Text/2005/7/deadp_emp_guideline_june05_5.pdf))

### **C. Text Books**

1. Canter, L. W. Environmental Impact Assessment. McGraw Hill Book Co., New York, 1977. ISBN:9780071141031
2. Munn, R. E. Environmental Impact Assessment. Mc Graw Hill Book Co., New York, 1979. ISBN:0471997455
3. Rau, J. G and Wooten, D. C. Environmental Impact Analysis Handbook, McGraw Hill Book Co., New York, 1980. ISBN:978-0070512177

### **D. Reference Books**

1. Murty, J.V.S. Watershed Management in India. Wiley Eastern Ltd., New Delhi, 1994.
2. TNPCB. Pollution Control Legislations - Tamil Nadu Pollution Control Board, Vol-I and II, Chennai, 1999.
3. Austin, G. T. Shreve's Chemical Processes in Industries. McGraw Hill Education, Asia. 1984; ISBN 10: 0070661677; ISBN 13: 9780070661677
4. Mahajan, S. P. Pollution Control in Process Industries. Tata McGraw Hill Co. Ltd., New Delhi, 2004. ISBN 10: 0074517724 / ISBN 13: 9780074517727
5. Trivedy, B.K. Pollution Control in Industries. Enviro Media Publishing Co., Karad, 1991.
6. Westman, W. E. Ecology, Impact Assessment and Environmental Planning. John Willey and Sons, New York, 1985. ISBN: 0471808954, 9780471808954

### **E. Web Links**

1. [https://www.in.gov/idem/airquality/files/qa\\_manual\\_chap\\_09.pdf](https://www.in.gov/idem/airquality/files/qa_manual_chap_09.pdf)
2. <https://tspcb.cgg.gov.in/Environment/Ambient%20Noise%20Standards.pdf>
3. [https://www.who.int/water\\_sanitation\\_health/resourcesquality/wqabegin.pdf](https://www.who.int/water_sanitation_health/resourcesquality/wqabegin.pdf)



## CORE PRACTICAL V - WATER QUALITY ANALYSIS

Semester: V  
Credits: 4

Course Code:U23ES5P5  
Hours/Week: 6

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Experiments
CO1	List the water pollution problems	K1	1-11
CO2	Analyze the water samples with the various physico-chemical parameters	K1	
CO3	Label the water samples from the various sources	K4	
CO4	Compare the results with the standards	K4	
CO5	Identify the pollution indicators	K3	
CO6	Recommend preventive and alternate practices to reduce pollution	K5	

### 2. A. Syllabus

#### List of Experiments

1. Estimation of pH - metric method
2. Estimation of EC - Conductivity method
3. Estimation of Turbidity -Nephelometric method
4. Estimation of Total Dissolved Solids (TDS)- Gravimetric and Filtration method
5. Estimation of Dissolved Oxygen- (DO) - Winkler's method
6. Estimation of Total Hardness
7. Estimation of Chloride
8. Estimation of Phosphorous
9. Estimation of Nitrite
10. Estimation of Nitrate
11. Identification of Pollution Indicators - (Plants, Planktons and Microbes)

#### B. Text Books

1. Trivedy, R. K and Goel, P. K. Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad,1984.
2. Sawyer,C.N. and McCarty, P. Chemistry for Environmental Engineering. Mc Graw Hill International,1978.

#### C. Reference Books

1. APHA. Standard Method for Examination of Water and Waste water. APHA -AWWA - WEF,1998.
2. APHA. Standard Method for Examination of Water and Waste water. APHA -AWWA - WPCF,1989.

#### D. Web links

1. [https://www.who.int/water\\_sanitation\\_health/resourcesquality/wqmchap6.pdf](https://www.who.int/water_sanitation_health/resourcesquality/wqmchap6.pdf)
2. [http://web.iitd.ac.in/~arunku/files/CEL212\\_2012/Lab%20%20Dissolved%20Oxygen.pdf](http://web.iitd.ac.in/~arunku/files/CEL212_2012/Lab%20%20Dissolved%20Oxygen.pdf)
3. <https://www.tandfonline.com/doi/pdf/10.1080/21553769.2016.1162753>

## Elective I - REMOTE SENSING AND GIS

Semester: V  
Credits: 3

Course Code: U23ES5:A  
Hours/Week: 4

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	Define remote sensing and explain Principles of EMR	K1	I
CO2	Describe the components of EM Spectrum Interpret the interaction of EMR with Atmosphere, vegetation, soil and water	K4	I
CO3	Explain the satellite platforms and sensors	K4	II
CO4	Specify the resolution and its types.	K5	III
CO5	Develop the skills on geographic co-ordinate system and maps	K4	IV
CO6	Apply the techniques of GIS	K4	V

### 2. A. Syllabus

#### Unit I Remote Sensing

Introduction; History; Definition – Components and Fundamental Principle of Remote sensing - Types of remote sensing - The Electromagnetic radiation: Wave model, Particle theory - Electromagnetic spectrum - Energy interaction with the atmosphere: Scattering (Types of Scattering), absorption and refraction - interactions of energy with earth surface: Reflection.

#### Unit II Satellite Platforms

Definition and Types of platforms (Ground Based, Airborne and Space borne) - Satellite orbits: Definition and Types (Polar, Geo-stationery and Sun-synchronous). Types of Sensors: Active and Passive - GPS and its applications

#### Unit III Resolution

Definition and Types – Spatial, Spectral, Radiometric and Temporal. Significance of Satellites - LANDSAT Series, SPOT Satellite and IRS Satellites.

#### Unit IV Geographic Co-ordinate & Information System

Definition, Latitude and longitude – Map: Definition and types. Significance of Geo-referencing map. Topo sheets - Definition and its uses; Map scale. **GIS**- Definition - Components of GIS – Hardware and software - Raster and Vector Data structure.

#### Unit V Remote Sensing and GIS Applications

Case studies; Groundwater potential zones; Landside mitigation; site selection of waste disposal - Uses of mapping of soil, drainage, contour, slopes, geology and wasteland.

### **C. Text Books**

1. Lilles and, T.M. and P.W. Kiefer. Remote Sensing and Image Interpretation. 7th Edition, John Wiley & Sons, New York. 2007. ISBN: 978-1-118-34328-9
2. Floy F. Sabins. Remote Sensing Principles and Interpretation. Freeman, San Francisco, 1978, ISBN: 9781577663539
3. Burrough, P. A. Principles of Geographical Information Systems for Land Resources Assessment. Oxford University Press, 1986, ISBN: 0 19 8545924.
4. Anji Reddy, M. Text book of Remote Sensing and GIS. 2012, BS Publications, ISBN: 9381075972
5. Basudeb Bhatta. Remote Sensing and GIS. 2nd Edition, Oxford; 2011, ISBN-10: 0198072392

### **D. Reference Books**

1. Surendra Singh, Geomorphology and Remote Sensing in Environmental Management. Scientific Publishers, Jodhpur, 1992. ISBN: 9788172330422.
2. Pirazizy, A.A. Environmental Geography and Natural Hazards. Concept Publishing Company, New Delhi, 1992. ISBN: 8170224241
3. John R. Jensen, Remote Sensing of the Environment. 2nd Edition, Pearson Education India Publication, 2013, ISBN: 10: 9789332518940
4. Giles M. Foody and Paul J. Curran. Environmental Remote Sensing from Regional to Global Scales. Wiley India Pvt Ltd, 2012, ISBN- 10: 9788126539796
5. Kang – Tsung Chang, Introduction to Geographic Information System. 4th Edition, McGraw Hill, Boston, 2017, ISBN-13: 978- 0070658981
6. Anand, P.J.J and Rajesh Kumar, V. Principles of Remote Sensing and GIS. Sri Venkateswara Publishers, Kumbakonam, 2002.
7. Anji Reddy, M. Textbook of Remote Sensing and GIS. (IT edition) BS Publications, Hyderabad, 2003.
8. Panda. B. C. Remote Sensing Principles and Application. Viva Books Private Limited, New Delhi, 2005.

### **E. Web links**

1. <https://ncert.nic.in/textbook/pdf/kegy307.pdf>
2. [https://www.patnauniversity.ac.in/e-content/social\\_sciences/geography/MAGeog71.pdf](https://www.patnauniversity.ac.in/e-content/social_sciences/geography/MAGeog71.pdf)
3. [https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/resource/tutor/fundamentals\\_e.pdf](https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/resource/tutor/fundamentals_e.pdf)
4. <https://www.patnauniversity.ac.in/e-content/science/geology/MScGeology34.pdf>
5. [http://ags.geography.du.ac.in/Study%20Materials\\_files/Punyatoya%20Patra\\_AM.pdf](http://ags.geography.du.ac.in/Study%20Materials_files/Punyatoya%20Patra_AM.pdf)

## Elective II - ENVIRONMENTAL LEGISLATION

Semester: V  
Credits: 3

Course Code: U23ES5:B  
Hours/Week: 4

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	Recognize the processes and scope of Environmental Impact Assessment	K3	I
CO2	Discuss about various processes of Environmental Impact Assessment and Risk identification.	K3	II
CO3	Relate global and national legislative efforts towards environmental protection.	K6	III
CO4	Describe the history and outcomes of various government and non-governmental efforts towards environmental protection.	K5	IV
CO5	List and mark sanction and enforcement bodies of environmental laws.	K6	V
CO6	Relate the Legislation and EIA	K6	V

### 2. A. Syllabus

#### Unit I Environmental Impact Assessment

Introduction; Types of EIA- Rapid, Comprehensive and Strategic EIA; Processes of EIA- Project Screening; Objectives and Alternatives in EIA; Project Planning and processes, Baseline information, Impact prediction, decision making; EIA Notifications of MoEF

#### Unit II Environmental Impact Statement

Environmental Impact Statements (EIS); Environmental Risk Assessment and Management; Hazard Identification and Characterization; Health Risk Assessment; Disaster Management; Environmental Management Plan (EMP)

#### Unit III Legislative Framework

National policy statement of environment and development; Legislative framework of environmental protection, historical perspectives and Indian constitutional provisions; International treaties on Environmental protection: Ramsar Convention, Montreal protocol, Kyoto protocol, Convention on International trade of endangered species.

#### Unit IV Environmental Laws

Sanction and enforcement bodies of environmental laws: role of high court (Green Bench), Supreme Court, State and Central Pollution Control Boards; National Environmental Movements: Silent valley Movement, Chipko movement, Narmada Movement, Appiko Movement, Almatti Dispute and Tehri Dam Movement.

#### Unit V Environmental Acts and Rules

Water (Prevention and control of Pollution Act, 1974), Forest (Conservation) Act (1980); Air (Prevention and control of Pollution Act, 1981), Environment (protection) Act (1986); National Environment Policy (2006); Coastal Regulation Zone (CRZ) Notifications.

### **C. Text Books**

1. Shrivastava, A. K. Environmental Impact Assessment. APH Publishing Corporation, New Delhi, 2003
2. Kukarni, V. S., Kaul, S. N and Trivedi, R. K. A Hand book of Environmental Impact Assessment. Scientific Publishers, Jodhpur, 2002
3. Canter, L.W. Environmental Impact Assessment. McGraw Hill Book co., New York, 1977.
4. Munn, R. E. Environmental Impact Assessment. McGraw Hill Book Co., New York, 1982.
5. Rau, J. G and Wooten, D. C. Environmental Impact Analysis Handbook. McGraw Hill Book Co., New York, 1980.

### **D. Reference Books**

1. Cutter, L. Environment Risks and Hazards. Prentice Hall of India Private Limited, New Delhi, 1999.
2. Kofi Asante. D-Duah. Risk Assessment in Environmental Management. John Wiley and Sons, New York. 515p. 1998.
3. Peter Calow. Hand Book of Environmental Risk Assessment and Management. Blackwell, Swence, London, 1998
4. Westman, W. E. Ecology, Impact Assessment and Environmental Planning. John Willey and Sons, New York, 1985.
5. Abbasi, S. A and Arya, D. S. Environmental Impact Assessment. Discovery Publishing House New Delhi, 2004
6. Maria Rosario Partidario. Perspectives on Strategic Environmental Assessment. Edited, Lewis Publishers, USA, 2000.
8. Uberoi, N. K. Environmental Management. Excel Book, New Delhi, 2004.

### **E. Web links**

1. [www.pdfdrive.com](http://www.pdfdrive.com)
2. [www.moef.gov.in/division/impact-asesment-related-notifications](http://www.moef.gov.in/division/impact-asesment-related-notifications)
3. [www.environmentwb.gov.in/pdf/EIA%20Notification,%202006.pdf](http://www.environmentwb.gov.in/pdf/EIA%20Notification,%202006.pdf)
4. <https://fenix.tecnico.ulisboa.pt/downloadFile/.../5.%20EIA%20methodologies.pdf>

**PRACTICE SCHOOL V**  
**INDUSTRIAL TRAINING PROGRAMME**

**Semester: V**  
**Credits: 2**

**Course Code: U23ES5I1**  
**Hours/Week: -**

**1. Course Outcomes**

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Activities
CO1	List the different types of industries	K2	I
CO2	Explain the common waste management facility / STP / ETP	K2	II
CO3	Describe the Green Energy technologies and Green Buildings	K2	III
CO4	Summarize EMS in Industries; EMP of the organization; Environmental Compliance	K4	IV
CO5	Discuss the options for waste management practices.	K4	
CO6	Acquire interpersonal skills, communication skills, leadership qualities etc.	K4	

**2. A. Syllabus**

**List of Activities**

**1 Industrial Exposure**

Industrial Exposure Training - Apparel Industries: Tannery and Textiles units; Agro Industries; Sugar, Distillery; Pulp and Paper; Edible oil; Dairy Sago units; Cement and Thermal Power Plants; Mining activity - Limestone mining

**2 Waste Management Facilities**

Common Waste management facility - Visit/Observation; Biomedical waste /Municipal Solid waste /Sewage Treatment Plants / Effluent Treatment Plant / E Waste Management facility /Treatment processes, Recycling, Reuse and up cycling practices

**3 Green Energy technologies and Green Buildings**

Sources of energy in the anthroposphere, Green technology and energy conversion efficiency. Energy conservation and renewable energy sources (list of sources only). Green Composites for buildings: Concepts of Green Composites. Water Utilization in Buildings and Low Energy Approaches to Water Management. Management of Solid Wastes, sewage and sullage. Urban Environment and Green Buildings. Green Cover and Built Environment.

**4 Environmental Management System**

Environmental Management System in Industries; Environmental Management Policy of the organization; Environmental Compliance; ISO 14001 and 18001 Certification; environmental Resource Auditing in industries. Waste management practices: Wastewater and Solid waste

**B. Text Books**

1. Patnaik, P. Handbook of Environmental Analysis - Chemical Pollutants in Air; Water; Soil and Solid wastes. Lewis Publishers, Boca Raton, 1997
2. Mahajan, S. P. Pollution Control in Process Industries. Tata McGraw Hill Co. Ltd., New Delhi, 1986.

### **C. Reference Books**

1. Austin, G. T. Shreve's Chemical Processes in Industries. McGraw Hill Book Co., New York, 1977.
2. Rao, M. N and Datta, A. K. Wastewater Treatment. Oxford and IBH, 1982.
3. APHA. Standard Methods for the Examination of Water and Wastewater. American Water Works Association, 21st Edition. ISBN 0875530478, 9780875530475 APHA Publishers, 2005.
4. Saxena, M. M. Environmental Analysis Water, Soil and Air. Agro Botanical Publishers, India. ISBN: 81-85031-22-3, 1987

### **D. Web links**

1. [https://www.who.int/water\\_sanitation\\_health/medicalwaste/decisionmguide\\_rev\\_oct06.pdf](https://www.who.int/water_sanitation_health/medicalwaste/decisionmguide_rev_oct06.pdf)
2. <https://nptel.ac.in/courses/105/102/105102195/>
3. <http://mohua.gov.in/upload/uploadfiles/files/Part2.pdf>

**(Note: Each student shall spend a total of 15 Hrs. in a selected industry / facility and prepare the detailed report. Evaluation shall be done internally through the assessment of report and viva-voce.)**

## Core VII - STATISTICS FOR ENVIRONMENTAL SCIENCES

Semester: IV  
Credits: 4

Course Code: U23ES607  
Hours/Week: 6

### 1. Course Outcomes

On completion of the course, the students will be able to:

CO No.	Course Outcomes	K-Level	Unit
CO1	Define statistics and explain its applications.	K1	I
CO2	Articulate a data collection	K3	II
CO3	Summarize the data and present it.	K2	II & III
CO4	Measure of central tendency and dispersion	K3	II & IV
CO5	Apply correlation and regression analysis.	K4	III
CO6	Explain the concepts of Probability and its rules	K2	V

### 2. A. Syllabus

#### Unit I Introduction

Introduction of Statistics – Is statistics a science? – Applications of Statistics – Function & Limitations of Statistics – Data Structure – Data Sources – Data Collection Techniques – Data Presentation.

#### Unit II Central Tendency

Measures of Central Tendency – Arithmetic mean, median, mode, weighted average, and geometric mean

#### Unit III Measures of Dispersion

Dispersion – Introduction – Range – Quartile Deviation – Mean Deviation – Standard Deviation – Relative Measures of Dispersion.

#### Unit IV Measures of Deduction

Correlation and Regression Analysis.

#### Unit V Probability

Probability – Definition – Meaning of Probability – Addition rules – Multiplication rules – Baye's Theorem (only problem)

### B. Text Books

1. Pillai, R. S. N and Bagavathi, V. Statistics. First Edition, S. Chand & Company Ltd., New Delhi, 1998. ISBN:81-219-0431-5
2. Joseph Anbarasu, D. Business Statistics. Learntech Press, Tiruchirappalli, 2006.
3. Mariappan, P. Biostatistics- An introduction. Pearson, Chennai.
4. 2013. ISBN: 978-81-317-7514-1.

### C. Reference Books

1. Perumal Mariappan. Statistics for Business. First Edition, CRC Press Taylor & Francis Group, Boca Raton London New York, 2019; ISBN: 978 – 1 – 138 – 33617 – 9.
2. Singhal, M, Elements of Statistics (Theory and Practice), Fourth Edition, Lakshmi Narain Agarwal, Educational Publishers, Agra, 2009.
3. Asthana, B.N, Elements of Statistics (Part One), Tenth Edition, Chaitanya Publishing House, Allahabad, 1996.

### D. Web Links

1. <https://www.umass.edu/landeco/teaching/ecodata/schedule/statistics.pdf>
2. <http://www.fao.org/3/X2465E/x2465e09.htm>
3. <https://www.youtube.com/watch?v=WM8vzYSQhs>



## Core VIII - ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT

Semester: VI  
Credits: 4

Course Code: U23ES608  
Hours/Week: 6

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	Analyze global consumption patterns of natural resources	K2	I
CO2	Explain the Sustainable Water Management and Land Management Strategies	K3	II
CO3	Apply the Sustainable Agriculture practices	K6	III
CO4	Apply the Sustainable Land resources management	K6	III
CO5	Justify the Forest Management through Social Forestry and Joint Forest Management	K5	IV
CO6	Explain the Disaster Management Strategies	K6	V

### 2. A. Syllabus

#### Unit I Resource Management and Sustainability

Global consumption patterns of natural resources; Environmental issues in the world; Approaches to Environmental Management; Environmental Management Strategy - Prevention - Enforcement - Monitoring - Education & Partnership; Sustainable development - history, concept and goals; strategies; circle of sustainability.

#### Unit II Global Conventions

Global conventions - Stockholm Conference, Brundtland commission, Rio Summit, Rio+10, Rio+20, Montreal Protocol, Kyoto protocol, Copenhagen summit; Global organizations - IPCC, UNEP, IUCN, WWF, Greenpeace International; National organizations - ATREE, BNHS, BSI, BVIEER, CEE, CSE, NEERI, NCF, SACON, TERI, WII, ZSI (Major objectives, activities and achievements).

#### Unit III Sustainable Management

Sustainable Water Management (SWM)- Water resources; Methods of water management: Conservation including rainwater harvest and watershed management), Allocation, retrofit program and Behavioral practices; Sustainable Land Management (SLM): Land use pattern; Land degradation - types, causes, impacts and control measures.

#### Unit IV Sustainable Agriculture

Factors affecting sustainability; Impacts of unsustainable agriculture; Intensification, water efficient agriculture, soil and nutrient amendments, integrated pests and weed management, crop rotation, polyculture / inter cropping, organic agriculture, alternative agriculture - urban agriculture, regenerative agriculture, integrated farming; Sustainable Forest Management (SFM): Principles and Techniques; Forest management in India - Social Forestry Schemes; Joint Forest Management.

#### Unit V Disaster Management

Types of disaster - Natural and Manmade; Complex Emergencies, Environmental Disaster and Pandemic Emergencies; COVID-19 The Impacts of a Global Crisis on Sustainable Development; Disaster Management Strategy: Prevention, Preparedness, Response and Recovery; Management- Flood, Earthquakes, Cyclone; Disaster management in India: National Disaster Management Authority (NDMA), State Disaster Management Authorities (SDMAs), District Disaster Management Authorities; Disaster Management Plan.

**B. Text Books**

1. Agarwala, V.P. Forests in India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi,1985. ISBN 978-81-204-0041-2
2. Gopal, L. J. Rural Development. Mangal Deep Publications, Jaipur,1997. ISBN-10: 8175940166;
3. Kurian Joseph and Nagendran, R. Essentials of Environmental Studies. Pearson Education Limited, New Delhi, 2004.ISBN 13 - 9788129704986
4. Murty, J. V. S. Watershed Management in India. Wiley Eastern Ltd., New Delhi, 1994; ISBN 81 - 224 - 0856 - 7
5. TNPCB. Pollution Control Legislations. Tamil Nadu Pollution Control Board, Vol-I and II, Chennai,1999.

**C. Reference Books**

1. Nandhithakrishna. Environmental Laws of India – An Introduction.
2. C.P.R. Environmental Education Centre, Chennai, 1998.ISBN 9781512068474
3. Canter, L. W. Environmental Impact Assessment. McGraw Hill Book co. NY,1977. ISBN9780070097674
4. Centre for Science and Environment. The State of India's Environment: The Second Citizen's Report, CSE, New Delhi,2008; ISBN 978-81- 86906-11-8.
5. Krishnamurthy, K.V. An Advanced Textbook on Biodiversity. Principles and Practice. Oxford &IBH Publishing Co., New Delhi,2004. ISBN-10:9788120416062

**D. Web Links**

1. <https://nptel.ac.in/content/storage2/courses/120108004/module1/lecture1.pdf>
2. <https://publications.iwmi.org/pdf/H039314.pdf>
3. <http://ifs.nic.in/Dynamic/pdf/JFM%20handbook.pdf>

## CORE PRACTICAL VI - SOIL ANALYSIS

Semester: VI  
Credits: 4

Course Code: U23ES6P6  
Hours/Week: 6

### 1. Course outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Experiment
CO1	Explain the collection, handling and preservation of the environmental samples	K2	I
CO2	Assess the PM <sub>10</sub> in the ambient air	K5	I
CO3	Demonstrate SO <sub>2</sub> and NO <sub>x</sub> in the ambient air	K2	I
CO4	Measure the ambient noise level.	K5	I
CO5	Analyze the physico- chemical parameters of soil	K4	II
CO6	Compare the results with the standards	K5	II

### 2. A. Syllabus

#### List of Experiments

1. Estimation of pH - pH metric method
2. Estimation of EC - Conductivity method
3. Estimation of Alkalinity
4. Estimation of Total Organic Matter
5. Estimation of Phosphorous
6. Estimation of Sodium and Potassium

#### B. Text Books

1. Patnaik, P, Handbook of Environmental Analysis–Chemical Pollutants in Air; Water; Soil and Solid wastes (1997). Lewis publishers, Boca Raton.
2. APHA Standard Methods for the Examination of Water and Wastewater 21<sup>st</sup> Ed. (2005). American Water Works Association Publisher. ISBN: 9780875530475.

#### C. Reference Books

1. Margesin R and Schinner. Manual of Soil Analysis - Monitoring and Assessing Bioremediation. Springer -Verlag BerlinHeidelberg,2005.
2. Trivedy RK, Goel PK and Trisal L, Practical Methods in Ecology and Environmental Sciences (1987). Environmental Publications, Karad.
3. Saxena MM, Environmental Analysis Water, Soil and Air (1987). Agro Botanical Publishers, India. ISBN: 8185031223.

#### D. Web Links

1. [http://moef.gov.in/wp-content/uploads/2019/05/NCAP\\_Report.pdf](http://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf)
2. <http://kspcb.gov.in/NAAQSManualVolumeI.pdf>
3. <https://www.youtube.com/watch?v=zXvEmlFqicw>

## ELECTIVE III - GLOBAL WARMING AND CLIMATE CHANGE

Semester: VI  
Credits: 3

Course Code: U23ES6:A  
Hours/Week: 5

### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Unit
CO1	Explain the importance of ozone layer and causes of its depletion	K2	I
CO2	Explain Green House Effect and global warming	K2	
CO3	Prove the global warming through the Trends in temperature changes and in CO <sub>2</sub> and other GHGs	K2	II
CO4	Describe the effects of Global Warming such as melting of polar ice and sea level rise	K2	III
CO5	Elaborate the implications of Climate Change (environmental, and socio-economic perspectives)	K2	IV
CO6	Discuss the International Initiatives in combating global warming	K2	V

### 2. A. Syllabus

#### Unit I Introduction

Introduction to Climate - Role of ozone in environment and its depletion - Green House Effect and global warming - role of fossil fuels

#### Unit II Global Warming

Global warming - Trends in temperature changes and in CO<sub>2</sub> and other GHGs. Global Warming Potential of GHGs. Effects of Global Warming - melting polar ice, sea level rise, positive feedback

#### Unit III Climate Change

Climate change and its socioeconomic and environmental implications (environment, biodiversity, agriculture, land use etc.)

#### Unit IV Global Initiatives

International Initiatives in combating global warming - UN Conferences formation of UNEP, IPCC and UNFCCC, Kyoto Protocol; Indian Government's commitment and initiatives - role of Ministry of Environment, Forest and Climate Change.

#### Unit V Mitigation Measures

Kyoto Mechanisms: Emission trading, Clean Development Mechanism, Joint Implementation. Annex I, Annex II and Annex B countries and their commitments / role; Basket of gases; Lima Call for Climate Action

### C. Text Books

1. Saha, T.K, Ecology and Environmental Biology. Books and Allied (P) Ltd. Kolkata, 2008.
2. Annon. World Health Organization, Climate and Health, Fact sheet, July, 2005.

### D. Reference Books

1. Annon, Climate Change 1995: Adaptation and Mitigation of Climate Change-Scientific Technical Analysis. Cambridge University Press, Cambridge, 1996.
2. Gosain, A.K. and Rao, S. Climate Change and India: Vulnerability Assessment and Adaptation. Eds. Shukla, P.R., Universities Press Pvt. Ltd., Hyderabad, 2003.
3. Lakshmipathy, M., Ramanan, S. R., Sathyanathan, R and Sudarsahn, J. S. Proceedings of the National Conference on Effect of climate change and sustainable resource management. SRM University, Kattankallathur, 2009.

## Practice School V

### ELECTIVE IV - INDUSTRIAL AND ECOSYSTEM EXPOSURE

Semester: VI  
Credits: 3

Course Code: U23ES6:B  
Hours/Week: 5

#### 1. Course Outcomes

On completion of this course, the students will be able to:

CO No.	Course Outcome	K-Level	Activities
CO1	Develop the field knowledge on the forest and ecosystem	K3	1
CO2	Compare the different ecosystem	K2	2
CO3	Identify the agricultural crops and analyze them	K5	3
CO4	Develop a report on the forest biodiversity	K3	4
CO5	Compare both the in-situ and ex-situ management practices	K4	5
CO6	List out the different sanctuaries and reserves in India	K4	5

#### 2. A. Syllabus

##### List of Activities

##### 1 Industrial Exposure

Industrial Visit - Apparel Industries: Tannery and Textiles units; Argo Industries; Sugar, Distillery; Pulp and Paper; Edible oil; Dairy Sago units; Cement and Thermal Power Plants; Mining activity - Limestone mining

##### 2 Natural Ecosystem Biodiversity

Montane ecosystem - visit and description - Forest- Thorn, Deciduous and Evergreen Littoral forests- visit and description - Grassland, Swamp, Mangrove and Dry evergreen forest

##### 3 Diversity of Artificial Ecosystems

Visit, description, impacts and mitigation

- Plantation Crops: Arecanut, Coffee, Tea and cardamom
- Commercial Crops: Cotton, Sugarcane, Tobacco, Cashew nut
- Forest Plantation: Wattle, Eucalyptus, Acacia and Teak
- Food crops: Paddy, Wheat, Maize and Potato

##### 4 Conservation of Biodiversity

Visit, list and description

- In-situ conservation
  - Wildlife Sanctuaries
  - National Parks
  - Biosphere Reserves
  - Conservation Reserves
  - Community Reserves

##### 5 Conservation of Biodiversity

Visit, list and description

- Ex-situ Conservation
  - Botanical gardens
  - Medicinal garden
  - Arboretum
  - Zoological parks
  - Aquaria
  - Butterfly Park
  - Crocodile bank

**B. Reference Books**

1. Chapman, J. Land Reiss, M. J. Ecology-Principles and Applications.
2. Cambridge University Press (Low price edition), 1995.
3. Melchias, G. Biodiversity and Conservation. Oxford IBH. New Delhi.
4. 236Pp, 2001.
5. Levin, S. A. Encyclopedia of Biodiversity: Second Edition. Academic Press 5 Vols,2000.
6. Singh, J. S., Singh, S. P and Gupta, S. R. Ecology, Environment and Resource Conservation. Anamaya Publ., New Delhi. 688 Pp,2006.

**C. Web links**

1. <https://www.youtube.com/watch?v=Z8jOcYEtyc0>
2. <https://nptel.ac.in/content/storage2/courses/105105110/pdf/m3l03.pdf>
3. [https://dducollegedu.ac.in/Datafiles/cms/ecourse%20content/PK%20\(AECC-EVS\)%20Chapter%20-%204%20Biodiversity.pdf](https://dducollegedu.ac.in/Datafiles/cms/ecourse%20content/PK%20(AECC-EVS)%20Chapter%20-%204%20Biodiversity.pdf)

**PROFESSIONAL COMPETENCY SKILL  
INSTITUTIONAL ENVIRONMENTAL AUDIT**

Semester: VI  
Credits: 2

Course Code: U23ES6G1  
Hours/Week: 2

**1. Course Outcomes**

On completion of this course, the students will be able to:

CO No.	Course Outcomes	K-Level	Activities
CO1	Formulate the methodology for study of the domestic / campus environment.	K2	1-4
CO2	Develop skill to audit water utility	K3	1
CO3	Develop skill to audit domestic energy usage	K3	2
CO4	Develop skill to audit waste in a domestic environment	K3	3
CO5	Develop skill to calculate domestic carbon footprint	K3	4
CO6	Assess the environmental audit in a domestic / campus environment.	K6	1-4

**2. A. Syllabus**

**Lit of Activities**

**1 Water Audit-**Importance and objectives-Methodology-Assessment-Result and inference-Conservation measures

**2 Energy Audit-**Importance and objectives-Methodology-Assessment-Result and inference-Conservation measures

**3 Waste Audit-** Importance and objectives-Methodology Assessment-Result and inference-Conservation measures

**4 Carbon footprint-** Carbon footprint calculation; Result and inference; Carbon offset measures

**B. Text Books**

- Canter, L. W. Environmental Impact Assessment. McGraw Hill Book Co., New York,1977.

**C. Reference Books**

- April Smith. Campus Ecology - A Guide to Assessing Environmental Quality and Creating Strategies for Change. Living Planet, LosAngeles,1993.
- Rao, M. N and Rao, H. V. N. Air Pollution. Tata McGraw Hill Publishing Co. Ltd., New Delhi,1989.
- Cunningham, A. B. Professional Ethics and Ethnobotanical Research. In: Alexiades M, Editor. Selected guidelines for Ethnobotanical Research: a field manual. Bronx: New York Botanical Garden; 1996.p.19-51.

**D. Web Link**

- [http://old.cwc.gov.in/main/downloads/DraftGuideline\\_Water\\_Audit.pdf](http://old.cwc.gov.in/main/downloads/DraftGuideline_Water_Audit.pdf)
- <https://www.adb.org/sites/default/files/publication/28555/estimating-carbon-footprints-road-projects.pdf>
- <https://nptel.ac.in/content/storage2/courses/105103025/pdf/pdf3.pdf>