

Syllabus under Outcome-Based Education

B.Sc. ENVIRONMENTAL SCIENCES

**For the Students Admitted in the
Academic Year 2019-2020**

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



**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**

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Vision

Envisions to accomplish academic and professional excellence through holistic Environmental Science Education, ignite young minds, foster ethical attitude, nurture mutual love and compassion towards nature, and empower them to take up a promising career to create and contribute to the Nation and ultimately to environmental sustainability.

Mission

- ✓ Impart World-Class Education through Scientific and Inter-disciplinary propensity, and create passion for Environment through well-designed curriculum and dedicated teaching.
- ✓ Inculcate principles of environmental stewardship by experiential learning and instil the aptitude and attitude for cutting-edge research in multifarious fields of environment.
- ✓ Promote holistic development by fostering environmental, ethical and social values and building scientific, communicative and leadership qualities with competency to face the Global Environmental Challenges.
- ✓ Nurture self-motivated, life-long learning environmentalists and environmental entrepreneurs in partnership with academia, industry, community, governmental and non-governmental organizations for achieving sustainable development goals.

PROGRAM OUTCOMES

On Successful completion of B.Sc. Environmental Sciences Program the graduand will be able to

Knowledge:

- PO1:** Demonstrate comprehensive knowledge of basic scientific concepts of the functioning of environment.
- PO2:** Critically analyze the relationships between abiotic and biotic components of the environment.
- PO3:** Exhibit scientific and research outlook to compare, assess the environmental issues and develop solutions to mitigate / combat the environmental problems

Skill:

- PO4:** Utilize appropriate tools and instruments with skills to analyze the environmental facets.
- PO5:** Evaluate the quality of environment using assessment models
- PO6:** Disseminate the research findings to the stakeholders through scientific report

Attitude:

- PO7:** Demonstrate with zeal and enthusiasm the willingness to collaborate with diverse teams in designing and formulating solutions for pressing environmental issues

Ethical and Social Responsibility

- PO8:** Practice moral and ethical values with environmental conscience in professional and social life.
- PO9:** Recognize the potential environmental threats, provide mitigation measures to restore the degraded ecosystems and contribute towards nation building initiatives

PROGRAM SPECIFIC OUTCOMES

- PSO1:** Apply the principles of environment and comprehend the relationships among various components using multi-disciplinary and inter-disciplinary approaches.
- PSO2:** Determine the properties of the environment qualitatively and quantitatively and interpret the results in comparison with the environmental standards
- PSO3:** Employ appropriate waste treatment / pollution control technology / strategy for clean environment
- PSO4:** Practice principles of preservation, conservation and ecological sensibility towards building a sustainable living.

B.Sc. Environmental Sciences – Programme Description
(For the students admitted from the year 20219-2022)

Structure of the Curriculum

Parts of the Curriculum		No. of Courses	Credits
PART – I	Language	4	12
PART – II	English	4	12
PART – III MAJOR			
	CORE Theory	10	41
	CORE Practical	4	12
	ELECTIVE	3	12
PART – III ALLIED			
	ALLIED Environmental Botany	2	5
	ALLIED Environmental Zoology	2	5
	ALLIED Environmental Chemistry	3	9
	Internship	5	10
	Group Project	1	5
PART – IV			
	SBEC	3	6
	NMEC	2	4
	VLOC	1	2
	Environmental Studies	1	2
	SBC	1	1
PART – V			
	Extension Activities	1	1
	Gender Studies	1	1
Total		48	140

B.Sc. Environmental Sciences – Programme Description (For the students admitted during 2019-2020)

Sem	Part	Course	Course Code	Course Title	Hrs. / week	Credits	Marks		
							CIA	ESA	Total
I	1	Tamil I	U18TM1L1	செய்யுள், இலக்கிய வரலாறு, உரைநடை, மொழிப்பயிற்சி, படைப்பாக்கம்	6	3	25	75	100
	2	English I	U16EGNL1	English Communication Skills -I	6	3	40	60	100
	3	Core I	U17ES101	Physical Environment	5	4	25	75	100
		Allied I	U17ESBY1	Environmental Botany	4	3	25	75	100
		Allied Prac.I	U18ESBP1	Environmental Botany Lab	3	2	40	60	100
	4	PS – Internship I	U17ES1F1	Explore Your Environment	2	2	--	--	100
		Environmental Studies	U16EST11	Environmental Studies	2	2	25	75	100
		Value Education	U15VL1:1/ U15VL1:2	Value Education (RI/MI)	2	2	25	75	100
II	1	Tamil II	U18T M2L2	செய்யுள், இலக்கிய வரலாறு, உரைநடை, சிறுகதைத் திரட்டு & படைப்பாக்கம்	6	3	25	75	100
	2	English II	U16EGNL2	English Communication Skills –II	6	3	40	60	100
	3	Core II	U17ES202	Ecology	5	4	25	75	100
		Core Prac. I	U17ES2P1	Ecology Lab	4	3	40	60	100
		Allied II	U19ESZY2	Environmental Zoology	4	3	25	75	100
	4	Allied Prac. II	U19ESZP1	Environmental Zoology Lab	3	2	40	60	100
		PS- Internship II	U17ES2F2	Ecology and Biodiversity	2	2	--	--	100
III	1	Tamil III	U18TM3L3	செய்யுள்- காப்பியங்கள், இலக்கிய வரலாறு, நாவல், மொழிப்பயிற்சி	6	3	25	75	100
	2	English III	U16EGNL3	English for Competitive Examinations	6	3	40	60	100
	3	Core III	U17ES303	Environmental Microbiology and Biotechnology	5	4	25	75	100
		Core Prac. II	U17ES3P2	Environmental Microbiology and Biotechnology Lab	3	3	40	60	100
		Allied III	U19ESCY3	Allied Chemistry– I	4	3	25	75	100
	4	PS- Internship III	U17ES3F3	Industrial Exposure Training (IET) and Green Initiatives	2	2	--	--	100
		SBEC I	U17ESPS1	Environmental Education and Awareness	2	2	40	60	100
		NMEC I	U17ES3E1	Global warming and Climate Change	2	2	25	75	100
IV	1	Tamil IV	U18TM4L4	செய்யுள், நாடகம், இலக்கிய வரலாறு, மொழிப்பயிற்சி	5	3	25	75	100
	2	English IV	U16EGNL4	English through Literature	5	3	40	60	100
	3	Core IV	U17ES404	Environmental Pollution	4	4	25	75	100
		Core V	U17ES405	Energy Resources and Biostatistics	4	4	25	75	100
		Allied IV	U19ESCY4	Chemistry for Environmentalists	3	3	25	75	100
	4	Allied Prac. III	U19ESCP3	Allied Chemistry Practicals	3	3	40	60	100
		PS- Internship IV	U17ES4F4	Industrial Practice School	2	2	--	--	100
	5	NMEC II	U17ES4E2	Environmental Safety, Health and Management	2	2	25	75	100
		Soft Skills	U16LFS41	Life Skills	2	1	-	--	100
		Extension Activities	U16ETA41	NSS, NCC, Rotaract, Leo Club Etc.	-	1	-	-	-

V	3	Core VI	U17ES506	Conservation Biology	5	5	25	75	100
		Core VII	U17ES507	Fundamentals of Environmental Engineering	5	4	25	75	100
		Core Prac. III	U17ES5P3	Water Pollution Lab	4	3	40	60	100
	4	Elective I	U17ES5:1	Tools and Techniques in Environmental sciences	5	4	25	75	100
		Elective II	U17ES5:2	Environmental Safety Health and Management	5	4	25	75	100
		PS- Internship V	U17ES5F5	Environmental Monitoring and Assessment	2	2	-	-	100
SBEC II		U17ES5S2	Ecology and Biodiversity of Birds	2	2	25	75	100	
SBEC III		U17ES5S3	Waste Management	2	2	25	75	100	
VI	3	Core VIII	U17ES608	Instrumental Analysis and Methods	5	4	25	75	100
		Core IX	U17ES609	Sustainable Development and Environmental Legislation	5	4	25	75	100
		Core X	U17ES610	Global Warming and Climate Change	5	4	25	75	100
		Core Prac. IV	U17ES6P4	Air and Soil Pollution Lab	5	3	40	60	100
		Elective III	U17ES6:3	Ecotourism	5	4	25	75	100
		Core Project	U17ES6PJ	Project Work	5	5	-	-	100
	5	Gender Studies	U16GST61	Gender Studies	-	1	-	-	100
						140			

SBEC-Skill Based Elective Course; **NMEC**-Non-Major Elective Course; **VLOC**- Value added Life Oriented Course; **SBC**-Skill Based Course; **CIA**-Continuous Internal Assessment; **ESA**-End Semester Assessment; **PS**- Practice School

* Other Languages	Hindi	Sanskrit	French		Hindi	Sanskrit	French
Semester I	U18HD1L1	U17SK1L1	U18FR1L1	Semester III	U18HD3L3	U17SK3L3	U18FR3L3
Semester II	U18HD2L2	U17SK2L2	U18FR2L2	Semester IV	U18HD4L4	U17SK4L4	U18FR4L4

Non-Major Elective Courses (NMEC) offered by the Department:

1. Global Warming and Climate Change –**U20ES3E1**;
2. Environmental Safety, Health and Management –**U20ES4E2**

Program Articulation Matrix for B.Sc. Environmental Sciences during 2019-2020

Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
U17ES101	Physical Environment	H	H	M	M	L	L	L	L	M	M	L	L	L
U17ESBY1	Environmental Botany	H	M	M	L	M	L	M	M	M	M	M	M	M
U18ESBP1	Environmental Botany Lab	M	M	M	-	L	L	-	L	L	H	L	M	M
U17ES1F1	Explore Your Environment	H	H	M	H	H	H	-	L	M	M	M	H	L
U16EST11	Environmental Studies	H	H	L	L	L	L	L	L	L	H	M	M	L
U17ES202	Ecology	H	H	M	M	-	M	M	M	M	H	-	-	L
U17ES2P1	Ecology Lab	H	H	H	H	H	H	M	M	M	M	M	-	L
U19ESZY2	Environmental Zoology	H	H	L	H	H	L	M	M	-	H	H	-	H
U19ESZP1	Environmental Zoology Lab	H	H	L	L	H	M	M	H	M	H	H	M	L
U17ES2F2	Ecology and Biodiversity	H	H	M	H	H	H	H	M	M	H	H	-	L
U17ES303	Environmental Microbiology and Biotechnology	M	L	L	M	-	-	M	-	-	L	L	M	M
U17ES3P2	Environmental Microbiology and Biotechnology Lab	L	M	L	L	L	-	-	-	L	L	M	M	L
U19ESCY3	Allied Chemistry- I	H	M	M	M	M	-	M	H	H	M	L	L	M
U17ES3F3	Industrial Exposure Training (IET) and Green Initiatives	L	-	M	L	M	M	M	M	M	M	M	H	H
U17ESPS1	Environmental Education and Awareness	H	H	M	H	H	H	H	HH	H	H	M	L	M
U17ES3E1	Global warming and Climate Change	H	H	M	L	L	L	L	L	L	H	M	M	L
U17ES404	Environmental Pollution	H	M	M	M	M	H	M	M	M	H	M	H	M
U17ES405	Energy Resources and Biostatistics	H	H	M	L	L	M	L	L	L	M	H	M	M
U19ESCY4	Chemistry for Environmentalists	M	M	M	M	M	M	M	M	M	H	H	H	H
U19ESCP3	Allied Chemistry Practicals	M	M	M	L	M	M	L	M	-	H	H	H	H
U17ES4F4	Industrial Practice School	L	-	M	L	M	M	M	M	M	L	M	H	H
U17ES4E2	Environmental Safety, Health and Management	H	M	M	M	M	L	M	M	L	H	M	M	M
U17ES506	Conservation Biology	M	M	M	L	M	L	L	L	M	M	M	-	H
U17ES507	Fundamentals of Environmental Engineering	H	H	M	H	H	H	-	L	M	M	M	H	L
U17ES5P3	Water Pollution Lab	M	M	M	L	L	L	L	L	L	M	M	L	M
U17ES5:1	Tools and Techniques in Environmental sciences	H	H	M	L	L	L	L	L	L	H	L	M	L
U17ES5:2	Environmental Safety Health and Management	H	H	M	M	M	L	M	L	H	M	M	M	M
U17ES5F5	Environmental Monitoring and Assessment	H	H	M	L	L	L	L	L	L	H	L	M	L
U17ES5S2	Ecology and Biodiversity of Birds	H	H	M	L	L	L	L	L	L	H	L	M	L
U17ES5S3	Waste Management	H	L	M	M	M	L	M	M	M	H	M	H	L
U17ES608	Instrumental Analysis and Methods	H	H	M	H	H	H	H	H	H	H	M	L	M
U17ES609	Sustainable Development and Environmental Legislation	H	M	M	M	M	M	M	M	L	H	M	M	M
U17ES610	Global Warming and Climate Change	H	H	M	L	L	L	L	L	L	H	M	M	L
U17ES6P4	Air and Soil Pollution Lab	L	L	M	H	H	M	L	L	M	L	H	L	L
U17ES6:3	Ecotourism	H	H	M	M	L	L	L	L	L	H	L	M	L

Core I: PHYSICAL ENVIRONMENT

Semester I
Credits: 4

Code: U17ES101
Hours/Week: 5

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Explain the concept and components of environment	K1	I
CO2	Relate and model the earth and sun relationship, seasonality, solstices and equinoxes	K4	I
CO3	Illustrate the atmosphere layers, radiation balance and global circulation	K5	II
CO4	Demonstrate the hydrological cycle and explain the ocean currents	K2	III
CO5	Examine the structure of lithosphere and the soil formation	K2	IV
CO6	Develop the concept of biomes, zones and their distribution	K6	V

2.A. Syllabus

Unit I Environment:

(19 Hrs.)

Definition and importance; Spheres of the Earth system – atmosphere, hydrosphere, biosphere, lithosphere, anthroposphere and their interrelationships; Continents and oceans; landmasses. Earth and Sun relationship: earth in the solar system, earth's planetary motions – rotation and revolution, seasonality, solstices and equinoxes.

Unit II Atmosphere

(15 Hrs.)

Composition of air- Layers of Atmosphere – Radiation balance- Horizontal distribution of temperature and pressure, Global Circulation.

Unit III Hydrosphere

(17 Hrs.)

Sources of water – importance of water, hydrologic cycle - Precipitation and types of precipitation, ocean currents – generation of ocean currents, types of ocean currents; Distribution of fresh water.

Unit IV Lithosphere

(12 Hrs.)

Earth's crust and its Composition-Internal structure of the earth- Different types of rocks- Process of soil formation.

Unit V Biosphere

(12 Hrs.)

Concept and definition; Types of Biomes and their distribution. Biogeographic zones: Phytogeographic zones, Zoogeographic zones.

B. Topics for Self-study

- <https://www.elsevier.com/books/principles-of-environmental-physics/monteith/978-0-12-386910-4>
- <https://www.oxfordbibliographies.com/view/document/obo-9780199363445/obo-9780199363445-0075.xml#:~:text=In%20this%20article%2C%20environmental%20physics,in%20which%20they%20are%20surrounded.>
- <https://www.cambridge.org/core/books/physics-of-the-atmosphere-and-climate/7DD7C2464E8B7F02065CA491FCDD11A3>

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.

- Joseph, K. and Nagendran, R., Essentials of Environmental Studies, Pearson Education Publisher, Delhi, 2004.
- Purohit, S.S., Shammi, Q.J. and Agarwal, A.K., A Textbook of Environmental Science, Students Edition, Jodhpur, 2004.
- Reddy, A.M., Textbook of Environmental Science and Technology, BSP Books Pvt. Ltd., Hyderabad, 2005.

D. Reference Books

- Botkin, D.B. and Keller, E.A., Environmental Science: Earth as a Living Planet, John Wiley and Sons, New Delhi, 2011.
- Cunningham, W. P. and Saigo, B.W., Environmental Science – A Global Concern, Eighth Edition. WCB/McGraw Hill, New York, 2007.
- McKinney, M.L., Schoch, R. and Yonavjak, R.M., Environmental Science Systems and Solutions, Jones & Bartlett Publishing Inc., Delhi, 2007.
- Anjaneyulu, Y., Introduction to Environmental Science, BSP Books Pvt. Ltd., Hyderabad, 2009.
- Lal, D.S. Climatology, Sharda Pustak Bhawan, Allahabad, 2003.
- Chapin III, F.S., Matson, P.A. and Vitousek, P.M., Principles of Terrestrial Ecosystem Ecology, Springer, New Delhi, 2012.
- Bloom, A.L., Geomorphology – A Systematic Analysis of Late Cenozoic Landforms, Third Edition, Pearson Education, Singapore, 2003.
- Dayal, P., A Textbook of Geomorphology, Shukla Book Depot, Patna, 2001.
- Singh, S., Environmental Geography, Prayag Pustak Bhawan, Allahabad, 2002.

E. Web Links

- https://www.amazon.in/Environment-Ecology-Preliminary-Examination-Examinations/dp/9389949424/ref=asc_df_9389949424/?tag=googleshopdes-
- <https://www.google.com/search?sa=X&q=Beyond+the+Atmosphere:+Early+Years+of+Space+Science+Homer+E.+Newell+Jr.&stick=H4sIAAAAAAAAAAGWUTWjUQBIGN6vdtmnr->
- <https://www.google.com/search?sa=X&q=Hydrosphere:+Freshwater+Systems+and+Pollution+Dana+Desonie&stick=H4sIAAAAAAAAAAGWST2jTUBzHm->
- <https://www.google.com/search?q=The+Lithosphere:+An+Interdisciplinary+Approach&stick=H4sIAAAAAAAAAAGVTT2jTUBxuquu2bJM2UxjFQ->
- <https://www.google.com/search?q=Ecology:+From+Ecosystem+to+Biosphere&stick=H4sIAAAAAAAAAAGWUT2jTUBzHm->

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Environment		
1.1	Environment: Definition and importance; Spheres of the Earth system – atmosphere, hydrosphere, biosphere, lithosphere, anthroposphere and their interrelationships;	Recall various components of environment	K1
		Illustrate the interrelationships among the Spheres	K2
1.2	Continents and oceans; landmasses.	Explain the continents and oceans	K2
		Illustrate the landmasses	K2
1.3	Earth and Sun relationship: earth in the solar system, earth's	Relate the Earth and Sun relationship	K1

	planetary motions – rotation and revolution, seasonality, solstices and equinoxes.	Demonstrate the earth in the solar system, earth's planetary motions	K2
		Explain the rotation and revolution, seasonality, solstices and equinoxes.	K2
Unit II	Atmosphere		
2.1	Composition of air- Layers of Atmosphere – Radiation balance-	Recall the composition of air and illustrate the radiation balance	K2
2.2	Horizontal distribution of temperature and pressure,	Examine the horizontal distribution of temperature and pressure	K2
2.3	Global Circulation.	Explain the Global Circulation	K2
Unit III	Hydrosphere		
3.1	Sources of water – importance of water, hydrologic cycle - Precipitation and types of precipitation,	Recall the importance of water	K2
		Illustrate the hydrological cycle	K2
		Explain the types of precipitation	K2
3.2	Ocean currents – generation of ocean currents, types of ocean currents;	Demonstrate the generation of ocean currents and explain the types of ocean currents;	K2
3.3	Distribution of fresh water	Illustrate the distribution of fresh water	K2
Unit IV	Lithosphere		
4.1	Earth's crust and its composition- Internal structure of the earth-	Illustrate the earth's crust and its composition	K2
4.2	Different types of rocks- Process of soil formation.	Classify the different types of rocks and explain the process of soil formation.	K2
Unit V	Biosphere		
5.1	Concept and definition; Types of Biomes and their distribution.	Recall the concept and definition of biomes	K1
		Classify the types of biomes and their distribution.	K2
5.2	Biogeographic zones: Phytogeographic zones, Zoogeographic zones.	Illustrate the Biogeographic zones: Phytogeographic zones, and Zoogeographic zones	K2

4. Mapping Scheme (POs, PSOs and COs)

U17ES101	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	L	L	L	L	M	L	M	H	L	-	M
CO2	H	H	M	L	L	L	L	-	-	H	L	-	L
CO3	H	H	H	M	M	L	M	L	-	H	L	-	L
CO4	H	H	H	M	M	M	L	L	L	L	M	L	L
CO5	H	M	L	M	L	L	L	-	L	L		L	L
CO6	H	H	M	H	L	M	L	M	M	M	-	-	M

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr.A.Chandramohan

ALLIED I: ENVIRONMENTAL BOTANY

Semester: I
Credits: 3

Code: U17ESBY1
Hours/Week: 4

1. Course Outcomes:

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

CO No.	Course Outcomes	K-Level	Unit
CO1	Interpret the basics of Plant diversity	K2	I
CO2	Describe the concept of Plant morphology and its Modifications	K2	II
CO3	Explain various aspects of inflorescence and plant taxonomy	K2	II
CO4	Discuss the basic concepts of plant Anatomy and plant Embryology	K2	III
CO5	Analyze the various concepts of Plant physiology	K4	IV
CO6	Describe the various plant diseases and also plant as ecological indicator.	K4	V

2.A. Syllabus:

Unit I Plant Diversity

(12 Hrs.)

Structure, reproduction and life cycle of Algae - *Chlamydomonas*, Fungi - *Penicillium*, Bryophyte - *Riccia*, Pteridophyte - *Lycopodium* and Gymnosperm - *Cycas*.

Unit II Morphology

(12 Hrs.)

Root, shoot system and its modification. Inflorescence - Simple and compound and Special types - one example each. Flower description. Taxonomy: Nomenclature (Binomial), Systems of Classification (Bentham and Hooker), Study of following families - Annonaceae, Apocynaceae, Lamiaceae, and Poaceae.

Unit III Anatomy

(12 Hrs.)

Tissue (Meristematic and Permanent), primary structures of Dicot and Monocot Stem and Root. Embryology: Structure of Anther and Ovule; Types of Pollination, Fertilization and development of Dicot Embryo.

Unit IV Plant Physiology

(12 Hrs.)

Absorption of water and salts. Role of mineral elements; Transpiration. Photosynthesis, Light and Dark Reactions - C3 Cycle, Respiration - aerobic, anaerobic, Krebs cycle.

Unit V Plant as an ecological indicator

(12 Hrs.)

Plant as an ecological indicator - characteristics, type and physiological changes. Plant pathology: Detailed study of the following plant diseases, symptoms, causal agents and control measures of white rust, citrus canker and tobacco Mosaic disease

B. Topics for Self-study

- **Hill reactions** (<https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/hill-reaction>)
- **Secondary Wall Thickening** (<https://www.biologydiscussion.com/plants/cell-wall/thickening-of-cell-wall-in-plants-with-diagram-botany/68837>)
- **Vegetative propagation** (<https://www.toppr.com/en-in/content/concept/vegetative-propagation-201517/>)

C. Text Books

1. Mathawat, G.S.P., Sharma, D. and Sahni. R.K. 1996. A text book of Botany, Ramesh Book depot, Jaipur.
2. Mehrothra, R.S. 1991. Plant Pathology, Tata McGraw Hill Publishing Co., Ltd., New Delhi.
3. Muneeswaran, A., 2004. Allied Botany, Titan Books, Madurai, India.
4. Pandey, B.P. 1999. Economic Botany, S. Chand and Co., New Delhi.
5. Rao, K.N. Krishnamoorthy, K. and Rao. G.S. 1979. Ancillary Botany, Rajalakshmi Publication, Nagerkoil.

D. References Books

1. Verma SK and Mohit Verma. 1995. A Textbook of Plant Physiology, Biochemistry and Biotechnology. S Chand Publications.
2. Vinod Kumar Jain. 2009. Laboratory Manual of Plant Pathology. Oxford Book Company.

E. Web Link

1. <https://nptel.ac.in/content/storage2/courses/122103039/pdf/mod1.pdf>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	Plant Diversity		
1.1	Structure, reproduction and life cycle of Algae - Chlamydomonos, Fungi - Penicillium, Bryophyte -Riccia, Pteridophyte – Lycopodium and Gymnosperm -Cycas.	Explain lower group of plant kingdom and their reproduction systems.	K2
Unit II	Morphology		
2.1	Root, shoot system and its modification.	Explain the importance and study morphological features of plants	K2
2.2	Inflorescence – Simple and compound and Special types – one example). Flower description.	Tell the inflorescence pattern.	K1
2.3	Taxonomy: Nomenclature (Binomial), Systems of Classification (Bentham and Hooker), Study of following families – Annonaceae, Apocynaceae, Lamiaceae, and Poaceae.	Explain the various taxonomical information of plants.	K2
Unit III	Anatomy		
3.1	Tissue (Meristematic and Permanent), primary structures of Dicot and Monocot Stem and Root.	Demonstrate understanding of fundamental concepts of plant anatomy	K2
3.2	Embryology: Structure of Anther and Ovule; Types of Pollination, Fertilization and development of Dicot Embryo.	Explain the simple concepts of embryology	K2

Unit IV	Physiology		
4.1	Absorption of water and salts. Role of mineral elements; Transpiration. Photosynthesis, Light and Dark Reactions – C3 Cycle, Respiration – aerobic, anaerobic, Krebs cycle.	Analyse fundamentals of plant physiology in plants.	K4
Unit V	Plant as an ecological indicator		
5.1	characteristics, type and physiological changes.	Distinguish different Plants as ecological indicator	K4
5.2	Plant pathology: Detailed study of the following plant diseases, symptoms, causal agents and control measures of <i>white rust</i> , <i>citrus canker</i> and <i>tobacco Mosaic</i> disease.	Demonstrate the various plant diseases in India.	K4

4. Mapping Scheme (POs, PSOs and COs)

U17ESBY1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	M	M	L	-	L	H	-	L	M	H	H	M
CO2	H	H	M	-	-	M	H	L	M	M	H	M	L
CO3	H	M	M	-	-	L	H	M	H	H	H	L	L
CO4	M	H	L	-	-	L	H	-	M	M	L	L	M
CO5	H	M	M	-	L	L	L	M	L	M	M	-	H
CO6	M	L	M	-	H	M	L	M	M	M	L	L	M

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Assessment in Practical works, sectioning, record submission.
2. Practical tests, Records etc. (as applicable), Class tests, Model Exams.
3. End Semester Examination

Indirect

1. Course-end Survey

Course Coordinator: Dr. M. Immanuel Sahayaraj

Allied Practical I: ENVIRONMENTAL BOTANY LAB

Semester: I
Credits: 2

Code: U18ESBP1
Hours/Week: 3

1. Course Outcomes

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

CO No.	Course Outcomes	K-level	Unit
CO1	Compare and interpret the different group of Species diversity. (Plant diversity – Algae, Fungi, Bryophytes, Pteridophyte and Gymnosperms)	K 4	I
CO2	Distinguish the various habitat in Plants and their Taxonomical form.	K 4	II
CO3	Discuss the different anatomical structures of various mature plant groups.	K 4	III
CO4	Examine the different types of Plant functions	K4	IV
CO5	Importance of Plant pathology (White rust, Citrus canker and Tobacco) Plant specimens for the ecological indicators	K 2	V
CO6	Understand the importance of plant conservation	K2	I, IV

2.A. Syllabus

Unit I

(9 Hrs.)

Plant diversity: Habit, stem, root and reproductive parts of Algae- Chlamydomonos; Fungi – Penicillium; Bryophyte - Riccia – habit, thallus and Capsule; Pteridophyte - Lycopodium – habit and stem; Gymnosperm – Cycas.

Unit II

(9 Hrs.)

Plant Taxonomy: Annonaceae – *Polyalthia longifolia*; Apocyanacea – *Vinca rosea*; Lamiaceae – *Leucas aspera*; Euphorbiaceae – *Euphorbia hirta*; Poaceae – *Chloris barbata*

Unit III

(9 Hrs.)

Plant Anatomy: T. S of monocot root - monocot stem - dicot stem - dicot leaf - Embryology: T. S of mature anther - Ovule L. S – Fertilization - Globular – embryo - Cordate embryo

Unit IV

(9 Hrs.)

Plant physiology (Demo only): Bell Jar, Thistle funnel, TA balance, Test tube funnel, Ganong light screen and respiroscope.

Unit V

(9 Hrs.)

Plant specimens for the ecological indicators; Plant pathology: White rust, Citrus canker and Tobacco Mosaic disease.

B. Topics for Self-study

- **Plant diversity** (<https://www.biologydiscussion.com/algae/algae-definition-characteristics-and-structure-with-diagram/46727>)
- **Plant Taxonomy** (<https://www.biologydiscussion.com/plant-taxonomy/plant-taxonomy-history-classification-and-plant-kingdom/41749>)
- **Plant Anatomy** (<https://www.biologydiscussion.com/plants/anatomical-structure-of-plants-with-diagram/6450>)
- **Plant physiology** (<https://www.biologydiscussion.com/plant-physiology-2/notes-plant-physiology/34597>)
- **Plant pathology** (<https://www.biologydiscussion.com/plant-pathology/biology-notes-on-plant-pathology/46320>)

C. Text Books

1. Mathawat, G. Sharma. S. P, and R.K. Sahni. R.K. 1996. A text book of Botany, Ramesh Book depot, Jaipur.
2. Mehrothra, R.S. 1991. Plant Pathology, Tata McGraw Hill Publishing Co., Ltd., New Delhi.
3. Muneeswaran, A. 2004. Allied Botany, Titan Nooks, Madurai, India.
4. Pandey, B.P. 1999. Economic Botany, S. Chand and Co., New Delhi.
5. Rao, K.N. Krishnamoorthy, K. and Rao. G.S. 1979. Ancillary Botany, Rajalakshmi Publication, Nagerkoil.
6. Verma, V. 1980. A Text Book of Economic Botany, Emkay Publications, New Delhi.

D. Reference Books:

1. Chattopadhyaya, S.B., 1991. Principles and Procedures of Plant protection, (3rd Ed.), Oxford and IBH Publishing (P) Ltd., New Delhi.
2. Edmond, J.B., Musser, A.M. and Andres, F.S. 1957. Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
3. Fuller, H.J. and Tippo, O.1967. College Botany, Henry Holt and Co., New York.
4. Gangully, A.K. 1971. General Botany, The New Book Stall Calcutta, Vol I and II. Rajalakshmi Publication., Nagerkoil.
5. Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications, Nagarkoil, India.

E. Web Links

1. https://onlinecourses.nptel.ac.in/noc19_ag04/preview

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I			
1.1	Plant diversity: Structure, reproduction and life cycle of (a) Algae - Chlamydomonos (b) Fungi - Penicillium (c) Bryophytes - Riccia (d) Pteridophytes - Lycopodium (e) Gymnosperms- Cycas	Explain the habit and habitat of Cryptogams and phanerogams	K2
		Distinguish life cycle of plant groups	K4
Unit II			
2.1	Plant Taxonomy: Annonaceae – <i>Polyalthia longifollia</i> ; Apocyanacea – <i>Vinca rosea</i> ; Lamiaceae – <i>Leucas aspera</i> ; Euphorbiaceae – <i>Euphorbia hirta</i> Poaceae – <i>Chloris barbata</i>	Examine the morphological feature of flowering plants	K4
		Illustrate the external characteristic features of plant	K2
Unit III			
3.1	Plant Anatomy: Primary and Secondary structure of Dicot and Monocot - (a) Leaf (b) Stem	Compare the internal structure of leaf, stem and root	K2

	(d) Root.	Determine the arrangement of tissues in leaf, stem and root	K5
4.1	Structure of Flower Embryology: T. S of mature anther - Ovule L. S – Fertilization - Globular – embryo - Cordate embryo	Illustrate the arrangements of various parts in flowers	K2
		Explain the importance of anther and pollen and internal structure of anther	K5
		Explain the structure of Ovule	K2
Unit IV			
	Plant physiology (Demo only): (a) Bell Jar, (b) Thistle funnel, (c) TA balance, (d) Test tube funnel, (e) Ganong light screen and (f) respiroscope	Demonstrate the various physiological process	K2
		Analyze the importance of plant functions	K4
Unit V			
	Plant specimens for the ecological indicators; Plant pathology: <i>White rust</i> , <i>Citrus canker</i> and <i>Tobacco</i>	Demonstrate the various infected plants	K2

4. Mapping Scheme (POs, PSOs and COs)

U18ESBP1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	M	H	-	-	M	-	L	L	H	-	M	L
CO2	M	M	H	-	L	L	-	-	M	H	L	M	H
CO3	L	L	H	-	-	L	-	L	L	H	M	M	L
CO4	M	L	L	-	-	-	-	-	L	H	L	M	L
CO5	L	M	M	-	-	-	-	-	L	H	L	L	-
CO6	L	L	-	-	-	-	-	-	M	H	L	M	-

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Assessment in Practical works,
2. Sectioning, Record submission.
3. Practical tests, Records etc. (as applicable),
4. Class tests,
5. Model Exams.
6. End Semester Examination

Indirect

1. Course-end Survey

Course Coordinator: Dr. M. Immanuel Sahayaraj

Practice School I - EXPLORE YOUR ENVIRONMENT

Semester: I
Credits: 2

Code: U17ES1F1
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	Outline to Know our Campus Environment	K2	I
CO2	Experiment with waste management practice in our Domestic Environment	K3	II
CO3	Develop the skill to map an area	K3	III
CO4	Examine the Micro-Meteorological Parameters	K4	IV
CO5	Explain the State of Environment through Field Work/Study	K5	V
CO6	Evaluate and Documenting the State of Environment Report	K5	V

2.A. Syllabus

Unit I

(6 Hrs.)

Know your Campus Environment (College/School campus), Profile of the college/school and its natural resources, Service – Learning in Environment and Health, Exploring/Mapping the campus: campus layout and preparation of the matriclayers, Experiential Learning in College/School campus, Assessment of Flora and Fauna, Water and waste water audit, Energy audit, Solid waste audit, Impacts and Mitigation

Unit II

(6 Hrs.)

Know your Domestic Environment, Water and energy audit, Greenery in house, Household Carbon footprint, Solid and liquid waste management practices,

Unit III

(6 Hrs.)

Know your Local Environment, Profile of the ward/lowest administrative unit, Mapping the ward, Water and waste water audit, Documenting the flora and fauna, Assessment of ecological footprint

Unit IV

(6 Hrs.)

Observation of Micro-Meteorological Parameters, Temperature, Humidity, pressure, Wind velocity, sunshine, Ambient noise levels

Unit V

(6 Hrs.)

Documenting the State of Environment through Field Work/Study: Need for field work, Methods, Steps involved in field study. Report writing methods. Preparation of State of Environment Report.

C. Text Books

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

D. Reference Books

1. Rao, M. N and Rao, H. V. N. Air Pollution. Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2017. ISBN: 978-0074518717.
2. 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.
3. 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. www.ecologicalfootprint.com
2. <https://4-h.org/parents/curriculum/exploring-your-environment/>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit 1			
1.1	Profile of the college/school and its natural resources Service – Learning in Environment and Health	Outline to Know our Campus Environment	K3
1.2	Exploring/Mapping the campus: campus layout and preparation of the maticlayers Experiential Learning in College/School campus	Identify the college floral diversity	K2
Unit 2			
2.1	Know your Domestic Environment Water and energy audit, Greenery in house, Household Carbon footprint, Solid and liquid waste management practices	Students will be a apply the developed skill in college campus in their community	K3
Unit 3			
3.1	Know your Local Environment Profile of the ward/lowest administrative unit Mapping the ward Water and waste water audit Documenting the flora and fauna Assessment of ecological footprint	Students will be a identify and develop a list of different fauna in the campus	K3
Unit 4			
4.1	Observation of Micro-Meteorological Parameters Temperature, Humidity, pressure Wind velocity, sunshine Ambient noiselevels	Students will be a apply the developed skill in college campus in their community	K4
Unit 5			
5.1	Documenting the State of Environment through Field Work/Study: Need for field work, Methods, Steps involved in field study.	Students will be a apply and discover the developed skill in college and their community at a forest or ecosystem	
5.2	Report writing methods. Preparation of State of Environment Report.	Students will be able to compile all the data and prepare a report	K5

4. Mapping Scheme (POs, PSOs and COs)

U17ES1F1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	M	H	H	-	-	M	L	-	-	L
CO2	H	H	-	H	-	M	-	L	-	H	M	H	-
CO3	-	H	-	H	-	M	-	L	-	-	M	H	-
CO4	H	H	-	H	-	M	-	L	-	-	M	H	-
CO5	L	H	M	H	H	H	-	-	M	M	L	-	L
CO6	H	M	M	H	M	H	-	L	L	M	-	M	-

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr.M. Sheela Mary

COURSE: ENVIRONMENTAL STUDIES

Semester: I
Credits: 2

Code: U16EST11
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	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

(2 Hrs.)

Definition, Scope and Importance. Need for Public awareness

Unit II Natural Resources

(5 Hrs.)

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

(3 Hrs.)

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

(6 Hrs.)

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

(5 Hrs.)

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 (5 Hrs.)

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 warning, 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 (4 Hrs.)

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. 16th 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>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Multi-Disciplinary Nature of Environmental Studies			
1.1	Definition and scope of Environmental Science	Define what is Environmental Sciences and opportunities by learning this course	K1
1.2	Importance of Environmental Sciences	Infer the importance for the Environmental studies	K2
1.3	Need for Public Awareness	Relate the environmental awareness with issues among public	K1
Unit II Natural Resources			
2.1	Renewable and Non-renewable resources	Extend their understanding about various resources	K2
2.2	Natural Resources and associated problems	Classify the resources available and can discover how the environmental issues related there with.	K4

2.3	Role of an individual in conservation of natural resources	Relate the Environmental issues with improper utilization of resources	K3
2.4	Equitable use of resources of sustainable lifestyles	Analyze and infer how well one can utilize the natural resources	K4
Unit III	Ecosystem		
3.1	Structure of Ecosystem- Producers, consumers and decomposers	Recall how ecosystems are structured and functioning	K1
3.2	Function of Ecosystem- Energy flow, ecological succession, food chains food webs and ecological pyramids	Discover How the organisms are interlinked	K4
3.3	Introduction, types, characteristics features, structure and function of the various ecosystems	Categorize and distinguish various types of ecosystems and justify their role of each system	K4
Unit IV	Biodiversity and its Conservation		
4.1	Introduction and definition of Biodiversity	Discover how organisms are diversely at various pecking orders	K4
4.2	Values of biodiversity	Identify and Justify how various organisms are valued to the sustenance of ecosystems	K5
4.3	Bio-geographical classification Biodiversity at global, national and global level.	Distinguish how various organisms are distributed across spatial and physiological realms	K2
4.4	Hotspots of biodiversity, threats and conservation of biodiversity	Discover the endemcity of certain organisms and why they should be conserved	K4

Unit V	Environmental Pollution		
5.1	Definition, Causes, effects, control measures and case studies of various pollutions	Explain how various environmental pollutions are caused and how they can be mitigated	K2
5.2	Role of an individual in prevention of pollution	Infer what are the individual's responsibilities towards pollution management	K4
5.3	Disaster management: Floods, earthquake, cyclone and landslides	Demonstrate the disaster management strategies	K2
Unit 6	Social Issues and the Environment		
6.1	Sustainable development, Environmental ethics: Issues and possible solutions,	Interpret how developmental activities should consider future generations	K5
6.2	Urban problems related to energy, Water conservation, rain water harvesting, watershed management,	Relate the resource utilization, examine and recommend the suitable management practices	K2
6.3	Resettlement and rehabilitation of people; its problems and concerns. Case studies	Outline, examine and determine the possibilities of resettlement and rehabilitation of victims of environmental issues	K4
6.4	Climate change, global warning, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies,	Explain current issues lie climate change global warming etc.	K2
6.5	Wasteland reclamation, Consumerism and waste products	Identify the options for efficient waste management, wasteland reclamation and relate how consumerism effects in waste production	K1
6.6	Environmental Policies, issues involved in enforcement of environmental legislation and Public awareness.	Outline how our Government is legislatively managing resources, pollution and developmental activities	K2
Unit 7	Human Population and the Environment		
7.1	Population growth, variation among nations, Population explosion, family welfare program	Infer how exponential population growth around the globe effects on resource utilization, pollution and public health.	K2
7.2	Environment and human health, human rights, value education, HIV/AIDS, women and child welfare	Relate the population dynamics with public health and also the fragile population group like women and children	K2

7.3	Role of information technology in environment and human health, case studies.	Apply the modern technological advancement in information science in mitigating issues related to environment and public health.	K3
Unit 8	Field Work		
8.1	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.	Assess the academic knowledge they gained through abovesaid units in real world.	K5

4. Mapping Scheme (POs, PSOs and COs)

U16EST11/ U16EST12	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	-	-	L	-	-	-	H	M	-	L
CO2	H	H	-	M	L	-	L	-	L	H	L	-	-
CO3	H	H	L	-	-	L	-	-	-	H	-	-	L
CO4	H	M	L	L	L	L	-	L	L	H	M	M	L
CO5	H	H	M	L	-	L	M	L	L	H	L	-	L
CO6	H	H	L	-	L	-	-	-		H	M	M	L
CO7	H	M	L	M	M	L	-	L		H	L	L	-
CO8	H	H	-	L	-	-	L	-		M	-	-	-

L-Low; M-Medium; H-High

Course Assessment

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr.C. Sukumar

Core II: ECOLOGY

Semester II
Credits: 4

Code: U17ES202
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 of population	K3	III
CO4	To summarize and theorize the attributes of community	K3	IV
CO5	To summarize and assess the attributes of an ecosystem	K5	IV
CO6	To distinguish, categorize and assess the habitats	K5	V

2.A. Syllabus

Unit I Introduction to Ecology and Ecosystem

(15 Hrs.)

Importance and scope of ecology – Ecosystem and its components – Abiotic factors – climate – temperature – light – humidity – edaphic - wind and biotic factors including biotic interactions – interspecific and intra-specific.

Unit II Characteristics of ecosystems

(15 Hrs.)

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 – biogeographic cycle in an ecosystem.

Unit III Population Ecology

(14 Hrs.)

Definition, Characteristics of Population: Density- Natality – Mortality – Age distribution – Growth form-Population Equilibrium – Biotic potential – Carrying capacity – Dispersal – Dispersion – Population fluctuations – Population regulation.

Unit IV Community Ecology

(14 Hrs.)

Characteristics of a Community; Physical structure – structure, stratification, Biological characteristics – Species richness, Species diversity, Abundance, Dominance, Frequency, Importance value, guild, niche, Ecotone, Edge effect, Ecological equivalents, Ecotypes, and Ecophenes; Ecological succession and ecological pyramid.

Unit V Habitat Ecology

(17 Hrs.)

Aquatic- Freshwater – lentic, lotic; Marine – neritic, estuarine - mangrove, intertidal, tidal flats, seagrass bed, coral bed; oceanic – pelagic, benthic; Terrestrial habitat - Tundra, Forest, Desert and mountain biomes.

C. Text Books

1. Sharma, P. D. Ecology and Environment. 13th 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. 5th ED., Brooks/Cole, 2004; ISBN: 978-0534420666.

D. 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.
- Chapman, J. L and Reiss, M. J. Ecology – Principles and Applications. Cambridge University Press, 1995; ISBN: 978- 0521588027.
 - Dash, M. C. Fundamentals of Ecology. Tata McGraw-Hill Publishing Co., 2001; ISBN: 9780070421479.
 - Kormondy, E. J. Concepts of Ecology. Prentice Hall of India, 1996; ISBN: 9780131660090.
 - Ricklefs, R. E and Miller. Ecology. 4thEd. W.H. Freeman and Co., 1999; ISBN: 978-0716728290.
 - Raven, P. H. and Johnson, G. B. Biology. 11thed. Wm. C. McGraw-Hill Education, 2016; ISBN: 978-1259188138.
 - Smith, T. M and Smith, R. L. Elements of Ecology. 9thed. Pearson Education, 2015; ISBN: 9780321934185.
 - Taylor, T. J., Green, N. P. O and Stout, G.W. Biological Science. Soper, R (Ed.). Cambridge University Press, 1998; ISBN: 978- 0521684170.
 - Wallace, R.A. Biology-The World of Life. Harper Collins Publications, 1990; ISBN: 978-0673464804.

E. Web links

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

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Ecosystem and its Components		
1.1.	Importance and scope of ecology	Recognize the importance and scope of ecology	K1
1.2	Components of an ecosystem	Describe the various components of an ecosystem	K1
1.3	Abiotic and biotic factors	Recognize and relate the various components of an ecosystem	K1
Unit II	Structure and Function of the Ecosystem		
2.1	Structure of an ecosystem	Describe and illustrate the structure of an ecosystem	K1
2.2	Function of an ecosystem	Illustrate the function of an ecosystem	K2
	Energy flow	Summarize and illustrate the energy flow and productivity of an ecosystem	K2
	Biogeochemical cycles	Illustrate the biogeochemical cycles of an ecosystem	K2

Unit III	Population Ecology		
3.1	Attributes of Population Ecology	Summarize the attributes of population in an ecosystem	K3
Unit IV	Community Ecology		
4.1	Community Ecology	Summarize the attributes of a community in an ecosystem	K3
4.2	Ecological pyramid	Construct the ecological pyramids in an ecosystem	K3
4.3	Ecological succession	Theorize the concept of ecological succession	K3
Unit V	Habitat Ecology		
5.1	Habitat Ecology- Concepts, features and adaptations of Aquatic habitat Lentic Lotic Marine	Distinguish, categorize and conclude the concepts of habitat ecology	K4
5.2	Concepts, features and adaptations of Terrestrial habitat	Distinguish, categorize and conclude the concepts of habitat ecology	K4

4. Mapping Scheme (POs, PSOs and COs) U17ES202

U17ES202	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	M	-	M	M	H	H	H	-	-	L
CO2	H	H	M	M	-	M	M	M	M	H	-	-	L
CO3	H	H	M	M	-	M	M	-	M	H	-	-	L
CO4	H	H	H	M	-	M	M	L	L	H	-	-	L
CO5	H	H	M	M	-	M	M	L	L	H	-	-	L
CO6	H	H	M	M	-	M	M	-	L	H	-	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. A. Daisy Caroline Mary

Core Practical I- ECOLOGY LAB

Semester: II
Credits: 3

Code: U17ES2P1
Hours/Week: 4

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

C. Text Books

1. Sharma, P.D. Ecology and Environment. 13th 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.

D. 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.

E. 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%2Dcapture%20methods>

3. Specific Learning Outcomes

Experiments	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
1	Study of herbal vegetation by quadrat method	Identify the plant species, record and memorize the herbal vegetation	K1
2	Quantitative assessment of herbal plants	Assess and interpret the herbal plants by quantitative methods	K2
3	Estimation of species diversity	Calculate the species diversity of plants	K4
4	Tree height, girth measurement	Measure the height and girth of trees	K4
5	Preparation of 5 herbarium sheets	Construct herbarium sheets	K6
6	Insect survey – with special reference to butterflies	Identify the butterflies	K4
7	Insect box preparation	Construct insect box	K6

4. Mapping Scheme (POs, PSOs and COs)

U17ES2P1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H	H	-	-	-	M	H	-	-
CO2	H	H	H	H	H	H	-	-	-	M	M	-	L
CO3	H	H	H	M	M	L	L	-	-	M	M	-	L
CO4	H	H	H	H	H	H	-	-	-	L	L	-	L
CO5	H	H	H	H	H	H	-	-	-	M	H	-	-
CO6	L	M	M	H	H	H	M	M	M	M	H	-	M

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Pre-semester and End-semester Examinations (ESE)
3. Reports, Observation Register, Record Note Books and Viva-voce

Indirect

1. Overall performance assessment, Discussions and co-curricular activities

Course Coordinator: Dr. A. Daisy Caroline Mary

Allied- II ENVIRONMENTAL ZOOLOGY

Semester: II
Credits: 3

Code: U19ESZY2
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	Explain the salient features of Kingdom Animalia and the levels of organization at cellular, tissue and organ grade level of organization	K6	I
CO2	Classify the major Phylum Invertebrata and Chordata with its distinctive characters and suitable examples	K3	II
CO3	Compare the major process of mechanism of migration and flight adaptations in animals.	K4	III
CO4	Explain the types of animal behaviour and distinguishing between stereotyped and Acquired behaviour in animals	K4	IV
CO5	Discuss the process of communication in birds and mammals	K6	V
CO6	Compare the external morphology of invertebrates and chordates	K4	II

2.A. Syllabus

Unit I Diversity of invertebrates and Chordates

(12 Hrs.)

Kingdom Animalia: Salient features - levels of organization: cellular, tissue, organ and organ system; Classification of major Invertebrata Phyla and Phylum Chordata upto classes - General characters and diversity of Major Invertebrata Phyla and Phylum Chordata with suitable examples.

Unit II Beneficial Insects, Vermiculture and Parasitology

(12 Hrs.)

Detailed study: Earthworm- Cockroach – Lamellidens – Starfish.

Economic importance of beneficial insects - Brief study of Vermiculture: vermicomposting and its applications. Parasitology-Vector borne diseases –Malaria, Dengue.

Unit III Migration and Adaptive Radiation in Chordates

(12 Hrs.)

Biological significance of Migratory animals: Fishes, Birds and Mammals. Flight adaptations in vertebrates - Aquatic adaptations in birds and mammals; embryonic adaptation: Extra embryonic membrane structure in Reptiles and Birds. Adaptive radiations in chordates: Aquatic, terrestrial and arboreal. Bioindicators- microbes.

Unit IV Animal Behaviour and Pheromones

(12 Hrs.)

Animal Behaviour: Stereotyped behaviour- instincts and motivation; Acquired behaviour: Pavlovian learning, trial and error learning, reasoning and imprinting; Pheromones and behaviour: types, significance – Pheromones with reference to insects and rodents.

Unit V Social Behaviour in Animals

(12 Hrs.)

Social behaviour: Birds, primates. Biological rhythms: circadian, tidal, lunar, circannual rhythms. Types of communication in animals: visual, olfactory, tactile, verbal and non-verbal- Communication in bees and birds, mimicry and animal colorations

B. Topics for Self-study:

- **Reptilia** (<https://www.notesonzoology.com/phylum-chordata/garden-lizard/external-morphology-of-garden-lizard-with-diagram-chordata-zoology/8383>)
- **Vector borne diseases** (<https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases>)
- **Apiculture** (<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/apiculture>)

C. Text Books

1. Jordan E.L. and Verma P.S., Invertebrate Zoology, 12thedn. Schand & Co. 1995.
2. Kotpal R.L., Agarwal, R.P.R., Khertarpa, Modern Text Book of Zoology-I –Rastogi Publications. 1989.

D. Reference Books

1. Ayyar E.K. Ananthakrishnan, T.N., Outlines of Zoology: Invertebrata, Vol-I and Vol-II Viswanathan Pvt. Ltd. 1993.
2. Hoshang. S, Gundevia and Hare Govind Singh, A textbook of Animal Behaviour, Chand & Co., 1997.
3. Shukla G.S and Upadhyay V.B., Economic Zoology, Rastogi Publications, 2004.
4. Jordan, E.L. and Verma P.S., Invertebrate Zoology, 12thedn. S.Chand & Co., 1995.
5. Kotpal, R.L., Agarwal, R.P.R., Khertarpa. I., Modern Text Book of Zoology, Rastogi Publications, 1989.
6. Dhama, D.S and Dhama, J.K.R., Chordate Zoology, Chand & Co., 1978.
7. Ismail, S.A., Vermiculture: The Biology of Earthworm, Orient Longman, London, 1970.

E. Web Links

1. <https://www.who.int/news-room/fact-sheets/detail/zoonoses>
2. <https://www.acs.edu.au/courses/invertebrate-animals-730.aspx>
3. <https://www.khanacademy.org/science/biology/crash-course-bio-ecology/crash-course-biology-science/v/crash-course-biology-123>
4. <https://courses.lumenlearning.com/suny-biology2xmaster/chapter/chordates/>

3. Specific Learning Outcomes (SLO)

Unit & Section	Course Content	Learning outcome	Highest Blooms Taxonomic Level of Transaction
Unit I	Diversity of Invertebrates and Chordates		
1.1	Salient features of Animalia	Discuss the salient features of Animalia	K6
1.2	Levels of organization	Classify the different levels of organization	K3
1.3	Classification- Invertebrates & Chordates	Explain the characteristics features of Invertebrates & Chordates	K4
Unit II	Beneficial Insects, Vermiculture and Parasitology		
2.1	Type study-Earthworm	Identify the morphological characters of the animal. Explain the different systems of Earthworm	K4 K4
2.2	Cockroach	Explain the morphological characters of Cockroach	K4
2.3	Lamellidens	Explain the feeding mechanism of Lamellidens	K4
2.4	Star fish	Explain the morphological characters of Star fish	K4
2.5	Social life of honey bee	Predict the social life of honey bees	K5
2.6	Vermiculture	Explain in detail the vermiculture. Compare the different types of vermicomposting	K4 K4

2.7	Vectorborne diseases- M Dengue	Examine the epidemiology of viral diseases	K4
Unit III	Migration and Adaptive Radiation in Chordates		
3.1	Migratory animals-Fish, Mammals	Explain the types of migration in fishes, birds & mammals	K4
3.2	Flight adaptations	Classify the adaptations in birds	K3
3.3	Aquatic adaptations	Devise/Formulae the aquatic adaptations	K5
3.4	Extra embryonic membrane	Describe the extra embryonic membrane Explain the characteristics of extra embryonic membranes	K1
3.5	Adaptive radiation	Explain the types of adaptive radiation	K4
Unit IV	Animal Behaviour AND Pheromones		
4.1	Animal behaviour	Discuss the various Animal behaviour	K6
4.2	Acquired behaviour	Explain the acquired behaviour of animal	K6
4.3	Pheromones & Social behaviour	Relate the Effect of pheromones in various social behaviours of animals	K1
Unit V	Social Behaviour in Animals		
5.1	Biological rhythms	Compare the animals based on different biological rhythms	K4
5.2	Types of communication- Animals, Birds	Explain various communication mechanisms of animals and birds	K4
5.3	Mimicry and colouration	Distinguish various patterns of mimicry and colouration	K4

4. Mapping Scheme (POs, PSOs and COs)

U19ESZY2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	L	H	H	L	M	-	-	H	H	-	H
CO2	H	H	L	H	H	L	M	-	-	H	H	-	H
CO3	H	H	L	H	H	L	M	M	-	H	H	-	M
CO4	H	H	L	H	H	L	M	-	-	H	H	-	M
CO5	H	H	L	H	H	L	H	-	-	H	H	-	H
CO6	H	H	-	H	H	-	M	-	-	H	H	-	H

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Ms.V.Hadline Kiruba

Allied Practical-II ENVIRONMENTAL ZOOLOGY LAB

Semester: II
Credits: 2

Course Code: U19ESZP1
Hours/Week: 3

1. Course Outcomes

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

CO No.	Course Outcomes	K-LEVEL	Experiment
CO1	Conversant with organ systems of Earthworm and cockroach.	K4	I
CO2	Mount body setae of Earthworm and observe under the microscope.	K5	II
CO3	Study and distinguish various mouthparts of insects with its functions.	K5	II
CO4	Analyze the process of biological rhythms and communication in bees.	K4	III
CO5	Interpret the various adaptation in animals	K4	III
CO6	Study the biological significance of the given spotters	K4	III

2.A. Syllabus

List of experiments

I. Virtual Dissections

- Cockroach : Digestive system and Nervous system
- Earthworm : Digestive system and Nervous system

II. Mountings

- Mosquito : Mouth parts
- House fly : Mouth parts
- Earthworm : Body setae
- Shark : Placoid scale

III. Spotters

Amoeba, Paramecium, Obelia colony, Tapeworm, Ascaris, Leech, Millipede, Centipede, Freshwater mussel, Starfish, Shark, Calotes, Pigeon, Rabbit, Eudrilus eugeniae, vermicasts, Biological rhythms and communication in bees.

B. Topics for Self-Study;

- **Pisciculture** (<https://helpforagmain.blogspot.com/2018/03/aquaculturefisheries-notes-pdf-files.html>)
- **Sericulture** (<https://doi.org/10.1016/B978-0-12-374144-8.00241-1>;
<https://krishijagran.com/agripedia/sericulture-an-introduction-to-silk-cultivation-and-production-in-india-along-with-its-policy-initiatives/>)
- **Apiculture**
(http://library.uniteddiversity.coop/Beekeeping/A_Practical_Manual_of_Beekeeping.pdf)
- **Lac Culture** (<https://www.studyandscore.com/studymaterial-detail/lac-culture-introduction-history-distribution-lac-culture-in-India-and-life-cycle-of-lac-insect>;
[https://gwpgc.ac.in/userfiles/B_%20Sc_%20III%20\(Zoology\)%20Lac%20Culture%20in%20India.pdf](https://gwpgc.ac.in/userfiles/B_%20Sc_%20III%20(Zoology)%20Lac%20Culture%20in%20India.pdf))
- **Rattus rattus** (<http://web.jhu.edu/animalcare/procedures/rat.html>;
[https://bio.libretexts.org/Bookshelves/Ancillary_Materials/Worksheets/Book%3A_The_Biology_Corner_\(Worksheets\)/Anatomy_Worksheets/Investigation%3A_Rat_Dissection](https://bio.libretexts.org/Bookshelves/Ancillary_Materials/Worksheets/Book%3A_The_Biology_Corner_(Worksheets)/Anatomy_Worksheets/Investigation%3A_Rat_Dissection))

D. Reference Books

1. Shukla G.S and Upadhyay V.B., Economic Zoology, Rastogi Publications, 2004.
2. Jordan, E.L and Verma P.S., Invertebrate Zoology, 12thedn. S. Chand & Co., 1995.

3. Specific Learning Outcomes (SLO)

Sl. No	Course contents	Learning outcomes	Blooms Taxonomy levels of Transaction
I VIRTUAL DISSECTION			
1	Dissection of Earthworm Digestive system and Nervous system	Understand the basic organization of earthworm organ systems	K4
2	Virtual dissection of cockroach Digestive system, nervous systems and reproductive system	Analyse the cockroach organ system using virtual platform.	K4
II MOUNTING & DISPLAY			
	Mountings of Mosquito : Mouth parts House fly : Mouth parts Earthworm : Body setae Shark : Placoid scale	Evaluate various mouth parts of insects by mounting	K4, K5
III SPOTTERS			
4	Spotters: Amoeba, Paramecium, Obelia colony, Tapeworm, Ascaris, Leech, Millipede, Centipede, Freshwater mussel, Starfish, Shark, Calotes, Pigeon, Rabbit, <i>Eudrilus eugeniae</i> , vermicasts, Biological rhythms and communication in bees.	Discuss the biological significance of the given species and adaptations.	K4

4. Mapping Scheme (POs, PSOs and COs)

U19ESZP1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	L	L	H	M	M	H	M	H	H	M	L
CO2	H	H	M	M	H	M	M	H	M	H	H	M	M
CO3	H	H	L	L	H	M	M	H	M	H	H	M	L
CO4	H	H	L	L	H	M	M	H	M	H	H	M	M
CO5	H	H	M	L	H	M	M	H	M	H	H	M	L
CO6	H	H	L	L	H	M	M	H	M	H	H	M	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Pre-semester and End-semester Examinations (ESE)
3. Reports, Observation Register, Record Note Books and Viva-voce

Indirect

1. Overall performance assessment, Discussions and co-curricular activities

Course Coordinator: Ms.Susan G.Suganya

Practice School - II: ECOLOGY AND BIODIVERSITY

Semester: II
Credits: 2

Code: U17ES2F2
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 Moist and Dry Tropical Ecosystem in India	K1	I
CO2	Relate the In situ and Ex situ conservations methods of India	K2	II
CO3	Categorize the different types of crop productions and plantations in India	K2	III
CO4	Illustrate the Biodiversity register to prepare the flora & fauna reports	K2	IV
CO5	Appraise the resource and assets of a particular village through resource mapping and assets mapping	K5	V
CO6	Identify the environmental impacts through social mapping and to suggest mitigation measures	K2	V

2.A. Syllabus

Unit I Ecosystem Biodiversity of India

(6 Hours)

- Moist Tropical:
- Wet evergreen
- Semi-evergreen
- Moist-deciduous
- Littoral Swamp
- Dry – Tropical forests
- Dry deciduous
- Thorn forest
- Dry evergreen

Unit II Conservation of Biodiversity

(6 Hours)

In-situ conservation

- National Parks and Sanctuaries
- Biosphere Reserves
- Nature Reserves
- Reserved and Protected forests

Ex-situ Conservation

- Botanical gardens
- Zoological parks
- Herbal garden

Unit III Crop Production

(6 Hours)

- Plantation Crops: Arecanut, Cocoa, Coffee, Tea and Rubber
- Commercial Crops: Cotton, Sugarcane, Tobacco, Jute and allied fibres
- Forest Plantation: Conifers (Pine), Wattle, Eucalyptus, Acacias and Teak
- Food crops: Paddy, Wheat, Maize and Potatoes

Unit IV Peoples' Biodiversity Register (6 Hours)

- Preparation of Ecology and Biodiversity report
- Flora
- Trees, shrubs, herbs, climbers
- Agricultural crops
- Medicinal plants

- Recent changes in floral diversity
- Fauna
- Wild animals
- Domestic animals
- Recent changes in faunal diversity

Unit V Participatory Rural Appraisal (PRA)

(6 Hours)

- Resource mapping
- Asset's mapping
- Social mapping
- Management plan

C. Text Books

1. Sharma, P. D. Ecology and Environment. 13th 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. 5th ED., Brooks/Cole, 2004; ISBN:978-0534420666.
5. Clarke GL, Elements of Ecology. John Wiley, London,2003.
6. Odum, E. P. Fundamentals of Ecology. W.B., Saunders Co, Philadelphia and London,1971.
7. Krishnamurthy, K.V. An Advanced Textbook on Biodiversity: Principles and Practice. Oxford and IBH. Publ. Co. New Delhi. 260p, 2004.
8. Krishnamurthy, K.V. An Advanced Textbook on Biodiversity: Principles and Practice. Oxford and IBH. Publ. Co. New Delhi. 260Pp, 2004.

D. 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. 4thEd. W.H. Freeman and Co.,1999; ISBN:978-0716728290.
7. Raven, P. H. and Johnson, G. B.Biology. 11thed. Wm. C. McGraw-Hill Education, 2016; ISBN: 978-1259188138.
8. Smith, T. M and Smith, R. L.Elements of Ecology. 9thed. 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.
11. Gadgil M, Peoples Biodiversity Register: A Record of India's Wealth, AmruthSpl. Suppl., 1- 16. (1996).
12. MadhavGadgil, Ecology is for the People – A Methodology Manual for People's Biodiversity Register, Centre for Ecological Sciences, Bangalore, 2005.
13. Melchias, G. Biodiversity and Conservation. Oxford IBH. New Delhi. 236Pp, 2001.
14. Groombridge, B. Editor. Global Biodiversity– Status of the Earth's living resources. Chapman & Hall, London,1994.
15. Levin, S. A. Encyclopedia of Biodiversity: Second Edition. Academic Press 5 Vol, 2000.

16. 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. <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>
6. <http://www.iucnredlist.org/https://www.unenvironment.org/>
7. <https://cpb.ucdavis.edu/news/resources-teaching-ecology-and-evolution>
8. <https://www.esa.org/programs/ecology-education/#gsc.tab=0>
9. <https://www.ugc.ac.in/oldpdf/modelcurriculum/Chapter4.pdf>
10. http://www.keralabiodiversity.org/images/pdf/book_english.pdf

4. Mapping Scheme (POs, PSOs and COs)

U17ES2F2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H	H	H	H	H	H	-	-	L
CO2	H	H	M	H	H	H	H	M	M	H	-	-	L
CO3	H	H	M	H	H	H	H	-	-	H	-	-	L
CO4	H	H	L	H	H	H	H	L	L	H	-	-	L
CO5	H	H	M	H	H	H	H	L	L	H	H	-	L
CO6	H	H	M	H	H	H	H	-	L	H	H	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. A. Daisy Caroline Mary

Core III – ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Semester: III
Credits: 4

Code: U17ES303
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 different types of microorganisms and their growth and reproduction	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

(15 Hrs.)

History and discovery of microorganisms - Spontaneous generation - Germ Theory of disease, Immunity – chemotherapy. Prokaryotic and Eukaryotic cell structure of bacteria, virus, fungi, yeast and algae, Growth and reproduction of bacteria and virus.

Unit II Microorganisms in Industry

(15 Hrs.)

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

Unit III Microorganism in Air, Water and Soil

(15 Hrs.)

Microorganisms in Air: 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

(15 Hrs.)

Concepts and scope of environmental biotechnology; Biofertilizers–use of Rhizobium, Azolla, Mycorrhiza; Vermiculture.

Unit V Principles of various Biotechnological Methods

(15 Hrs.)

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. TataMcGraw-Hill,2010.
2. L. E Casida, JR, Industrial Microbiology. New Age International, PJ Limited, Publisher,2015
3. Reed, G. Prescott and Dunn'sIndustrial 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
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/>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Environmental Microbiology		
1.1	History and discovery of microorganisms	Recall the development of the field of microbiology	K1
1.2	Spontaneous generation - Germ Theory of disease; Immunity – chemotherapy	State theories about origin of microbiology and the concept of immunity	K1
1.3	Prokaryotic and Eukaryotic cell structure of bacteria, virus, fungi, yeast and algae	Visualize and recite the ultra-structure of various microorganisms	K1
1.4	Growth and reproduction of bacteria and virus	Describe the reproductive means of bacteria and viruses	K1
Unit II	Microorganisms in Industry		
2.1	Sterilization-physical and chemical methods	Classify various sterilization techniques used in Industrial applications	K2
2.2	Culture Techniques- Types of media	Demonstrate various culture and media types	K2
2.3	Environmental Determinants- Temperature, Radiation, Pressure, Salinity, pH and Water Activity	Discuss factors influencing the growth and development of microorganisms	K2
2.4	Microorganisms in Industry – Production of lactic acid, Amino acid, Alcohol fermentation, Penicillin Production	Apply the knowledge of industrial scale production of various biotechnology products	K3
2.5	Microorganisms in food: milk, fruits, egg and Fish	Identify and review the use of microorganisms in the food industries	K2
2.6	Principles of food spoilage and food preservation; Microorganisms and sanitation	Explain the importance of knowledge of microbiology in food preservation and sanitation	K2
Unit III	Microorganisms in Air, Water and Soil		
3.1	Microorganism in Air: Air borne Infections – Causative Microbes - Control Measures	Discuss the microbiology of air, its impacts and control measures	K2
3.2	Sick Building Syndrome; Droplet infection	Identify and examine the Sick Building Syndrome and Droplet infection	K3
3.3	Aquatic Microbiology: Water-borne Diseases Disinfection of water for potable purposes	Discuss the microbiology of water, its impacts and control measures	K2
3.4	Soil Microbiology: Rhizosphere and Rhizoplane Microflora – Composting	Discuss the microbiology of soil, its uses, impacts and control measures	K2
Unit IV	Environmental Biotechnology		
4.1	Concepts and scope of environmental biotechnology	Generalize the concept of biotechnology and its scope	K2

4.2	Biofertilizers–use of Rhizobium, Azolla, Mycorrhiza; Vermiculture	Demonstrate the use of biofertilizers and vermicomposting techniques	K2
Unit V	Principles of various Biotechnological Methods		
5.1	Principles of various biotechnological methods: plasmid isolation; restriction, digestion; PCR; RAPD; RFLP	Experiment and demonstrate various biotechnological methods	K3
5.2	Genetically Modified Crops; Genetically Engineered species and pest control	Analyze the tools and product of genetic engineering	K4
5.3	Salient features of Guidelines and policy of GMOs in India	Evaluate the need and impacts of Guidelines and policy of GMOs in India	K4

4. Mapping Scheme (POs, PSOs and COs)

U17ES303	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	L		-	-	-	-	-	-	L	L	-	-
CO2	L	L	L	-	-	-	-	-	-	L	-	-	L
CO3	L	M	-	L	-	-	-	-	-		L	-	L
CO4	M	-	-	M	-	-	M	-	-	L	-	M	-
CO5	M	-	-	M	-	-	M	-	-	M	-	-	M
CO6	M	-	-	M	-	-	M	-	-	-	-	M	M

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Ms.D. Udhayabanu

Core Practical II - ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY LAB

Semester: III
Credits: 3

Code: U17ES3P2
Hours/Week: 3

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	Preparation of culture media for bacteria and fungi and acquire the expertise in Isolation of Bacteria from Water	K4	6 & 7
CO5	Estimate Coliform Group of Bacteria with the help of MPN Technique	K2	8
CO6	Demonstrate the Gel Electrophoresis and PCR	K2	9

2.A. Syllabus

List of Experiments

1. Demonstration of Microscope (3 Hrs.)
2. Gram staining of Bacteria (6 Hrs.)
3. Methylene Blue Reductase Test (6 Hrs.)
4. Identification of Fungi – Lactophenol Cotton Blue Staining. (6 Hrs.)
5. Isolation of Fungi from Soils – Pour Plate Method. (3 Hrs.)
6. Preparation of culture media for microorganisms. (6 Hrs.)
7. Isolation of Bacteria from Water/Wastewater – Serial Dilution Technique. (6 Hrs.)
8. Estimation of Coliform Group of Bacteria – MPN Technique- Presumptive Test. (6 Hrs.)
9. Demonstration of Gel Electrophoresis and PCR (3 Hrs.)

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 Links

1. https://www.wpiinc.com/media/wysiwyg/pdf/PZMIV_IMs.pdf
2. https://www.who.int/water_sanitation_health/resourcesquality/wqmchap10.pdf
3. https://www.who.int/bloodsafety/transfusion_services/sop-bts_bangladesh.pdf

3. Specific Learning Outcomes

Experiment	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
1.	Demonstration of Microscope	Recognize and explore the microscopic techniques	K4
2.	Gram staining of Bacteria	Differentiate gram-positive and gram-negative bacteria	K2
3.	Methylene Blue Reductase Test	Determine the quality of a milk sample	K3
4.	Identification of Fungi – Lactophenol Cotton Blue Staining.	Examine the fungal species with suitable biochemical tests	K3
5.	Isolation of Fungi from Soils – Pour Plate Method.	Identify and evaluate the fungal members in the soil samples	K4
6.	Preparation of culture media for microorganisms.	Illustrate the different types of media and their preparation.	K3
7.	Isolation of Bacteria from Water/Wastewater – Serial Dilution Technique.	Perform a culture development of bacterial culture from water samples for identification	K4
8.	Estimation of Coliform Group of Bacteria – MPN Technique- Presumptive Test.	Estimate the coliform bacteria and correlate with water quality	K4
9.	Demonstration of Gel Electrophoresis and PCR	Choose suitable molecular tools for DNA isolation and multiplication	K3

4. Mapping Scheme (POs, PSOs and COs)

U17ES3P2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	-	L	-	-	-	-	-	-	L	M	-	-
CO2	L	-	L	L	L	-	-	-	-	L	M	-	-
CO3	L	-	-	M	M	-	-	-	-	L	M	-	-
CO4	L	M	L	M	M	-	-	-	L	L	L	M	L
CO5	L	-	L	L	L	-	-	-	-	-	-	-	-
CO6	L	-	L	L	L	-	-	-	-	L	-	-	-

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. End-semester Examinations (ESE)
3. Reports, Observation Register, Record Note Books and Viva-voce

Indirect

1. Overall performance assessment, Discussions and co-curricular activities

Course Coordinator: Dr.M. Sheela Mary

Allied III: ALLIED CHEMISTRY-I

Semester: III
Credits: 3

Course Code: U19ESCY3
Hours/Week: 4

1. Course Outcomes:

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

CO No.	Course Outcomes	Level	Unit
CO1	Distinguish the geometry and shape of molecules using VSEPR theory	K4	I
CO2	Illustrate the mechanism for different basic organic reactions	K3	II
CO3	Compare the different concepts of acids and bases	K2	III
CO4	Explain the kinetics of chemical reactions	K3	IV
CO5	Summarize the applications of catalytic reactions	K2	IV
CO6	Identify different applications of colloids in day-to-day life	K2	V

2.A. Syllabus**Unit I Chemical Bonding****(12 Hrs.)**

1.1 Ionic bond- Nature of Ionic bond–structure of NaCl, KCl & CsCl- Factors influencing the formation of ionic bond.

1.2. Covalent bond- nature of covalent bond–VSEPR theory - shapes of BeCl₂, BF₃, CH₄, PCl₅, IF₇, NH₃& H₂O.

1.3 Coordinate Bond–Nature of coordinate bond, Werner's theory and structure of some complexes – Ni (CO)₄, [Co(NH₃)₆]Cl₃, K₄[Fe(CN)₆].

1.4. Hydrogen bonding–Theory of Hydrogen bonding - Inter and Intra molecular hydrogen bonding- consequences of hydrogen bonding, van der Waals and London Dispersive forces in simple molecules.

Unit II Types of Reactions**(12 Hrs.)**

2.1- Types of chemical reactions, Types of intermediates- Electrophiles – nucleophiles – free radicals.

2.2 – Substitution Reactions: Nucleophilic and electrophilic substitution with mechanism (one example for each), Addition Reactions (Addition of HBr on alkenes) – Elimination Reactions (Dehalogenation of alkyl halides) – Condensation Reactions (formation of ester).

2.3 – Polymerization Reactions (Formation of Poly vinyl Chloride) – Reduction reactions (Hydrogenation of oil)- Oxidation Reactions (Conversion of benzaldehyde to benzoic acid).

UNIT III Solutions**(12 Hrs.)**

3.1 Types of Solutions – Homogeneous and Heterogeneous, saturated and unsaturated, Mole Concept, Normality, Molarity, Molality and Parts per Million–**Problems.**

3.2 Primary and secondary standards and preparation of standard solutions -**Problems.**

3.3 Acids and bases: Arrhenius, Lowry- Bronsted, Lewis concepts- strong and weak acids and Bases-pH, pK_a, pK_b, buffer solutions, Derivation of Henderson – Hasselbalch equation.

Unit IV Chemical Kinetics and Catalysis**(12 Hrs.)**

4.1 Chemical kinetics: rate of reaction, order, molecularity, first order rate law, half-life period and derivation of the first order rate equation.

4.2 Catalysis–homogeneous and heterogeneous catalysis, intermediate complex formation theory and adsorption theory, Positive and Negative Catalysts, Promoters and poisons, Auto catalysis, applications.

4.3 Enzyme catalysis –Mechanism and Michaelis-Menton Equation (No derivation)- Factors affecting enzyme catalysis.

Unit V Colloids**(12 Hrs.)**

- 5.1** Colloids – Types with examples – classification based on affinity (Lyophilic & Lyophobic).
- 5.2** Optical, Kinetic and Electrical properties of colloids– Electrophoresis, Electro-osmosis, Peptization, Coagulation.
- 5.3** Applications of colloids- Dialysis, Desalination of water, Artificial Rain.

B. Topics for Self-study

- https://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/syllabus/MIT3_091SCF09_aln02.pdf
- https://profiles.uonbi.ac.ke/sderese/files/h-sch_102_-_types_of_organic_reactions_and_mechanisms.pdf
- <https://www.askiitians.com/revision-notes/chemistry/solutions/>
- <https://www.britannica.com/science/catalysis>
- <https://nios.ac.in/media/documents/313courseE/L10.pdf>

C. Text Books

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2017 (**Unit I, II, III**)
2. Arun Bahl and B.S. Bahl, *Advanced Organic Chemistry*, S. Chand & Co. Ltd., New Delhi, 2012 (**Unit IV**)
3. B.R. Puri, L.R. Sharma and Madan S. Pathania, *Principles of Physical Chemistry* Vishal Publishing Co., Jalandhar, 2017 (**Unit V**)
4. P.L.Soni, H.M. Chawla, *Text Book of Organic Chemistry*, Sultan Chand & Sons, New Delhi, 2004
5. R.L. Madan and G.D. Tuli, *Inorganic Chemistry*, S. Chand Co. Ltd., New Delhi, 2010
6. Gurdeep Raj, *Advanced Physical Chemistry*, Goel Publishing House, Meerut, 2016.

D. Reference Books

1. J.D. Lee, “*Concise Inorganic Chemistry*”, Oxford University Press, New Delhi, 2008.
2. Morrison and Boyd “*Organic Chemistry*” Pearson Education, 2016.
3. Peter Atkins and Julio de Paula, “*Physical Chemistry*” Oxford University Press, 2018.

E. Web Links:

1. [https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_\(Wade\)/04%3A_The_Study_of_Chemical_Reactions/5.01%3A_Introduction](https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_(Wade)/04%3A_The_Study_of_Chemical_Reactions/5.01%3A_Introduction)
2. [https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_Principles_of_Modern_Chemistry_\(Oxtoby_et_al.\)/Unit_5%3A_Rates_of_Chemical_and_Physical_Processes/18%3A_Chemical_Kinetics/18.7%3A_Kinetics_of_Catalysis](https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_Principles_of_Modern_Chemistry_(Oxtoby_et_al.)/Unit_5%3A_Rates_of_Chemical_and_Physical_Processes/18%3A_Chemical_Kinetics/18.7%3A_Kinetics_of_Catalysis)

3. Specific Learning Outcomes

Unit	Course Contents	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit 1	Chemical Bonding		
1.1	Ionic bond - Nature of ionic bond; Factors influencing the formation of ionic bond	Recall the concepts of formation	K1
		Explain the factors influencing the formation of ionic bond.	K2
1.1	Structure of NaCl, KCl and CsCl	Compare the structure of NaCl, KCl and CsCl	K2
1.2	Covalent bond; Nature of Covalent bond	Explain the concept of Covalent bond with examples	K2

1.2	VSEPR theory	Predict the shape of a given molecule based on VSEPR theory	K4
1.3	Coordinate bond; Nature of Coordinate bond	Explain the concept of Coordinate bond	K2
1.3	Werner's theory and structure of some complexes	Infer the structure of some complexes with the aid of Werner's theory	K2
1.4	Hydrogen bonding; Theory and types of hydrogen bonding; Consequence of hydrogen bonding	Compare the types of hydrogen bonding in compounds	K4
1.5	Van der Waals forces and London Dispersive forces	Identify the various forces of attraction in molecules	K3
Unit 2	Types of Reactions		
2.1	Types of intermediates – Electrophiles, Nucleophiles and Free radicals	Compare the different types of radical intermediates	K2
2.2	Substitution reactions – Electrophilic, Nucleophilic with mechanism	Explain the electrophilic and nucleophilic substitutions along with mechanism	K3
2.2	Addition reaction – Addition of HBr on alkenes	Apply the mechanistic pathway for addition reaction to alkenes	K3
2.2	Elimination reactions – Dehalogenation of alkyl halides	Apply the mechanistic pathway for Dehalogenation of alkyl halides	K3
2.2	Condensation reactions – formation of ester	Explain the condensation reaction with an example	K2
2.3	Polymerization reactions – formation of poly vinyl chloride	Describe the preparation method of PVC	K2
2.3	Reduction reactions – hydrogenation of oil	Explain the reaction of hydrogenation of oil	K2
2.3	Oxidation reactions – conversion of benzaldehyde to benzoic acid	Write the mechanism for conversion of benzaldehyde to benzoic acid	K3
Unit 3	Solutions		
3.1	Homogeneous and Heterogeneous solutions Saturated and Unsaturated solutions	Identify the different types of solutions	K2
3.1	Mole concept – Normality, Molarity, Molality and Parts per Million – problems	Calculate strength of given solution based on mole concept	K2
3.2	Primary and secondary standard solutions and preparation	Identify the primary and secondary standard solutions	K2
3.3	Arrhenius theory	Outline the Arrhenius theory concept of acids and bases.	K2
3.3	Lowry-Bronsted theory	Explain the Lowry-Bronsted theory concept of acids and bases.	K2
3.3	Lewis acid base theory (strong and weak)	Classify strong and weak acids and bases with the	K2

		aid of Lewis acid base theory	
3.3	Buffer solutions Henderson-Hasselbalch equation	Predict the pH of the buffer solution based on Henderson-Hasselbalch equation	K2
Unit 4	Chemical Kinetics and Catalysis		
4.1	Rate law	Explain the rate of chemical reaction	K2
4.1	Order and Molecularity of a chemical reaction	Compare the order and molecularity of chemical reaction	K2
4.1	Half-life period	Illustrate the half-life period of particular reactions	K2
4.1	First order rate constant equation	Develop the rate constant equation for first order reaction	K3
4.2	Homogeneous and Heterogeneous catalysis	Compare the homogeneous and heterogeneous catalysis	K2
4.2	Intermediate complex formation theory	Explain the formation of intermediate complex theory	K2
4.2	Adsorption theories of catalysis	To explain the theories of adsorption of catalysis	K2
4.2	Positive catalyst, Negative catalyst, Auto catalyst, promoters and poisons	Classify the catalyst based on their function	K2
4.2	Application of catalysis	Summarize the application of catalysis	K2
4.3	Enzyme catalysis – mechanism Michaelis – Menton Equation (no derivation)	Explain the mechanism of enzyme catalysis based on Michaelis-Menton Equation.	K2
4.3	Factors affecting the enzyme catalysis	Explain the factors which affect the enzyme catalysis	K2
Unit 5	Colloids		
5.1	Colloids and its types with examples; Lyophilic and Lyophobic colloids	Classify the types of colloids with examples	K2
5.2	Optical and Kinetic properties of colloids (electrophoresis, electro osmosis)	Compare the optical and kinetic properties of colloids	K2
5.3	Peptization and Coagulation	Differentiate the properties of peptization and coagulation	K2
5.4	Applications of colloids – Dialysis, Desalination of water and Artificial Rain	Identify different applications of colloids in day-to-day life	K2

4. Mapping Scheme (POs, PSOs and COs)

U19ESCY3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	-	-	-	-	-	-	-	-	-	-	-
CO2	H	-	L	L	M	-	-	-	-	M	L	L	-
CO3	H	M	-	-	H	-	M	H	M	L	-	-	-
CO4	H	L	M	M	-	-	M	-	H	L	L	L	-
CO5	H	-	-	-	L	-	-	-	M	M	L	L	M
CO6	H	H	M	M	H	-	-	H	H	M	-	-	M

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. End-semester Examinations (ESE)
3. Reports, Observation Register, Record Note Books and Viva-voce

Indirect

1. Overall performance assessment, Discussions and co-curricular activities

Course Coordinator: Dr. T. Nalini

**Practice School – III:
INDUSTRIAL EXPOSURE TRAINING (IET) AND GREEN INITIATIVES**

Semester III
Credits: 2

Course Code: U17ES3F3
Hours/Week: 2

Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	List the various types of industries, CWM; GET; GB; EML & ERA	K1	I
CO2	Explain the manufacturing process and pollution control in various industries	K2	I
CO3	Examine the waste management facilities and treatment plants	K4	II
CO4	Categories the treatment processes and recycling practices	K3	II
CO5	Plan the GET system to be established	K3	III
CO6	Propose and Develop the EML and facilities to monitor parameters	K6	IV

2.A. Syllabus

Unit I Industrial Exposure Training

(6 Hrs.)

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

Unit II Common Waste management facility

(8 Hrs.)

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

Unit III Green Energy technologies and Green Buildings

(8 Hrs.)

Sources of energy in the Anthro sphere. 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.

Unit IV Environmental Monitoring Laboratories in Regulatory agencies and Industries

(8 Hrs.)

Pollution control Board/King Institute/ISI laboratories; Laboratory facility in industries to monitor Air (ambient and Stack), Water and wastewater and noise parameters; NABL Accredited Laboratories

B. Topics for Self-study

- **Industrial Exposure** (<https://sanskriti.edu.in/blog/importance-of-industrial-exposure-in-education/>)
- **Waste management & Disposal** (<https://www.conserve-energy-future.com/waste-management-and-waste-disposal-methods.php>)
- **Laboratory Guidelines** (<https://parivesh.nic.in/writereaddata/ENV/envlab/envlabguideline.pdf>)

C. Text Books

1. Austin GT, Shreves, Chemical processes in industries, McGraw Hill Book Co., New York, 1977.
2. Mahajan SP, Pollution Control in process industries, Tata McGraw Hill Co. Ltd., New Delhi, 1986.
3. Rao MN and Datta, Wastewater treatment, Oxford and IBH, 1982.
4. Patnaik, P, Handbook of Environmental Analysis – Chemical Pollutants in Air; Water; Soil and Solid wastes –Lewis publishers, Boca Raton, 1997

D. Reference Books:

1. APHA Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Edition. ISBN 0875530478, 9780875530475 APHA Publisher, 2005.
2. Saxena MM, Environmental Analysis Water, Soil and Air, Agro Botanical Publishers, India. ISBN: 81-85031-22-3, 1987.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Industrial Exposure Training			
1.1	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	List the types of Industries	K1
		Illustrate the various industrial manufacturing & treatment processing units	K2
Unit II Common Waste management facility			
2.1	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	Demonstrate the various types of waste management facilities	K3
		Explain the various treatment processes and management practices	K2
Unit III Green Energy technologies and Green Buildings			
3.1	Sources of energy in the Anthrosphere. 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.	Explain the various Green technologies	K2
		Formulate Green technological system with reference to green buildings	K6
		Illustrate waste management practices: sewage; solid waste; sullage; and green cover and build environment	K2
Unit IV Environmental Monitoring Laboratories in Regulatory agencies and Industries			
4.1	Pollution control Board/King Institute/ISI laboratories; Laboratory facility in industries to monitor Air (ambient and Stack), Water and wastewater and noise parameters; NABL Accredited Laboratories	Recommend PCB and laboratories	K5
		Illustrate Industrial Pollution monitoring devices	K2

4. Mapping Scheme (POs, PSOs and COs)

U17ES3F3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	-	-	M	L	-	L	L	L	L	-	M	H	H
CO2	-	-	M	L	L	M	M	M	M	L	M	H	H
CO3	-	-	-	-	-	L	M	M	L	-	M	M	H
CO4	L	-	M	L	M	M	M	M	M	M	M	M	H
CO5	L	-	M	L	L	L	L	M	H	M	H	H	H
CO6	L	-	M	L	M	M	M	M	H	M	M	H	H

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. A. Chandramohan

SBEC I: ENVIRONMENTAL EDUCATION AND AWARENESS

Semester: III
Credits: 2

Course Code: U17ESPS1
Hours/Week: 2

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Explain about the history of environmental education	K4	I
CO2	Summarize the concept of environmental education	K2	I
CO3	Explain the methodology of Environmental Education	K4	II
CO4	Categorize the different forms of education	K4	II
CO5	Plan and design the environmental education programs for various target groups	K5	III, IV & V
CO6	Execute and review the environmental education programs for various target groups	K6	III, IV & V

2.A. Syllabus

Unit I Theory: Basics of Environmental Education (8 Hrs.)

Concepts, Principles and Characters of Environmental Education; Importance and history of Environmental Education; Global (UNEP, WII, CSE, IPCC, IUCN) and National (WWF- I, CPR Environmental Education Centre, Centre for Environmental Education, BVIEER) Environmental organizations – objectives and activities, Major Environmental Activism Movements – Bishnoi, Chipko & Silent Valley.

Unit II Theory: Methodology of Environmental Education (8 Hrs.)

Forms of Environmental Education – Formal, non-formal; Guidelines of contents for early childhood, higher education, adult and general public; Current practices in India.

Unit III Practice (6 Hrs.)

Planning, preparation, Implementation and Evaluation of Environmental Awareness for rural school children

Unit IV Practice (4 Hrs.)

Planning, preparation, Implementation and Evaluation of Environmental Awareness for urban school / college community

Unit V Practice (4 Hrs.)

Planning, preparation, Implementation and Evaluation of Environmental Awareness for general public

B. Topics for Self-study

- **Citizen Science** (<https://www.citizenscience.gov/>)
- **Education for Sustainable Development** (<http://www.esdtoolkit.org/discussion/default.htm>)
- **Experiential Learning** (<https://www.experiential.institute/deep>)
- **Outdoor Learning** (<https://www.outdoor-learning.org/>)

C. Text Books

1. UNEP. Public Environmental Awareness and Education, 2007
2. MOEF. Ministry of Environment & Forests. Government of India Paryavaran Bhawan CGO Complex Lodhi Road, New Delhi, 110003, National Environment Awareness Campaign. 2011-2012.

D. Reference Books

1. Early Childhood Environmental Education Programs: Guidelines for Excellence, North American Association for Environmental Education, 2000, USA, www.naaee.org www.eelink.net.
2. Joyce Meredith. A Project of Ohio. EE 2000: A Strategic Plan for Environmental Education in Ohio. Published by: Environmental Education Council of Ohio P.O. Box 2911 Akron, OH 44309-2911,2000.
3. Non-formal Environmental Education Programs: Guidelines for Excellence. North American Association for Environmental Education. 2000 P Street, NW - Suite 540 Washington, DC 20036, USA.

E. Web Links

1. <http://envfor.nic.in/division/environmental-education-awareness-and-training-eeat>
2. http://www.moef.nic.in/sites/default/files/chap5_0.pdf
3. <http://www.yourarticlelibrary.com/environment/environmental-education-objectives-aims-and-principles-of-environmental-education/39724/>
4. <http://www.yourarticlelibrary.com/environment/organizing-environmental-education-system-formal-and-non-formal-education/28153/>
5. <http://www.yourarticlelibrary.com/essay/environment-essay/how-environmental-awareness-can-be-achieved/39725/>
6. <http://www.yourarticlelibrary.com/speech/importance-of-public-awareness-for-conservation-of-environment-in-india/30187/>
7. <http://www.unep.org/dec/onlinemanual/Enforcement/InstitutionalFrameworks/PublicAwarenessEducation/tabid/99/Default.aspx?page>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Basics of Environmental Education		
1.1	Basics of Environmental Education- Concepts, Principles and Characters of Environmental Education	Recall the concepts of environmental education	K1
1.2	Importance and history of Environmental Education	Recall the history of environmental education	K1
1.3	Global and national environmental organizations	List and analyze the different environmental organizations	K1
Unit II	Methodology of Environmental Education		
2	Methodology of Environmental Education: Forms of Environmental Education – Formal, non-formal; Guidelines of contents for early childhood, higher education, adult and general public; Current practices in India.	Categorize the different forms of education	K4
Unit III	Environmental Awareness		

3	Practice of Environmental Education - Planning, preparation, Implementation and Evaluation of Environmental Awareness for rural school children	Perform Environmental education programs in rural areas	K6
Unit IV	Environmental Awareness for Urban Community		
4	Practice of Environmental Education - Planning, preparation, Implementation and Evaluation of Environmental Awareness for urban school / college	Perform Environmental awareness programs in urban areas	K6
Unit V	Environmental Awareness for General Public		
5	Practice of Environmental Education - Planning, preparation, Implementation and Evaluation of Environmental Awareness for general public	Perform Environmental awareness programs for general public	K6

4. Mapping Scheme (POs, PSOs and COs)

U17ESPS1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H	H	H	H	H	H	M	L	M
CO2	H	H	M	H	H	H	H	H	H	H	M	L	M
CO3	H	H	M	H	H	H	M	M	H	H	M	L	M
CO4	M	M	L	H	H	H	M	M	H	H	M	L	M
CO5	M	M	M	H	H	H	H	H	H	H	M	L	M
CO6	M	M	M	H	H	H	H	H	H	H	M	L	M

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. A. Daisy Caroline Mary

NMEC I - GLOBAL WARMING AND CLIMATE CHANGE

Semester: III

Credits: 2

Course Code: U17ES3E1

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	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 ₂ 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

(6 Hrs.)

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

(6 Hrs.)

Global warming – Trends in temperature changes and in CO₂ and other GHGs. Global Warming Potential of GHGs. Effects of Global Warming – melting polar ice, sea level rise, positive feedback

Unit III Climate Change

(6 Hrs.)

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

Unit IV Global Initiatives

(6 Hrs.)

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 Treaties & Measures

(6 Hrs.)

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, Intergovernmental Panel on Climate Change (IPCC) Climate Change 2001. Third Assessment Report (Volume I), Cambridge University Press, Cambridge,2001.
3. 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. Houghton, J. Global Warming: The Complete Briefing, Cambridge University Press, Cambridge, 2005.
4. 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.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Introduction		
1.1	Introduction to Climate - Role of ozone in environment and its depletion	Describe the role of ozone in the Environment.	K2
		Explain ozone depletion	K2
		Define Greenhouse effect	K1
1.2	Green House Effect and global warming - role of fossil fuels	Describe global warming, causes and impacts	K2
		Explain temperature change and CO ₂ and other GHGs	K2
Unit II	Global Warming		
2.1	Global warming – Trends in temperature changes and in CO ₂ and other GHGs.	Classify the difference between climate change and global warming	K4
		Distinguish between weather and climate	K2
		Explain Global Warming Potential	K2
2.2	GWP of GHGs. Effects of Global Warming – melting polar ice, sea level rise, positive feedback	Explain the causes global warming?	K2
		Explain sea level raising	K2
		Explain impacts of polar ice melting and sea level rise	K2
Unit III	Climate Change		
3.1	Climate change and its socioeconomic and environmental implications (environment, biodiversity, agriculture, land use etc.)	Explain economic impacts of global climate change	K2
		Describe social economic and environmental impacts of climate change	K2
		Explain the international agreements to control global warming	K2
Unit IV	International Initiatives		
4.1	International Initiatives in combating global warming – UN Conferences formation of UNEP, IPCC and UNFCCC, Kyoto Protocol	Describe Kyoto Protocol	K2
		What can be done to combat global warming?	K1
		Describe the role of Ministry of Environment, Forest and Climate change.	K2
4.2	Indian Government's commitment and initiatives – role of Ministry of Environment, Forest and Climate Change.	Recognize various environmental reform initiatives taken in India	K1
		Explain Kyoto Mechanisms	K2

Unit V	Treaties & Measures		
5.1	Kyoto Mechanisms: Emission trading, Clean Development Mechanism,	Describe Clean Development Mechanism	K2
	Joint Implementation. Annex I, Annex II and Annex B countries and their commitments / role; Basket of gases; Lima Call for Climate Action	Explain Annex I, Annex II and Annex B countries and their commitments	K2
		Discuss Lima Call for Climate Action	K2

4. Mapping Scheme (POs, PSOs and COs)

U17ES3E1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	-	-	-	M	-	-	-	H	M	-	L
CO2	H	H	-	M	L	-	M	-	L	H	M	-	-
CO3	H	H	M	-	-	L	-	-	-	H	-	-	L
CO4	H	H	L	L	L	L	-	L	L	H	M	M	L
CO5	H	H	M	L	-	L	L	L	L	H	L	-	L
CO6	H	H	M	L	L	L	L	-	L	H	L	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. R. Teneson

Core IV: ENVIRONMENTAL POLLUTION

Semester: IV
Credits: 4

Code: U17ES404
Hours/Week: 4

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Understand the key chemical transformations of air pollution.	K4	I
CO2	Plan measurement and monitoring of air pollutants	K3	I
CO3	describe the main sources of water pollution, the main types of pollutant and how each type may be controlled	K4	II
CO4	Explain basic principles of pollution transport in soil.	K5	III
CO5	Explain control measures to prevent land pollution	K4	IV
CO6	Describe remedial measures to control noise pollution	K4	V

2. a. Syllabus

Unit I Air pollution

(15 Hrs.)

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; Bhopal Gas disaster; acid rain.

Unit II Water Pollution

(15 Hrs.)

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

Unit III Soil pollution

(10 Hrs.)

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

Unit IV Thermal pollution

(10 Hrs.)

Introduction; sources of thermal pollution – Nuclear power plants, Hydro electrical power plants, coal power plants; Effects of thermal pollution.

Oil pollution – sources and effects – oil pollution and marine biota; Microbial degradation of oil in the sea; flora and fauna – bio indicators to oil spill

Unit V Noise pollution

(10 Hrs.)

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

B. Topics for Self-study

- **Ambient Air Pollution Monitoring**
<https://nptel.ac.in/courses/105/102/105102089/>
- **Eutrophication**
<https://www.nature.com/scitable/knowledge/library/eutrophication-causes-consequences-and-controls-in-aquatic-102364466>
- **Control of soil pollution**
<https://nptel.ac.in/content/storage2/courses/105103025/pdf/pdf4.pdf>
- 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>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Air Pollution		
1.1	Air pollution – Introduction – structure and composition of atmosphere	Recall the structure of Atmosphere	K2
	classification of air pollutants – primary and secondary, particulate and gaseous	Listing out the different type of pollutants	K4
1.2	Sources of air pollution - vehicular pollution;	Identify the specific type of pollutants in Vehicles	K3
1.3	Effects of air pollution on – Man, Plants and Materials	Explain the effects of air pollution on humans and other living and non-living objects	K5

	Greenhouse effect – global warming – ozone depletion; acid rain	Discuss the concepts of greenhouse effect, global warming, ozone depletion and acid rain	K2
	Indian air quality standards.	Compare the pollution level with the national air quality standards	K2
	Bhopal Gas disaster.	Discuss the after effects of the Bhopal gas disaster	K2
Unit II	Water Pollution		
2.1	Water Pollution: Introduction – sources – point and non- point	Recall the different sources of pollution	K1
2.2	Oxygen demanding waste, industrial effluents and domestic sewage and its effects	Estimate the amount or the level of waste generated	K4
	Eutrophication, Bioaccumulation, Bio-magnification	Estimate the level of pollutant in the environment	K4
2.3	Classification: Ground water – Surface water	Explain about the properties of surface and ground water	K3
	Causes of waterborne diseases	Analyze the sources and control measures of water-borne disease	K4
	Water Quality standards	Compare the values with the national water quality standards	K2
	Water treatment (Theory only) – physical, chemical and biological.	Inspect the water for pollutants	K4
2.4	Indian water quality standards.	Recall the standards in India – its existence and characteristics	K1
	Mina Meta disaster	Discuss the after effects of the Mina meta disaster	K2
Unit III	Soil Pollution		
3.1	Soil pollution: Soil texture, structure,	Analyze the physical characteristics of the soil	K4
	Physical, chemical and biological properties	Interpret the physical, chemical and biological properties of soil	K2
3.2	Sources and Effects of soil pollution	Estimate the level of pollutant in the environment	K4
	Pesticides in soil environment and their effects	Interpret the number of pesticides present in the soil as well their impacts	K2
	Biological magnification	Discuss the concept of bio-magnification by which how the pollutants increased through food chain	K2

3.3	Pollution through mining and Control of soil pollution.	Evaluate the effects and suggest remedies for controlling the pollutants in the mining area	K4
Unit IV	Thermal and Oil Pollution		
4.1	Thermal pollution – Introduction; sources of thermal pollution –	Recall various sources of thermal pollution	K1
	Nuclear power plants, Hydro electrical power plants, coal power plants;	List out the different type of pollutants from various industries	K1
4.2	Effects of thermal pollution	Analyze the effects of thermal pollution caused by various industries	K4
4.3	Oil pollution – sources and effects on flora and fauna	Analyze the effects of oil pollution on biological organisms	K4
	Bio indicators to oil spill	Discuss the concept of Bio indicators	K2
Unit V	Noise Pollution		
5.1	Noise pollution: Sources – natural and manmade;	Analyze various sources of thermal pollution	K4
	Characteristics of sound – frequency, intensity	Compare the sound frequency with standards devised by regulatory agencies	K5
5.2	Time of exposure, Intermittence	Infer the sound quality measured in terms of pollution	K2
	Effects of noise pollution – Man and materials	Examine the effects of pollutions on human ear and surrounding	K4

4. Mapping Scheme (POs, PSOs and COs)

U17ES404	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	H	M	M	-	M	-	-	H	H	H	M
CO2	-	-	L	M	M	-	-	M	M	-	M	H	-
CO3	H	L	-	-	-	H	-	M	-	H	-	-	-
CO4	H	-	L	M	H	-	M	-	M	-	M	H	H
CO5	H	-	H	M	M	M	-	L	M	-	L	-	L
CO6	H	H	M	-	L	-	-	-	H	M	H	-	L

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. A. Chandramohan

Core V: ENERGY RESOURCES AND BIOSTATISTICS

Semester: IV
Credits: 4

Course Code: U17ES405
Hours/Week: 4

1. Course Outcomes

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

CO No.	Course Outcomes	K-Level	Unit
CO1	Classify types of energy sources	K2	I
CO2	Explain Renewable energy sources and their types	K2	II
CO3	Define statistics and explain data presentation	K1	III
CO4	Measure of central tendency and dispersion	K3	IV
CO5	Analyze the relationship between variables using coefficient of correlation	K4	IV
CO6	Test the hypothesis (testing of hypothesis) using Z test and t-test	K6	V

2.A. Syllabus

Unit I Energy Resources

(12 Hrs.)

Introduction - Natural Resources – types and classifications (primary/ secondary)- Fundamentals of energy and measurements: Classification –Conventional, Non- conventional energy – Renewable, non – renewable energy - fossil fuels: coal, oil, natural gas – non-fossil fuels: nuclear energy: cosmic origin - isotope of Uranium called U-235 - Indian Energy Scenario – supply, consumption and demand.

Unit II Renewable Energy sources

(12 Hrs.)

Introduction - Alternative Energy Resources -Availability of Resources - Solar energy: radiation measuring instrument - Principle of photovoltaic conversion of solar energy - Application of solar energy - Wind energy: characteristics and measurement -Wind energy conversion principles -Types and classification of WECS - Biomass Energy: Classification of biomass - Physicochemical characteristics of biomass as fuel- Biomass conversion routes - Hydropower: Overview of micro, mini and small hydro system - types of hydro turbine - Ocean Energy: Principle of ocean thermal energy conversion system - Principles of Wave and Tidal energy conversion - Geothermal energy: Origin of geothermal resources - type of geothermal energy deposits - Hydrogen as a source of energy - types of fuel cell - fuel cell system.

Unit III Statistics

(12 Hrs.)

Definition – Functions and Limitations of Statistics – Diagrammatic Representation of Data: Bar diagram – Pie diagram, Graphical representation of Data: Histogram, Frequency Polygon, Frequency Curve, Ogives.

Unit IV Measures of Central Tendency

(12 Hrs.)

Types of Averages – Arithmetic mean, median, mode, Geometric mean. Measures of Dispersion: Range, Standard Deviation and coefficient of variation. Correlation: Karl Pearson coefficient of correlation – Spearman's Rank correlation coefficient

Unit V Hypotheses

(12 Hrs.)

Introduction - Testing of hypothesis – Standard error, Difference between standard deviation and standard error - Tests of significance for attributes (Test for number of successes and test for proportion of successes) Tests of significance for large samples - Testing the difference between means of two samples - Tests of significance for small samples– Student's t distribution – (Test of hypothesis about the population mean and Test of hypothesis about the difference between two means)

D. Reference Books

1. G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.
2. R.K. Rajput, Non-Conventional Energy Sources and Utilisation, S.Chand& Company Ltd., 2012.
3. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFNSpon Ltd., 1986.
4. B.H.Khan, Non-Conventional Energy Resources, Tata McGraw Hill, 2nd Edn, 2009.
5. Bent Sørensen, Renewable Energy Conversion, Transmission and Storage, Elsevier Inc, 2007.
6. Demirel and Yaşar, Energy-Production, Conversion, Storage, Conservation, and Coupling, Springer Link, 2012.
7. S. P. Gupta, Statistical Methods, Sultan Chand & sons, 2009.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Introduction to Energy		
1.1	Energy Resources: Introduction - Natural Resources – types and classifications (primary/ secondary)- Fundamentals of energy and measurements	List the types of energy resources. Recall the fundamentals of energy and its measurements	K1
1.2	Classification –Conventional, Non-conventional energy – Renewable, Non – renewable energy - fossil fuels: coal, oil, natural gas– Non-fossil fuels: nuclear energy: cosmic origin - isotope of Uranium called U-235	Explain the classification of energy resources into renewable and non-renewable resources; Summarize the types of fuels under non-renewable resources	K2
1.3	Indian Energy Scenario – supply, consumption and demand.	Appraise the energy scenario in India based on supply and demand	K5
Unit II	Renewable Energy Sources		
2.1	Renewable Energy sources: Introduction - Alternative Energy Resources -Availability of Resources	Explain the alternative energy resources under renewable energy sources and their availability	K2
2.2	Solar energy: radiation measuring instrument - Principle of photovoltaic conversion of solar energy -Application of solar energy	Demonstrate solar energy and its tapping	K3
2.3	Wind energy: characteristics and measurement -Wind energy conversion principles -Types and classification of WECS	Explain the wind energy and classify the WECS	K2
2.4	Biomass Energy: Classification of biomass - Physicochemical characteristics of biomass as fuel- Biomass conversion routes	Explain biomass energy, their characteristics and routes of conversion; Classify the biomass.	K4

2.5	Hydropower: Overview of micro,mini and small hydro system - types of hydro turbine - Ocean Energy: Principle of ocean thermal energy conversion system - Principles of Wave and Tidal energy conversion - Geothermal energy: Origin of geothermal resources - type of geothermal energy deposits	Explain hydro-power, tidal energy and geothermal energy.	K4
2.6	Hydrogen as a source of energy - types of fuel cell - fuel cell system.	Explain the hydrogen as a source of energy and types of fuel cell	K4
1.1	Introduction of Statistics – Is statistics a science? – Applications of Statistics – Function & Limitations of Statistics	Explain the significance of statistics and its functions and limitations.	K2
Unit III	Statistics		
3.1	Statistics: Definition – Functions and Limitations of Statistics.	Summarize the functions and limitations of statistics	K2
3.2	Diagrammatic Representation of Data: Bar diagram – Pie diagram, Graphical representation of Data: Histogram, Frequency Polygon, Frequency Curve, Ogives.	Construct bar diagram, pie diagram histogram, frequency polygon, frequency curve and ogives to represent the data	K3
Unit IV	Central Tendency, Measures of Dispersion and Correlation		
4.1	Measures of Central Tendency - Types of Averages – Arithmetic mean, median, mode, Geometric mean.	Analyze the data for computation of measures of central tendency	K4
4.2	Measures of Dispersion: Range, Standard Deviation and coefficient of variation	Interpret the data based on measures of dispersion	K6
4.3	Correlation: Karl Pearson coefficient of correlation – Spearman’s Rank correlation coefficient	Calculate correlation and interpret the results	K4
Unit V	Testing of hypothesis		
5.1	Testing of hypothesis – Standard error, Difference between standard deviation and standard error - Tests of significance for attributes (Test for number of successes and test for proportion of successes) Tests of significance for large samples - Testing the difference between means of two samples - Tests of significance for small samples– Student’s t distribution – (Test of hypothesis about the population mean and Test of hypothesis about the difference between two means)	Formulate the hypothesis and test the hypothesis	K5 & K6

4. Mapping Scheme (POs, PSOs and COs)

U17ES405	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	L	-	-	-	-	L	L	L	-	-	-
CO2	H	-	M	L	M	M	M	L	L	L	M	M	M
CO3	H	-	L	L	L	M	L	L	-	L	M	-	-
CO4	H	-	M	M	L	M	L	-	-	L	H	-	-
CO5	H	H	M	-	M	M	L	-	L	H	H	-	-
CO6	H	H	H	L	L	M	L	M	L	M	H	-	-

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. C. Ravichandran

Allied IV: CHEMISTRY FOR ENVIRONMENTALISTS

Semester: IV
Credits: 3

Course Code: U19ESCY4
Hours/Week: 3

1. Course outcomes:

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

CO No.	Course Outcomes	Level	Unit
CO1	Analyze the constituents of atmosphere and chemistry of various atmospheric reactions	K4	I
CO2	Apply the concepts of water quality parameters and treatment processes	K3	II
CO3	Identify the types of errors in experimental data	K2	III
CO4	Apply the principles of volumetric estimation	K3	IV
CO5	Explain principles of chromatographic and colorimetric techniques	K2	IV
CO6	Illustrate the mechanism of organic reactions	K3	V

2.A. Syllabus

Unit I Chemistry of Atmosphere

(12 Hrs.)

1.1-Chemical constituents of the atmosphere; oxygen in the atmosphere-atomic oxygen, molecular oxygen and ozone and their chemical reactions in atmosphere, Ozone-oxygen cycle in stratosphere-photochemical reactions in ozone layer.

2.2-Nitrogen and its compound in atmosphere - their sources and reactions, Photochemical reaction, O₃ in troposphere, Inorganic carbon compounds- CO, CO₂ and their sources and reactions, Hydrocarbons in Atmosphere, Water vapor – hydroxyl radical formation and their reactions.

Unit II Chemistry of Water

(12 Hrs.)

2.1 Water as a universal solvent-hardness of water- permanent and temporary hardness, disadvantages of hard water- DO, BOD and COD -definition, Methods of determination (any one method).

2.2 Water Softening methods - Zeolite process, Reverse Osmosis.

2.3 Preparation of De-ionized water- Distilled water-Double Distilled water-Packaged drinking water.

Unit III Basics of Quantitative Analysis

(12 Hrs.)

3.1. Error analysis: accuracy, precision, determinate and indeterminate errors, relative error, absolute error.

3.2. Quantitative analysis: Titrimetry- principle, acid-base titrations and redox titrations with examples -End point and equivalence point.

3.3. Theory of Indicators- Types of indicators - Quinonoid theory.

Unit IV Analytical Techniques

(12 Hrs.)

4.1 Chromatography-introduction-principle, sampling and applications of paper, thin layer and column chromatography.

4.2 Photochemistry: Laws of Photochemistry, components of a colorimeter (Block diagram), application (estimation of iron).

4.3Purification methods – Steam distillation, Vacuum Distillation, Fractional Distillation, Solvent extraction, Crystallization and Sublimation.

Unit V Industrial Chemistry

(12 Hrs.)

5.1- Synthetic Polymers: Preparation, Properties and uses of Teflon, Polyester, Nylon-66 PVC, Polyethylene.

5.2 – Halogen containing compounds: Preparation and uses of Freons, CH₂Cl₂, CHCl₃, CCl₄, Pesticides- DDT, BHC- Preparation and uses.

5.3- Fuel gases: Water gas, Producer gas, LPG, Gobar gas, Natural Gas- Manufacture and uses.

5.4- Cosmetics: Basic ingredients, Additives and fragrances used in Soaps, Toothpaste, Lipstick, Perfumes, Deodorants and Antiperspirants. Basic tests for identification of good and bad cosmetics-pH test.

B. Topic for Self-Study

- **Atmosphere**
(<http://www.uvm.edu/~gpetrucc/courses/chem196/lectures/Chemistry%20of%20the%20Atmosphere.pdf>)
- **Water Chemistry:**
(https://www.cusd80.com/cms/lib/AZ01001175/Centricity/Domain/586/Lecture_Water.pdf)
- **Polymer Chemistry**
(<https://www.ch.ntu.edu.tw/~sfcheng/HTML/material94/Polymer-1.pdf>)
- **Analytical Techniques** (<https://www.lucideon.com/testing-characterization/analytical-techniques-chemical-analysis>)

C. Text Books

1. Tiwari K.S., Melhotra S.N., Vishnoi N.K, A Text book of Organic Chemistry, Vikas Publishing House Pvt. Ltd., New Delhi, 2006 (Unit-I, V).
2. R. Gopalan, P. S. Subramanian and K. Rengarajan, Elements of Analytical Chemistry, Sultan Chand and Sons, New Delhi, 1997(Unit- IV).
3. Puri B.R., Sharma L. R., Kalia K.K, Principles of Inorganic Chemistry-23rd edition, New Delhi, Shoban Lal Nagin Chand & Co, 1993(Unit- I, III).
4. Puri B.R., Sharma L. R., Kalia K.K, Principles of physical Chemistry, 23rd edition, New Delhi, Shoban Lal Nagin Chand & Co, 1993(Unit-II).

D. Reference Books

1. R.T. Morrison & R.N. Boyd, Study Guide to Organic Chemistry, Prentice Hall, New Delhi, 2000.
2. R.L. Madan and G.D. Tuli, Inorganic Chemistry, S. Chand Co., Ltd., New Delhi, 2003
3. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House, Meerut, 2000.

E. Web Links

1. <https://www2.acom.ucar.edu/sites/default/files/ua/lecture1.pdf>
2. <https://dnr.mo.gov/env/wpp/vmqmp/docs/chpt-07-intro-water-chemistry-1-09.pdf>
3. <http://www.uvm.edu/~gpetrucc/courses/chem196/Textbooks/Manahan%20-%20Fundamentals%20of%20Environmental%20Chemistry/1491Ch25.pdf>

3. Specific Learning Outcomes

Unit	Course Contents	Learning Outcomes	Blooms Taxonomic levels of Transaction
Unit I Chemistry of Atmosphere			
1.1	Chemical constituents of atmosphere.	Discuss the chemical constituents of atmosphere	K2
1.2	Oxygen in the atmosphere Atomic oxygen, molecular oxygen & ozone and their reactions in atmosphere Ozone- oxygen cycle in the stratosphere Photochemical reactions in ozone layer	Explain the oxygen content and its reactions in atmosphere, ozone layer cycle and its photochemical reactions	K4
1.3	Nitrogen and its compound in Atmosphere-Sources & reactions of N and its compound in atmosphere. Photochemical reactions Ozone in troposphere	Summarize the nitrogenous compounds in atmosphere, and its Photochemical reaction in troposphere.	K2
1.4	Inorganic compounds – CO & CO ₂ sources and their reactions Hydrocarbons in atmosphere Water vapour – Hydroxy radical formations and their reactions	Discuss about the inorganic compounds, hydrocarbons, formation and reaction of water vapour and hydroxy radical, in atmosphere.	K2
Unit II Chemistry of Water			
2.1	Water as a universal solvent.	Describe the importance of water in everyday life	K2
2.1	Hardness of water – permanent & temporary Disadvantage of hard water Definition & determination of DO, BOD and COD	Explain the hardness, DO, BOD and COD in water.	K3
2.2	Water softening method – zeolite process and reverse osmosis	Explain the various water softening methods.	K3
2.3	Preparation of De-ionized water, Distilled water, Double distilled water and Packaged drinking water.	Describe the methods preparation of de-ionized, distilled and double distilled water.	K2
Unit III Basics of Quantitative Analysis			
3.1	Accuracy and precision of error analysis, Determinate and indeterminate errors, Relative and absolute error	Interpret the various types of errors with reasons in an experimental data.	K2
3.2	Quantitative analysis using titrimetry and its principle Acid base titration, Redox titrations – example End points and equivalent points	Illustrate the principles behind the various kind of titrations.	K3

3.3	Theory of indicators Types of indicators Quinonoid theory	Select indicators based on Quinonoid theory	K2
Unit IV Analytical Techniques			
4.1	Chromatography – principle, procedure, sampling	Outline the principles involved in chromatographic separations.	K2
4.1	Thin Layer, paper and column Chromatography – principle, procedure & applications	Explain the methodology of TLC, PC and Colum chromatography	K2
4.2	Colorimeter – Principle – Beer Lambert’s law Components of colorimeter Applications of colorimeter – Iron estimation	Describe the colorimetric procedure to find the strength of iron in a given solution.	K2
Unit V Industrial Chemistry			
5.1	Types of chemical reactions Substitution reaction – Nucleophilic & Electrophilic	Explain the electrophilic and nucleophilic substitutions along with mechanism	K3
5.1	Addition of HBr on Alkenes	Apply the mechanistic pathway for addition reaction to alkenes	K3
5.1	Elimination reaction – Dehalogenation of Alkyl Halides	Apply the mechanistic pathway for Dehalogenation of alkyl halides	K3
5.1	Condensation – Formation of Ester	Explain the condensation reaction with an example	K2
5.1	Polymerization – Formation of poly vinyl chloride	Describe the preparation method of PVC	K2
5.1	Reduction – Hydrogenation of oil Oxidation- KMnO ₄ for conversion of benzaldehyde to benzoic acid	Write the mechanism of oxidation and reduction reactions.	K2
5.2	Types of intermediates – Electrophiles, Nucleophiles and Free radicals	Classify the reaction intermediates and their role in reaction mechanisms.	K2

4. Mapping Scheme (POs, PSOs and COs)

U19ESCY4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	M	H	L	M	L	M	-	H	H	H	-	-
CO2	H	M	H	M	H	M	M	M	M	H	H	H	H
CO3	L	L	L	M	L	M	-	-	-	-	-	-	-
CO4	M	M	H	H	H	H	M	-	-	M	H	M	-
CO5	M	-	M	M	L	L	-	-	L	M	M	-	-
CO6	L	L	-	-	-	-	-	-	-	-	-	-	-

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Mr. J. Thangarathinam

Allied Practical III: Allied Chemistry Practicals

Semester: IV
Credits: 3

Course Code: U19ESCP3
Hours/Week: 3

1. Course Outcomes:

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

CO No.	Course Outcomes	Level
CO1	Relate the basic principles and types of volumetric analysis.	K2
CO2	Infer the redox reaction concept.	K3
CO3	Estimate the strength of the given solution.	K3
CO4	Apply complexation concept to check water quality	K3
CO5	Identify organic compounds and quantifying.	K5
CO6	Classify the primary standard solutions and to prepare standard solutions in different concentration units.	K3

2.A. Syllabus

I. Preparation of standard solution (Molar, ppm & Normal) & basic principles of organic analysis

A. Volumetric Analysis

- Estimation of hydrochloric acid (Acidimetry and Alkalimetry)
- Estimation of sodium hydroxide (Acidimetry and Alkalimetry)
- Estimation of oxalic acid using KMnO_4 (Permanganometry)
- Estimation of ferrous sulphate KMnO_4 (Permanganometry)

II. Organic Analysis: Analysis of organic compounds

(Carbohydrate, Diamide, Aldehyde, Ketone and Carboxylic Acid) with the following tests for,

- Aromatic/ Aliphatic nature,
- Saturation / unsaturation
- Solubility in common solvents and
- Presence of nitrogen

Text Book

Venkateswaran, R. Veerasamy, A.R. Kulandaivelu, Basic Principles of Practical, Chemistry, Sultan Chand & Sons, New Delhi, 1997

Web link:

- <http://www.ecs.umass.edu/cee/reckhow/courses/572/572bk16/572BK16.html>
- https://www.csub.edu/chemistry/organic/manual/Lab14_QualitativeAnalysis.pdf

Self-Study Topics:

- <https://www.aplustopper.com/prepare-standard-solution/>
- http://wwwchem.uwimona.edu.jm/lab_manuals/c10expt25.html

Specific Learning Outcomes:

S. No.	Course Content	Learning Out Comes	Blooms Taxonomic levels of Transaction
Volumetric Analysis			
1	Preparation of standard solution (Molar, ppm & Normal)	To relate the basic principles and types of volumetric analysis. To classify primary standard substances To prepare standard solutions in different concentration units.	K2 K3 K3
2.	Estimation of Hydrochloric acid	To estimate the acid base neutralization reaction. To select indicators for acid base titration with different pH value.	K3
3	Estimation of Sodium Hydroxide	To estimate the acid base neutralization reaction. To select indicators for acid base titration with different pH value.	K3
4	Estimation of oxalic acid using KMnO_4	To infer the redox reaction concept.	K3
5	Estimation of ferrous sulphate using KMnO_4	To estimate the strength of the given Oxalic acid/ FeSO_4 solution.	K3
Organic Analysis			
6	Analysis of organic compounds (Carbohydrate, Diamide, Aldehyde, Ketone and Carboxylic Acid) with the following tests for (i)Aromatic/ Aliphatic nature, (ii)Saturation/ unsaturation (iii)Solubility in common solvents (iv)Presence of nitrogen	To infer aromatic substitution reaction To relate addition reaction to saturation test. To analyse unknown samples systematically and report the same	K3 K3 K5

4. Mapping Scheme (POs, PSOs and COs) U19ESCP3

U19ESCP3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
CO1	H	-	M	-	M	M	L	M	-	H	H	H
CO2	M	-	M	-	M	M	L	M	-	H	M	M
CO3	M	-	M	-	M	M	L	M	-	H	H	H
CO4	H	M	M	L	M	L	L	M	-	H	H	H
CO5	M	-	M	-	H	M	L	-	-	H	H	-
CO6	M	-	M	-	-	L	L	M	-	H	H	H

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. End-semester Examinations (ESE)
3. Reports, Observation Register, Record Note Books and Viva-voce

Indirect

1. Overall performance assessment, Discussions and co-curricular activities

Course Coordinator: Dr. T. Nalini

Practice School – IV: INDUSTRIAL PRACTICE SCHOOL

Semester IV
Credits: 2

Code: U17ES4F4
Hours/Week: 2

1. Course Outcomes

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

CO	Outcomes	K-level	Unit
CO1	List the various types of industries, GOs, NGOs and centers	K1	I
CO2	Explain the profile of organizational, administrative and environmental stations	K2	II
CO3	Examine the materials of production, processing and management facilities of industries	K4	III
CO4	Plan the environmental management system to be established	K3	III
CO5	Develop the OHS in the industries	K6	IV
CO6	Compile the Industrial Practice School Report	K6	V

Duration: (Minimum duration of 15 days in any one of the IPS stations mentioned below).

2.A. Syllabus

Unit I Industrial Practice School (IPS):

Types of IPS – Stations

Textile processing, Dyeing and Bleaching units

Drinking water applications: Water softening/DM plants

Common Waste Management Facility: Wastewater/Solid waste/Biomedical waste

Environmental Consultant Organizations: GOs/ NGOs

Ecology and Biodiversity Centres

Unit II Profile of the IPS stations

Organizational setup/Administrative structure

Environmental setting of the station

Material production and processing in Industries/waste management facilities

Unit III Environmental Management System in IPS stations

Environmental Management Policy of the organization

Environmental Compliance

ISO 140001 and 18001 Certification

Environmental Resource Auditing in industries

Waste management practices: Wastewater and Solid waste

Unit IV Occupational health and safety in industries

Occupational Health and Safety: Occupational health and hazards – physical –chemical – biological hazards, Occupational disease s-prevention and control, Health protection measures for workers – health education – medical first-aid. Management of medical emergencies, Personal protective equipments OSHAS compliance,

Unit V IPS Report:

The Narrative should contain information on the following topics:

ACTIVITY DESCRIPTION

What projects where you assigned?

What were the objectives of these projects?

What were your project responsibilities?

What problems did you encounter?

How did you solve these problems?

What did you do to complete your responsibilities?

ANALYSIS

What did you learn?

How did the projects and responsibilities relate to theory learned in the classroom?

How will this assignment help in achieving your long-term career goals?

How might you have improved your performance?

B. Topics for Self-study

- <https://www.scribd.com/doc/296118182/Chemical-Process-Industries-5th-Ed-Shreve-s-pdf>
- <https://www.worldcat.org/title/pollution-control-in-process-industries/oclc/59045547>
- <https://kuliahdianmardi.files.wordpress.com/2016/03/human-factors-and-ergonomics-national-safety-council-handbook-of-occupational-safety-and-health-national-safety-council-crc-press-2010.pdf>
- <https://www.amazon.com/Complete-Guide-OSHA-Compliance/dp/0873716817>

C. Text Books

1. Austin GT, Shreves, **Chemical processes in industries**, McGraw Hill Book Co., New York, 1977.
2. Mahajan SP, **Pollution Control in process industries**, Tata McGraw Hill Co. Ltd., New Delhi, 1986.
3. Diberardinis LJ, **Handbook of Occupational Safety and Health**, John Wiley, New York, 1998.

D. Reference Books:

1. Peterson RD and Cohen JJ, **The complete guide to OSHA Compliance**, Lewis publishers, New York, 1997

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Industrial Practice School (IPS):			
1.1	Types of IPS – Stations Textile processing, Dyeing and Bleaching units; Drinking water applications: Water softening/DM plants; Common Waste Management Facility: Wastewater/Solid waste/Biomedical waste ; Environmental Consultant Organizations: GOs/ NGOs. Ecology and Biodiversity Centres	Recall Types of IPS – Stations	K1
		Illustrate the various industrial manufacturing & treatment processing units; Environmental Organizations & Centres	K2
Unit II Profile of the IPS stations			
2.1	Organizational setup/Administrative structure; Environmental setting of the station, Material production and processing in Industries/waste management facilities	Demonstrate the various Organizational setup/Administrative structure; Environmental setting of the station	K3
		Explain the material production and processing in Industries/waste management facilities	K2

Unit III		Environmental Management System in IPS stations	
3.1	Environmental Management Policy of the organization, Environmental Compliance; ISO 140001 and 18001 Certification; Environmental Resource Auditing in industries; Waste management practices: Wastewater and Solid waste	Explain the various environmental management system	K2
		Formulate environmental resource auditing in industries;	K6
		Illustrate waste management practices: Wastewater and Solid waste	K2
Unit IV		Occupational health and safety in industries	
4.1	Occupational Health and Safety: Occupational health and hazards – physical –chemical – biological hazards, Occupational disease s- prevention and control, Health protection measures for workers – health education – medical first-aid. Management of medical emergencies, Personal protective equipments OSHAS compliance,	Recommend Occupational Health and Safety with reference to the health hazards	K5
		Illustrate medical first-aid, Management of medical emergencies and PPE,	K2
		Adopt OSHAS compliance,	K6
Unit V		IPS Report::	
5.1	The Narrative should contain the information about the activity; description and analysis	Compile a IPS report	K6

4. Mapping Scheme (POs, PSOs and COs)

U17ES4F4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	-	-	M	L	-	M	M	M	M	-	M	H	H
CO2	-	-	M	L	L	M	M	M	M	L	M	H	H
CO3	-	-	-	-	-	L	M	M	L	-	M	M	H
CO4	L	-	M	L	M	M	M	M	M	L	M	M	H
CO5	L	-	M	L	L	L	L	M	H	L	H	H	H
CO6	L	-	M	L	M	M	M	M	H	L	M	H	H

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Ms. D. Udhaya Banu

NMEC II: ENVIRONMENTAL SAFETY, HEALTH AND MANAGEMENT

Semester: IV
Credits: 2

Code: U17ES4E2
Hours/Week: 2

1. Course Outcomes

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

CO	Course Outcomes	K-level	Unit
CO1	Compare the communicable disease and management of public hygiene.	K2	I
CO2	Relate the occupational health and Its hazards.	K3	II
CO3	Match the Occupational diseases and its prevention, control.	K5	III
CO4	Evaluate the Industrial Safety & Management System	K5	III & IV
CO5	Discuss on Industrial Safety Standards and Regulations	K2	IV
CO6	Discuss the Accident, Prevention & Its Control strategies	K2	V

2.A. Syllabus

UNIT I Introduction

(6 Hrs.)

Definition- need for good health- factors affecting health, Types of diseases (deficiency, infection, pollution diseases).

UNIT II Personnel Safety

(6 Hrs.)

Personal hygiene food (balanced diet): Food habits & cleanliness, food adulterants, avoiding smoking, drugs & alcohols.

UNIT III Public Health

(6 Hrs.)

Communicable diseases, mode of transmission (epidemic and endemic diseases).
Management of hygiene in public places (railway stations, bus stands and other public places).

UNIT IV Occupational Health and Safety

(6 Hrs.)

Occupational health and safety: Occupational health and hazards-physical-chemical and biological; Occupational diseases - prevention and control.

UNIT V Industrial Safety

(6 Hrs.)

Industrial safety and management techniques: Industrial safety standards and regulations; Accidents- definitions-prevention and control.

B. Topics for Self-study

- **Residential Safety** (<https://www.bu.edu/ehs/ehs-topics/dormitory-safety/>)
- **Hazard Communication** (<https://www.bu.edu/ehs/ehs-topics/hazard-communication/>)
- **Fire Safety** (<https://www.bu.edu/ehs/ehs-topics/hazard-communication/>)
- **Biological Safety** (<https://www.bu.edu/ehs/ehs-topics/hazard-communication/>)

C. Text Books

1. Sandra. S. C. Environmental Science. New Central Book Agency Publisher, Kolkata,2001.
2. Diberardins L.J. Hand Book of Occupational Safety and Health. John Willey, New York,1998.

D. Reference Books

1. Scoot, R. M. Basic Concepts of Industrial Hygiene. Lewis Publisher, NewYork,1997
2. Park, K. Park's Text Book of Preventive and Social Medicine. Bhanot Publisher,2005.
3. Schilling, R.S.E. Occupational Health Practice. Buffer Worth, London, 1973

4. Khan M.A.O., John. P and Bederka. S. Survival in Toxic Environment. Academic Press, New York, 1974.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Introduction			
1.1	Definition- Need for good health; Factors affecting health and Types of disease	Identify the need for good health and learn the factors affecting health and Identify the types of disease.	K3
Unit II Personnel Safety			
2.1	Personal hygiene food (balanced diet): Food habits & cleanliness, food adulterants, avoiding smoking, drugs & alcohols.	Identify the Food habits, Cleanliness and Food adulterants and able to list out the unwanted food habitats and avoid smoking drugs and alcohols	K3
Unit III Public Health			
3.1	Public health: communicable diseases, mode of transmission (epidemic and endemic diseases). Management of hygiene in public places (railway stations, bus stands and other public places).	Recognize the communicable diseases & its mode of transmission. Assess the management of hygiene in public places.	K5
Unit IV Occupational Health and Safety			
4.1	Occupational health and safety: Occupational health and hazards physical, chemical and biological; Occupational diseases – prevention and control.	Identify the hazards in the occupational health and safety.	K3
Unit V Industrial Safety			
5.1	Industrial safety and management techniques: Industrial safety standards and regulations; Accidents- definitions- prevention and control.	Apply the skill in the safety management technique and be able to compile all the data and prepare a report for the Industrial standards and regulations.	K6

4. Mapping Scheme (POs, PSOs and COs) U20ES4E2

U17ES4E2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	-	-	-	-	M-	-	H	M	-	L
CO2	H	M	-	H	L	-	-	L	L	H	M	-	-
CO3	H	H	M	-	-	M	-	-	-	H	-	-	M
CO4	H	M	L	L	M	L	-	H	L	H	M	M	L
CO5	H	H	M	L	-	L	M	L	L	H	L	-	M
CO6	H	H	M	L	M	L	M	-	L	H	L	-	H

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. M. Sheela Mary

Core VI: CONSERVATION BIOLOGY

Semester: V
Credits: 5

Code: U17ES506
Hours/Week: 5

1. Course Outcomes

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

CO	Course Outcomes	K-level	Unit
CO1	Illustrate and classify various biodiversity regimes at various levels of approaches	K2	I
CO2	Recognise the significant values and threats to biodiversity	K1	II
CO3	Evaluate threats and decide the levels of conservation approaches	K3	III
CO4	Adapt suitable conservation measure in specific animal or plant conservation	K6	III
CO5	Administer the threats to biodiversity with the aid of legislation and policies	K3	IV
CO6	Evaluate the biodiversity using various quantitative and qualitative indices	K5	V

2.A. Syllabus

Unit I Biodiversity:

(15 Hrs.)

Introduction, Concept and definition, Levels of biodiversity - genetic - species - ecosystem biodiversity; Biodiversity at Global, National and local levels; the mega-diversity countries of the world; Hot spots of biodiversity; Bio geographical classification of India.

Unit II Importance and value of biodiversity:

(15 Hrs.)

consumptive use - productive use - social- ethical -aesthetic and option values; Threats to Biodiversity-Habitat loss, Invasive species, population pollution and poaching of wild life; IUCN categories - Red Data Book; Endangered and endemic species of India.

Unit III Strategies of Conservation:

(15 Hrs.)

In-situ conservation-protected Areas-National parks, Wildlife sanctuaries, Biosphere reserves, Strategic Species approach - key stone species, indicator species, flagship species, umbrella species. Ex-situ Conservation-Botanical gardens, zoos, aquaria, Gene banks, Seed banks, Arboretum, Inter specific pregnancy.

Unit IV Policies and Laws pertaining to Biodiversity conservation:

(15 Hrs.)

Salient features of - National Forest Policy 1988; Wildlife Protection Act 1972; Forest Conservation Act, 1980, Biodiversity Act 2002; Convention on Biological Diversity (CBD). Concept and importance of traditional knowledge and sacred groves.

Unit V Measurement of Biodiversity:

(15 Hrs.)

Quantitative Sampling methods in Ecology: Vegetation sampling - Transect, Quadrat, point; Sampling phytoplankton, Sampling animal populations - True census, Sampling Estimates, Indices. Diversity indices: Species diversity - Density, Frequency, Relative Frequency, Richness, Abundance, Evenness - Simpson Index- Shannon Wiener Index- Alpha, Beta and Gamma Diversity.

B. Topics for Self-study

- **Documentation and Measurement of Biodiversity** (<https://www.nina.no/archive/nina/PPPBasePdf/utredning/050.pdf>)
- **people biodiversity register** (<https://mpsbb.nic.in/pbr/PBR%20Manual%20and%20Format%20-%20English.pdf>)
- **Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating'** (<https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/>)
- **EnviroAtlas Benefit Category** (<https://www.epa.gov/enviroatlas/enviroatlas-benefit-category-biodiversity-conservation>)

C. Text Books

1. Misra S.P, Pandey S.N, Essential Environmental Studies, Ane Books Pvt. Ltd, Chennai, 2009.
2. Erach Bharucha, Text Book of Environmental Studies, Orient Longman Pvt. Ltd., Ernakulam, 2005.
3. Sharma, P.D, Ecology and Environment, Rastogi Publications, New Delhi, 1998.
4. Purohit, S.S, Shammi, J, and Agarwal, A.K, Environmental Science: A new approach, Jodhpur Agrobios Publisher, Jodhpur, 2012.
5. Asthana D. K. and Meera Asthana, A Text Book of Environmental Studies, S. Chand & Co, New Delhi, 2004.
- 6.

D. Reference Books:

1. Chapman J. L. and Reiss M., Ecology: Principles and Applications, Cambridge University Press, U.K. 1993.
2. Maiti, S.K, Handbook of Methods in Environmental Studies, Vol. 1 & 2, Oxford Book Company Publishers, Jaipur, 2011.
3. Trivedy R. K. and Goel P.K., Practical Methods in Ecology and Environmental Science, Enviro Media Publications, 1987.
4. Brian Groombridge and Martin D. J, World Atlas of Biodiversity Earth's Living Resources in the 21st Century, University of California Press, Los Angeles, US, 2010.
5. Sabbins, F.F, Remote Sensing: Principles and Interpretation, 2nd edition, Freeman and Company, New York, 1987.
6. Verma, P.S and Agarwal, V.K, Environmental Biology, S. Chand Publishing, New Delhi, 2012.
7. Menon, A.R.R, Remote Sensing and GIS, KFRI Publications, KFRI, Peechi, Thrissur, 2006.

E. Web Links

1. <http://www.tiem.utk.edu/~gross/bioed/bealsmodules/shannonDI.html>
2. <https://www.jstor.org/stable/25475140>
3. <http://nbaindia.org/content/25/19/1/act.html>
4. <https://www.downtoearth.org.in/blog/wildlife-biodiversity/biodiversity-governance-the-agreements-and-laws-that-help-enforce-it-72094>
5. http://www.wiienviis.nic.in/Database/Protected_Area_854.aspx

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Biodiversity			
1.1	Introduction, Concept and definition,	Describe the concept of biodiversity	K2
1.2	Levels of biodiversity - genetic – species - ecosystem biodiversity;	Classify different levels of biodiversity	K2
1.3	Biodiversity at Global, National and local levels;	Evaluate the status of biodiversity at various levels	K5
1.4	the mega-diversity countries of the world;	Explain the concept of mega-biodiversity	K2
1.5	Hot spots of biodiversity;	Indicate the geographical significance of biodiversity	K2
1.6	Bio geographical classification of India.		
Unit II Importance and value of biodiversity			
2.1	consumptive use - productive use – social- ethical -aesthetic and option values;	Demonstrate various levels of biodiversity	K3
2.2	Threats to biodiversity-Habitat loss, Invasive species, population pollution and poaching of wild life	Evaluate the threats to biodiversity	K5
2.3	IUCN categories - Red Data Book	Identify and categorize threat to biodiversity	K2
2.4	Endangered and endemic species of India.		
Unit III Strategies of Conservation			
3.1	In-situ conservation–protected areas-National parks, Wildlife sanctuaries, Biosphere reserves,	Explain the significance of in-situ conservation	K2
3.2	Strategic Species approach - key stone species, indicator species, flagship species, umbrella species.	Determine species level significance of an ecosystem	K3
3.3	Ex-situ conservation-Botanical gardens, zoos, aquaria, Gene banks, Seed banks, Arboretum,	Explain the significance of ex-situ conservation	K2
3.4	Inter specific pregnancy.	Appraise the need for Interspecific pregnancy.	K5
Unit IV Policies and Laws pertaining to Biodiversity conservation			
4.1	Salient features of – National Forest Policy 1988; Wildlife Protection Act 1972; Forest Conservation Act, 1980, Biodiversity Act 2002;	Administer the biodiversity threats with suitable legislative measures	K3
4.2	Convention on Biological Diversity (CBD).	Restate the significance of convention of biodiversity	K2
4.3	Concept and importance of traditional knowledge and sacred groves	Demonstrate the concept of sacred groves	K2

Unit V	Measurement of Biodiversity		
5.1	Quantitative Sampling methods in Ecology: Vegetation sampling - Transect, Quadrat, point;	Assess the floral biodiversity by quantitative measures	K5
5.2	Sampling phytoplankton, Sampling animal populations	Assess the faunal biodiversity by quantitative measures	K5
5.3	True census, Sampling Estimates, Indices.	Facilitate and analyse the biodiversity assessment through census programs	K6
5.4	Diversity indices: Species diversity - Density, Frequency, Relative Frequency, Richness, Abundance, Evenness	Assess biodiversity using various parameters	K5
5.5	Simpson Index- Shannon Wiener Index-	Estimate various indices related to biodiversity assessment	K4
5.6	Alpha, Beta and Gamma Diversity.	Compare biodiversity of different ecosystems at various geographic levels	K5

4. Mapping Scheme (POs, PSOs and COs) U17ES506

U17ES506	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	L	-	L	L	L	-	-	-	M	L	-	M
CO2	M	M	M	L	L	L	-	L	H	M	M	-	M
CO3	L	L	L	L	M	M	L	L	M	M	M	-	H
CO4	M	M	M	L	M	M	-	L	M	M	M	-	M
CO5	-	-	-	-	-	L	L	M	M	L	L	-	H
CO6	M	M	M	M	H	L	L	-	-	L	M	-	H

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. R. Carlton

Core VII: FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING

Semester: V
Credits: 4

Course Code: U17ES507
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	Identify the sources and quantity of surface and ground water bodies and their demand for the public distribution	K3	I
CO2	Define and explain the significance of terms and parameters frequently used in water supply engineering and wastewater management.	K2	II
CO3	Evaluate the influence of the different parameter in design and treatment of water treatment plant (water quality parameters) and wastewater treatment plant (wastewater characteristics)	K5	III
CO4	Analyse various physical chemical unit processes in Industries.	K4	I-III
CO5	Identify air pollution problems and interpret criteria air quality data	K3	IV
CO6	Recognize various environmental transformation processes of pollutants under extreme weather condition.	K4	V

2.A. Syllabus

Unit I (Description with Diagram only)

(15Hrs.)

Water supply Schemes and Water requirement: Objectives of public water supply schemes–planning–Quantity of water–water requirements–continuous and intermittent supply–waterdemand–variationsinrateofdemand–itseffectondesign–designperiod–population growth and forecast–estimating the quantity of water required, Water distribution systems.

Unit II (Description with Diagram only)

(15Hrs.)

Purification of Water – Natural and Engineered systems of water purification: Treatment of water-working principles of all the unit process of water treatment, Purpose and its design–screening–plains edimentation–coagulationsedimentation–filtration–disinfection–water softening and Desalination–Operation & Maintenance aspects of all the unit process.

Unit III (Description with Diagram only)

(15Hrs.)

Wastewater treatment and disposal: Wastewater sources and flow rates; analysis of constituent mass loading, calculation of mass loading. Mass balance analysis - Principles, design and applications of unit operations and processes – Physical, chemical and biological. Lay out of Wastewater treatment plants.

Unit IV (Description with Diagram only)

(15Hrs.)

Air pollution control: Control of particulates, Settling chamber, Cyclone, Fabric filter, Scrubber.

Unit V (Description with Diagram only)

(15Hrs.)

Air pollution control: Control of gaseous contaminants – Adsorption and absorption techniques, Condensation and combustion techniques.

C. Text books

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2001
2. Punmia B.C, Arun K. Jain, Ashok K. Jain, "Water supply Engineering" Lakshmi publication private limited, NewDelhi, 1998.
3. Birdie. G.S., "Water Supply and Sanitary engineering", Dhanpat Rai andsons, 1991.
4. Duggal. K.N., "Elements of public Health Engineering", S. Chand and Company Ltd, New Delhi, 1998.
5. Mark J. Hammer & Mark J. Hammer Jr., "Water and Waste Water Technology", Prentice Hall of India Pvt. Ltd., New Delhi, 2008.

D. Reference Books

1. Fair. G.M., Geyer. J.C., "Water Supply and Waste Water Disposal", John Wiley and Sons, 1954.

E. Web Link

1. https://books.google.co.in/books?id=MHqMdCqN_58C&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit 1			
1.1	Water supply Schemes and Water requirement: Objectives of public water supply schemes. Water distribution systems.	Select or construct appropriate treatment schemes to remove certain pollutants present in water or wastewater.	K1
Unit 2			
2.1	Purification of Water – Natural and Engineered systems of water purification: Operation & Maintenance aspects of all the unit process.	Select Operation & Maintenance aspects of all the unit process.	K3
Unit 3			
3.1	Wastewater treatment and disposal: Lay out of Wastewater treatment plants.	Design a water or wastewater treatment component. Learn how to characterize wastewater, and the best available technology (BAT) for physical, chemical and microbiological treatment of wastewater.	K6
Unit 4			
4.1	Air pollution control: Control of particulates. Control of particulates, Settling chamber, Cyclone, Fabric filter, Scrubber.	Analyze the fundamentals of air pollution and its associated environmental impacts.	K4
Unit 5			
5.1	Air pollution control: Control of gaseous contaminants. Adsorption and absorption techniques, Condensation and combustion techniques.	Earn to describe the key concepts of air quality management.	K5

4. Mapping Scheme (POs, PSOs and COs)

U17ES507	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	M	H	H	-	L	M	L	-	-	L
CO2	H	M	-	H	-	H	-	-	-	H	M	H	-
CO3	-	H	-	M	-	M	-	L	-	-	L	H	-
CO4	H	H	-	H	-	M	-	L	-	-	M	H	-
CO5	M	H	M	H	H	H	-	-	M	M	M	-	L
CO6	H	H	M	M	-	M	-	-	L	-	-	M	-

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. C. Ravichandran

Core Practical III: WATER POLLUTION LAB

Semester: V
Credits: 3

Course Code: U17ES5P3
Hours/Week: 4

1. Course Outcomes

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

CO No.	Course Outcome	K-Level	Experiments
CO1	Find the water pollution related problems	K1	1-15
CO2	Analyze the water samples with the various physico-chemical parameters	K1	
CO3	Classify 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

1. Estimation of pH - pH metric method **(2 Hrs.)**
2. Estimation of EC – Conductivity method **(2 Hrs.)**
3. Estimation of Turbidity –Nephelometric method **(2 Hrs.)**
4. Estimation of Total Dissolved Solids (TDS)- Gravimetric and Filtration method **(4 Hrs.)**
5. Estimation of Dissolved Oxygen- (DO) - Winkler's method **(3 Hrs.)**
6. Estimation of Biological Oxygen Demand- (BOD) **(7 Hrs.)**
7. Estimation of Chemical Oxygen Demand – (COD) **(5 Hrs.)**
8. Estimation of Carbonates-bicarbonates **(2 Hrs.)**
9. Estimation of Total Hardness **(3 Hrs.)**
10. Estimation of Chloride **(2 Hrs.)**
11. Estimation of Fluoride **(2 Hrs.)**
12. Estimation of Phosphorous **(2 Hrs.)**
13. Estimation of Nitrite **(2 Hrs.)**
14. Estimation of Nitrate **(2 Hrs.)**
15. Pollution Indicators – (Plants, Planktons and microbes) **(20 Hrs.)**

C. 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.

D. 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.

E. Web Links

1. https://www.who.int/water_sanitation_health/resourcesquality/wqmchap6.pdf
2. http://web.iitd.ac.in/~arunku/files/CEL212_2012/Lab%206%20Dissolved%20Oxygen.pdf
3. <https://www.tandfonline.com/doi/pdf/10.1080/21553769.2016.1162753>

3. Specific Learning Outcomes

Experiments	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
1-3	Estimation of pH in metric methods; Estimation of EC in Conductivity method and Estimation of Turbidity in Nephelometric method	Explain the principles, concept and Importance	K2
		Analyze the different water samples with various parameters	K4
		Compare the results with the standards	K5
		Determine the pollution load of the water sample	K5
		Recommend the samples for the consumption based on their quality	K5
3-4	Estimation of Total Dissolved Solids (TDS)- Gravimetric and Filtration method	Explain the principles, concept and Importance	K2
		Analyze the different water samples with various parameters	K4
		Compare the results with the standards	K5
		Determine the pollution load of the water sample	K5
		Recommend the samples for the consumption based on their quality	K5
5-7	Estimation of Dissolved Oxygen- (DO) in Winkler's method, Estimation of demand parameters such as BOD and COD	Explain the principles, concept and Importance	K2
		Analyze the different water samples with various parameters	K4
		Compare the results with the standards	K5
		Determine the pollution load of the water sample	K5
		Recommend the samples for the consumption based on their quality	K5
6-14	Estimation of Carbonates - bicarbonates, Total Hardness, Chloride, Fluoride, Phosphorous, Nitrite and Nitrate	Explain the principles, concept and Importance	K2
		Analyze the different water samples with various parameters	K4
		Compare the results with the standards	K5
		Determine the pollution load of the water sample	K5
		Recommend the samples for the consumption based on their quality	K5
15	Identification of Pollution Indicators – (Plants,	Define Pollution Indicators	K1

	Planktons and Microbes)	Explain the concept and Importance of Pollution Indicators	K2
		Analyze the different water samples	K4
		Compare the results with the standards	K5
		Determine the condition of the water sample	K5
		Recommend samples for the consumption	K5
		Formulate the rules and regulation for the conservation	K6

4. Mapping Scheme (POs, PSOs and COs)

U17ES5P3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	L	L	-	L	L	-	L	L	M	M	M
CO2	H	H	L	-	L	-	L	-	L	M	L	L	L
CO3	H	H	M	H	M	M	L	L	L	H	L	M	M
CO4	L	M	L	L	L	L	-	-	L	L	M	L	L
CO5	H	H	M	L	L	L	L	-	L	H	M	L	L
CO6	H	H	M	L	L	L	L	L	L	H	L	L	M
CO7	L	L	M	-	L	L	L	L	L	H	H	L	M

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Pre-semester and End-semester Examinations (ESE)
3. Reports, Observation Register, Record Note Books and Viva-voce

Indirect

1. Overall performance assessment, Discussions and co-curricular activities

Course Coordinator: Dr. A. Chandramohan

Elective I: TOOLS AND TECHNIQUES IN ENVIRONMENTAL SCIENCES

Semester: V
Credits: 4

Course Code: U17ES5:1
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	Explain remote sensing and Principles of EMR	K2	I
CO2	Explain Air quality parameters - Gaseous and Particulate matters	K2	II
CO3	Explain the water quality monitoring and sampling techniques	K2	III
CO4	Analyse soil texture and its physical, chemical and biological attributes	K4	IV
CO5	Identify various pollution sources of soil	K1	IV
CO6	Assess the Noise pollution in the ambient environment	K5	V

2.A. Syllabus

Unit I Geo-informatics

(15 Hrs.)

Remote Sensing - Definition – principles – EMR - platforms – sensors – resolution. GIS: Components – Hardware and software. Maps: Types. Use of RS and GIS in Environmental Sciences.

Unit II Air Quality Monitoring

(15 Hrs.)

Ambient air quality monitoring; Meteorological measurements; Measurement of SPM; CO; NO_x; SO_x.

Unit III Water quality

(20 Hrs.)

Water sampling techniques; Principles and procedures for measurement of pH, conductivity, Total Solids, hardness, chloride, Dissolved Oxygen, phosphorous, nitrogen, heavy metals (Atomic Absorption Spectrophotometry method) and total Coliform count.

Unit IV Soil

(15 Hrs.)

Morphological, Physical, Chemical and Biological attributes; sustainable soil use and management: Best agricultural practices

Unit V Sound quality

(10 Hrs.)

Signal level- Frequency Response-Distortions- Noise- Wow and Flutter

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, Sanfrancisco,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
6. Masters, G.M. and Wendell, E, Introduction to Environmental Engineering and Science, Third Edition, Prentice-Hall India Pvt. Ltd., New Delhi,2008.
7. Dara, S.S, Environmental Chemistry and Pollution Control, S. Chand, New Delhi,2003.
8. Chapman, J.L. and Reiss, M.J, Ecology – Principles and Applications, Cambridge University Press, Cambridge,2005.

D. 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.

E. Web Links

1. 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
3. <https://nptel.ac.in/content/storage2/courses/119108006/downloads/Lecture16.pdf>
4. http://environmentclearance.nic.in/writereaddata/Online/TOR/0_0_31_Oct_2014_1615420501AdditionalInformation.pdf
5. https://pubs.usgs.gov/twri/twri9a4/twri9a4_Chap4_v2.pdf
6. https://www.in.gov/idem/airquality/files/qa_manual_chap_09.pdf
7. <https://tspcb.cgg.gov.in/Environment/Ambient%20Noise%20Standards.pdf>
8. https://www.who.int/water_sanitation_health/resourcesquality/wqabegin.pdf

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Geo-informatics		
1.1	Remote Sensing - Definition – principles – EMR - platforms – sensors – resolution.	Illustrate Principles of Remote Sensing; Types of Remote Sensing and its Advantages Explain satellite platform and satellite imagery processing methods	K2
1.2	GIS: Components – Hardware and software. Maps: Types. Use of RS and GIS in Environmental Sciences.	Explain Geographic information system (GIS) uses and its applications	K2
Unit II	Environmental Monitoring of Micro-Meteorological parameters		
2.1	Environmental Monitoring of Micro-Meteorological Parameters:	Interpret meteorological data and develop capability to assessment of project proposal, air quality pollution index for any region	K2

2.2	Ambient Air: Particulates PM2.5, PM10. Gaseous contaminants: SO2, H2S, NOx, CO, CO2. Ambient Noise levels. National standards for air quality and noise	Identify air pollution problems and interpret criteria air quality data	K1
Unit III	Environmental Monitoring of Hydrological parameters		
3.1	Water sampling techniques; Principles and procedures for measurement of pH, conductivity, Total Solids, hardness, chloride, Dissolved Oxygen, phosphorous, nitrogen, heavy metals (Atomic Absorption Spectrophotometry method) and total Coliform count.	Explain the water sampling techniques and estimation of various parameters	K2
		Estimation of various water quality parameters	K5
Unit IV	Soil quality		
4.1	Morphological, Physical, Chemical and Biological attributes; sustainable soil use and management: Best agricultural practices	Analyse soil texture and its physical, chemical and biological attributes	K4
Unit V	Sound Quality parameters		
5.1	Signal level- Frequency response-Distortions- Noise- Wow and Flutter	Assess the Noise pollution in the ambient environment	K4

4. Mapping Scheme (POs, PSOs and COs)

U17ES5:1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	-	-	L	-	-	-	H	M	-	L
CO2	H	H	-	M	L	-	L	-	L	H	L	-	-
CO3	H	H	M	-	-	L	-	-	-	H	-	-	L
CO4	H	H	L	L	L	L	-	L	L	H	M	M	L
CO5	H	H	M	L	-	L	L	L	L	H	L	-	L
CO6	H	H	M	L	-	L	L	L	L	H	L	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. R. Teneson

ELECTIVE II - ENVIRONMENTAL SAFETY, HEALTH AND MANAGEMENT

Semester: V
Credits: 4

Code: U17ES5:2
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	Outline about the need for Good Health & Factors affecting health	K2	I
CO2	Compare the communicable disease and management of public hygiene	K2	II
CO3	Explain the Public health and Safety	K2	II
CO4	Match the Occupational diseases and its prevention, control	K5	III
CO5	Evaluate the Industrial Safety & Management System	K5	IV
CO6	Discuss on Industrial Safety Standards and Regulations	K2	V

2.A. Syllabus

UNIT I Introduction

(6 Hrs.)

Definition- need for good health- factors affecting health. Types of diseases (deficiency, infection, pollution diseases); Personal hygiene food (balanced diet); Food habits & cleanliness, food adulterants, avoiding smoking, drugs & alcohols.

UNIT II Personnel Safety

(6 Hrs.)

Communicable diseases, mode of transmission (epidemic and endemic diseases). Management of hygiene in public places (railway stations, bus stands and other public places).

UNIT III Public Health

(6 Hrs.)

Occupational health and safety: Occupational health and hazards-physical-chemical and biological; Occupational diseases- prevention and control.

UNIT IV Occupational Health and Safety

(6 Hrs.)

Industrial safety and management techniques: Industrial safety standards and regulations; Accidents definitions-prevention and control.

UNIT V Industrial Safety

(6 Hrs.)

Safety management system: concepts of safety management systems- EMS ISO 14000 and 14001 OSHA, PUBLIC LIABILITY INSURANCE ACT.

B. Topics for Self-study

- **Residential Safety** (<https://www.bu.edu/ehs/ehs-topics/dormitory-safety/>)
- **Hazard Communication** (<https://www.bu.edu/ehs/ehs-topics/hazard-communication/>)
- **Fire Safety** (<https://www.bu.edu/ehs/ehs-topics/hazard-communication/>)
- **Biological Safety** (<https://www.bu.edu/ehs/ehs-topics/hazard-communication/>)

C. Text Books

1. Sandra. S. C. Environmental Science. New Central Book Agency Publisher, Kolkata, 2001.
2. Diberardins L.J. Hand Book of Occupational Safety and Health. John Willey, New York, 1998.

D. Reference Books

1. Scoot, R. M. Basic Concepts of Industrial Hygiene. Lewis Publisher, NewYork,1997
2. Park, K. Park's Text Book of Preventive and Social Medicine. Bhanot Publisher, 2005.
3. Schilling, R.S.E. Occupational Health Practice. Buffer Worth, London,

1973

4. Khan M.A.O., John. P and Bederka. S. Survival in Toxic Environment. Academic Press, New York, 1974.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Introduction			
1	Definition- Need for good health; Factors affecting health and Types of disease	Identify the need for good health and learn the factors affecting health and Identify the types of disease.	K3
Unit II Personnel Safety			
2	Personal hygiene food (balanced diet): Food habits & cleanliness, food adulterants, avoiding smoking, drugs & alcohols.	Identify the Food habits, Cleanliness and Food adulterants and able to list out the unwanted food habitats and avoid smoking drugs and alcohols	K3
Unit III Public Health			
3	Public health: communicable diseases, mode of transmission (epidemic and endemic diseases). Management of hygiene in public places (railway stations, bus stands and other public places).	Recognize the communicable diseases & its mode of transmission. Assess the management of hygiene in public places.	K5
Unit IV Occupational Health and Safety			
4	Occupational health and safety: Occupational health and hazards physical, chemical and biological; Occupational diseases – prevention and control.	Identify the hazards in the occupational health and safety.	K3
Unit V Industrial Safety			
5.1	Industrial safety and management techniques: Industrial safety standards and regulations; Accidents- definitions- prevention and control.	Apply the skill in the safety management technique and be able to compile all the data and prepare a report for the Industrial standards and regulations.	K6
5.2	EMS ISO 14000 and 14001 OSHA, Public Liability Insurance Act.	Importance of the Environmental Management System and The Public Liability Insurance Act for the Employees	K5

4. Mapping Scheme (POs, PSOs and COs)

U17ES5:2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	-	-	-	-	M-	-	H	M	-	L
CO2	H	M	-	H	L	-	-	L	L	H	M	-	-
CO3	H	H	M	-	-	M	-	-	-	H	-	-	M
CO4	H	M	L	L	M	L	-	H	L	H	M	M	L
CO5	H	H	M	L	-	L	M	L	L	H	L	-	M
CO6	H	H	M	L	M	L	M	-	L	H	L	-	H

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Ms. D. Udhaya Banu

Practice School V: ENVIRONMENTAL MONITORING AND ASSESSMENT

Semester: V
Credits: 2

Course Code: U17ES5F5
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	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 (7 Hrs.)

Temperature, humidity, Atmospheric pressure, wind velocity, wind direction, sunshine. Ambient Air: Particulates PM2.5, PM10. Gaseous contaminants: SO₂, H₂S, NO_x, CO, CO₂. Ambient Noise levels. National standards for air quality and noise

Unit II Environmental Monitoring of Hydrological parameters (7 hrs.)

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 (8 Hrs.)

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 (4 Hrs.)

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

Unit V Environmental Management Plan (4 Hrs.)

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)

C. Text Books

1. Canter, L. W. Environmental Impact Assessment. McGraw Hill Book Co., NewYork,1977. ISBN:9780071141031
2. Munn, R. E. Environmental Impact Assessment. Mc Graw Hill Book Co., New York,

1979. ISBN:0471997455

- Rau, J. G and Wooten, D. C. Environmental Impact Analysis Handbook, McGraw Hill Book Co., New York, 1980. ISBN:978-0070512177

D. Reference Books

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

E. Web Links

- https://www.in.gov/idem/airquality/files/qa_manual_chap_09.pdf
- <https://tspcb.cgg.gov.in/Environment/Ambient%20Noise%20Standards.pdf>
- https://www.who.int/water_sanitation_health/resourcesquality/wqabegin.pdf

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Environmental Monitoring of Micro-Meteorological parameters		
1.1	Environmental Monitoring of Micro-Meteorological Parameters:	Interpret meteorological data and develop capability to assessment of project proposal, air quality pollution index for any region	K2
1.2	Temperature, humidity, Atmospheric pressure, wind velocity, wind direction, sunshine.	recognize various environmental transformation processes of pollutants under extreme weather condition.	K1
1.3	Ambient Air: Particulates PM2.5, PM10. Gaseous contaminants: SO ₂ , H ₂ S, NO _x , CO, CO ₂ . Ambient Noise levels. National standards for air quality and noise	Identify air pollution problems and interpret criteria air quality data	K1
Unit II	Environmental Monitoring of Hydrological parameters		
2.1	Water Quality Monitoring Protocol 2006 and Sampling techniques of water;	Identify the sources of water for various water uses.	K1
2.2	Preservation of water samples for the analysis of various parameters.	Explain unit operations and processes of water treatment system	K2

2.3	Standard methods for the Examination of water and wastewater. Water quality standards	Apply the principles and design water treatment units. Analyze water quality	K3
Unit III Impact of Developmental Activity			
3.1	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).	Evaluate the subjects which must be considered in EIA projects	K4
3.2	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.	Apply the knowledge and professional skills necessary to undertake environmental impact assessment.	K3
Unit IV Environmental Impact Assessment and Statement			
4.1	Environmental / Baseline / Setting; Identification of impacts; Prediction of impacts and Preparation of Environmental Impact Statement.	Identify the implications of current jurisdictional and institutional arrangements in relation to environmental impact assessment	K1
Unit V Environmental Management Plan			
5.1	Environmental Management Plan: Air, Water, Land, Socio-economic, Ecology and Biodiversity.	Discuss and provide definitions of environment, management, systems and organizations in relation to environmental management	K2

4. Mapping Scheme (POs, PSOs and COs)

U17ES5F5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	-	-	L	-	-	-	H	M	-	L
CO2	H	H	-	M	L	-	L	-	L	H	L	-	-
CO3	H	H	M	-	-	L	-	-	-	H	-	-	L
CO4	H	H	L	L	L	L	-	L	L	H	M	M	L
CO5	H	H	M	L	-	L	L	L	L	H	L	-	L
CO6	H	H	M	L	-	L	L	L	L	H	L	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. R. Teneson

SBEC II: ECOLOGY AND BIODIVERSITY OF BIRDS

Semester: V
Credits: 2

Course Code: U17ES5S2
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	Explain the morphology and the importance of birds	K2	I
CO2	Identify the various birds in the environment	K1	II
CO3	Apply various methods of bird identification	K2	II
CO4	Analyse species diversity of birds in a particular environment	K3	III
CO5	Assess the birds status of the local environment	K4	IV
CO6	Apply knowledge field visit to a bird sanctuary and counting of birds	K3	V

2.A. Syllabus

Unit I (6 Hrs)

Introduction to birds –morphology of birds

Unit II (6 Hrs)

Key to Identification of birds and methods of bird count

Unit III (6 Hrs)

Study of Species diversity of birds in an urban college Quiz on bird identification

Unit IV (6 Hrs)

Field observation of birds in an urban area Quiz on bird identification

Unit V (6 Hrs)

Field visit to a bird sanctuary and counting of birds Group project: Report of bird count.

C. Text books

1. Relton A, **Bird of Bishop Heber College**, Heber Au Sable Institute of Environmental Studies, Trich, ISBN 978 – 93 – 80767 – 00 – 0. 81 pages,2010.
2. GrimmettRichard, Tim Inskipp, **Birds of India, Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives**, Second Edition, Princeton Field Guides, 2012.
3. Ali S., The book of Indian birds, 13th revised edition, Bombay Natural History Society, Mumbai, (2002)

D. Reference Books

1. Grimmet, R., Inskipp, C., & Inskipp T. (2000). Pocket guide to the birds of the Indian Subcontinent. Oxford University Press, New Delhi, 384.
2. Grimmett, R. and Inskipp, T. (2007). Birds of Sourthern India. *Om Books International*, New Delhi, India.
3. BirdLife International, (2001). Threatened Birds of Asia. *The BirdLife International Red Data Book. Cambridge, UK: BirdLife International.* 3026.
4. BirdLife International, (2003). Saving Asia's Threatened Birds: a guide for government and civil society. *Cambridge, UK: BirdLife International.* 246.
5. Grewal B., Harvey, B., & Pfister O. (2002). A Photographic Guide to Birds of India and the Indian Subcontinent. *Periplus Edition (HK) Ltd. Singapore*, 513.

E. Web Links

1. <https://www.birdwatchersdigest.com/bwdsite/connect/youngbirders/how-to-identify-birds.php>

- <https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/fauna/birds/other-bird/#:~:text=Waterbirds%20can%20be%20difficult%20to,difficult%20to%20find%20and%20identify.>
- <https://www.discoverlife.org/mp/20q?guide=Waterbirds>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Introduction to bird			
1.1	Introduction to birds – morphology of birds	Explain the morphology and the importance of birds	K2
Unit II Identification of Birds			
2.1	Key to Identification of birds and methods of bird count	Apply various methods of bird identification	K2
Unit III Species Diversity			
3.1	Study of Species diversity of birds in an urban college Quiz on bird identification	Analyse species diversity of birds in a particular environment	K3
Unit IV Field observations			
4.1	Field observation of birds in an urban area Quiz on bird identification	Assess the birds status of the local environment	K4
Unit V Local visit and Report preparation			
5.1	Field visit to a bird sanctuary and counting of birds Group project: Report of bird count	Apply knowledge to field visit to a bird sanctuary and counting of birds	K3

4. Mapping Scheme (POs, PSOs and COs)

U17ES5S2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	-	-	L	-	-	-	H	M	-	L
CO2	H	H	-	M	L	-	L	-	L	H	L	-	-
CO3	H	H	M	-	-	L	-	-	-	H	-	-	L
CO4	H	H	L	L	L	L	-	L	L	H	M	M	L
CO5	H	H	M	L	-	L	L	L	L	H	L	-	L
CO6	H	H	M	L	-	L	L	L	L	H	L	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

- Continuous Internal Assessment (CIA)-T1 & T2
- Assignments, Seminars and Quizzes
- Field observation and report preparations
- Open Book Test

Indirect

- Student Participation in co-curricular activities
- Course-end Survey

Course Coordinator: Dr. R. Carlton

SBEC III- WASTE MANAGEMENT

Semester: V
Credits: 2

Course Code: U17ES5S3
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	Recall the sources and types of waste & their characteristics	K1	I
CO2	Compare waste transportation & disposal methods, sanitary land filling Techniques	K2	II
CO3	Explain solid waste disposal techniques.	K3	III
CO4	Discuss the ethical and socio-economic issues related to Rag Pickers	K5	IV
CO5	Recommend the 4 'R's – Reduction, Reuse, Recycle and Recovery strategies	K5	V
CO6	Apply various lab-scale applications to the field wherever required in waste management	K3	V

2.A. Syllabus

Unit I

(5 Hrs.)

Introduction to waste Wastes-Introduction, Sources, Characteristics, Composition, Classification - Global Scenario of waste – Indian Scenario of waste – Waste Collection, Storage and segregation – Transportation and Disposal Methods – Sanitary Land filling Techniques.

Unit II

(6 Hrs.)

Municipal Solid Waste Definition – Sources and types of solid waste – Composition and Its determinants of solid waste – Factors influencing generation – Quantity assessment of Solid Wastes – Methods of sampling and characterization.

Unit III

(6Hrs.)

Collection and Transfer Collection – Collection of solid waste – collection system, equipments – Time and frequency of collection – Labour requirements – Factors affecting collection, Analysis of collection system, Need for transfer operation – Transfer Stations – Location of Transport Stations – Selection of Location, types and design requirements, operation and maintenance.

Unit IV

(6 Hrs.)

Solid waste Disposal Landfilling - Types, Environmental problems, Aerobic composting - Windrow composting and Vermicomposting Anaerobic Treatment: Bio - gas production

Unit V

(7 hrs)

Hazardous Waste Management Hazardous waste – Introduction, Characteristics – Classification of hazardous waste (Industrial, Hospital and Domestic) - Handling of hazardous solid wastes (Segregation, Recovery of hazardous waste substance) – Hazardous waste disposal Techniques – Radioactive wastes: Sources, Pollution, types of radioactive waste and its control and management

B. Topics for Self-study

- **Nuclear Pollution** (<https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-waste-management.aspx>)
- **Meteorological Studies** (<https://rmets.onlinelibrary.wiley.com/journal/14698080>)
- **Carbon Foot Print** (<https://www.carbonfootprint.com/calculator.aspx>)
- **Forensic Science** (<https://www.aboutbioscience.org/topics/forensic-science/>)

C. Text Books

1. Chandrappa, R and Das, D. B. Solid Waste Management Principles and Practice. Springer, Verlag- Heidelberg, 2012. ISBN: 978-3-642- 28681-0
2. Subash Anand, Solid Waste Management. Mittal Publications, New Delhi, 2010.

D. Reference Books

1. Santra, S. C. Environmental Sciences. NBCA, Kolkata, India, 2011. ISBN: 978-8173814044
2. Young, G C. Municipal Solid Waste to Energy Conversion Process- Economic, Technical and Renewable Comparisons. John Wiley and sons Inc. NJ, USA, 2010. ISBN: 978-0470539675

E. Web Links

1. www.satavic.org/vermicomposting.htm
2. www.encapafrika.org/EGSSAA/solidwaste.pdf
3. <https://nptel.ac.in/courses/120/108/120108005/>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Municipal Solid Waste		
1.1	Introduction to waste Wastes- Introduction, Sources, Characteristics, Composition, Classification	Identify solid wastes and its source, composition and determinants of Solid waste	K1
1.2	Global Scenario of waste – Indian Scenario of waste – Waste Collection, Storage and segregation – Transportation and Disposal Methods – Sanitary Land filling Techniques.	Assess the scenario of waste- Collection, Storage & Segregation - Disposal in Global & Indian Level	K5
Unit II	Collection and Transfer Collection		
2.1	Municipal Solid Waste Definition – Sources and types of solid waste – Composition and Its determinants of solid waste –	Explain the sources & collection of solid wastes, Composition & Its determinants of solid waste	K2
2.2	Factors influencing generation – Quantity assessment of Solid Wastes – Methods of sampling and characterization.	Assess the factors influencing the generation of solid waste & Methods of sampling & Characterization.	K5

Unit III		Waste Recovery	
3.1	Collection and Transfer Collection – Collection of solid waste – collection system, equipments – Time and frequency of collection – Labour requirements – Factors affecting collection, Analysis of collection system,	Explain the collection of solid wastes, factors affecting collection and master schedules	K2
3.2	Need for transfer operation – Transfer Stations – Location of Transport Stations – Selection of Location, types and design requirements, operation and maintenance.	Select the location and the transfer operation and design requirements for operation and maintenance.	K3
Unit IV		Waste Disposal	
4.1	Composting and Vermicomposting Anaerobic Treatment: Bio - gas production	Sketch land and plan for a Bio- gas plant layout for composting & Vermi – composting	K3
Unit V		Institutional Aspects	
5.1	Hazardous Waste Management Hazardous waste – Introduction, Characteristics – Classification of hazardous waste (Industrial, Hospital and Domestic) - Handling of hazardous solid wastes (Segregation, Recovery of hazardous waste substance) – Hazardous waste disposal Techniques	Identify the Hazardous wastes and its source, characteristics & classification, Segregation of hazardous waste	K1
5.2	Radioactive wastes: Sources, Pollution, types of radioactive waste and its control and management	Formulate & Identify the Radioactive Wastes: Sources, Types, Control & Management of Radioactive wastes	K5

4. Mapping Scheme (POs, PSOs and COs)

U17ES5S3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	-	-	-	-	M-	-	H	M	-	L
CO2	H	M	-	H	L	-	-	L	L	H	M	-	-
CO3	H	H	M	-	-	M	-	-	-	H	-	-	M
CO4	H	M	L	L	M	L	-	H	L	H	M	M	L
CO5	H	H	M	L	-	L	M	L	L	H	L	-	M
CO6	H	-	H	M	-	-	M	M	H	H	M	H	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Ms. D. Udhaya Banu

Core VIII: INSTRUMENTAL ANALYSIS AND METHODS

Semester: V
Credits: 4

Code: U17ES608
Hours/Week: 5

1. Course Outcomes

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

CO	Course Outcomes	K-level	Unit
CO1	Explain about Water Sampling & Sampling Stations, Handling & Preservation	K4	I
CO2	Examine the Various Physical, Chemical & Biological Parameters of water sampling.	K2	II
CO3	Examine the Various Physical, Chemical & Biological Parameters of soil sampling.	K5	III
CO4	Interpret the significance of Water and Soil analysis.	K5	II & III
CO5	Analyse the Physical & Chemical Parameters of Air.	K5	IV
CO6	Explain about the Principles of GIS, Types & Its components	K4	V

2.A. Syllabus

Unit I Environmental analysis:

Water sampling; Sampling stations - Collection of water samples - Handling and Preservation. Water analysis - Physical parameters: Colour -Temperature-Transparency-Turbidity.

Unit II Water Analysis: Chemical parameters: pH - Electrical Conductivity-Total Solids-Total suspended solids Dissolved oxygen - Carbonates-bicarbonates -Hardness - Calcium - Magnesium - Total alkalinity – Fluoride – Iron - Nitrate -nitrite – Phosphate Biochemical Oxygen Demand (BOD) -Chemical Oxygen Demand (COD). Biological Parameters: Macrophytes – Phytoplankton – Zooplankton -Primary Productivity Bacteriological Measurements-Standard Plate count method-MPN (Most Probable number).

Unit III Soil /Sediment: Analysis Physical parameters

Density-Specific gravity -Texture Chemical Parameters: pH - Electrical conductivity - Total Alkalinity –Chloride – Nitrates – Phosphate – Iron - organic matter Biological parameters: Animal population – Benthos - Bacteria.

Unit IV

Air Analysis Physical parameters

Wind velocity - Atmospheric pressure – Temperature - Humidity Chemical Parameters: Carbon dioxide - Carbon monoxide - Sulphur dioxide - Nitrogen oxide.

Unit V Remote sensing

Principle – Types - GIS-Components - Types of maps –Digitizer – Scanner - Scale of measurements

B. Topics for Self-study

- **Citizen Science** (<https://www.citizenscience.gov/>)
- **Educationfor Sustainable Development** (<http://www.esdtoolkit.org/discussion/default.htm>)
- **Experiential Learning** (<https://www.experiential.institute/deep>)
- **Outdoor Learning** (<https://www.outdoor-learning.org/>)

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 Wiley and Sons, New York, 1985. ISBN: 0471808954, 9780471808954
7. APHA. Standard Method for Examination of Water and Waste water. APHA –AWWA – WEF, 1998.
8. APHA. Standard Method for Examination of Water and Waste water. APHA –AWWA – WPCF, 1989.

E. Web Links

1. 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/wqmchap6.pdf
4. http://web.iitd.ac.in/~arunku/files/CEL212_2012/Lab%206%20Dissolved%20Oxygen.pdf
5. <https://www.tandfonline.com/doi/pdf/10.1080/21553769.2016.1162753>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Environmental Analysis		
1.1	Water sampling; Sampling stations - Collection of water samples.		K1
1.2	Handling and Preservation of Water Samples.		K1
1.3	Water analysis - Physical parameters: Colour -Temperature-Transparency-Turbidity	List and analyse the different parameters	K1
Unit II	Water Analysis		
2.1	Chemical parameters: pH – Electrical conductivity-Total solids-Total suspended solidsDissolved oxygen – Carbonates-bicarbonates -Hardness – Calcium – Magnesium – Total alkalinity – Fluoride – Iron – Nitrate -nitrite – Phosphate Biochemical Oxygen Demand (BOD) - Chemical Oxygen Demand (COD).	List and analyse the different parameters	K4

2.2	Biological Parameters: Macrophytes – Phytoplankton – Zooplankton -Primary Productivity Bacteriological measurements-Standard Plate count method-MPN (Most Probable number).	List and analyse the different parameters	
Unit III	Soil & Sediment Analysis		
3.1	Soil /Sediment Analysis – Physical parameters: Density-Specific gravity - Texture	List and analyse the different parameters	K4
3.2	Chemical Parameters: pH - Electrical conductivity - Total Alkalinity –Chloride – Nitrates – Phosphate – Iron - organic matter Biological parameters: Animal population – Benthos - Bacteria.	List and analyse the different parameters	K4
Unit IV	Air Analysis		
4	Air Analysis - Physical parameters: Wind velocity - Atmospheric pressure – Temperature - Humidity Chemical Parameters: Carbon dioxide - Carbon monoxide - Sulphur dioxide - Nitrogen oxide.	List and analyse the different parameters	K4
Unit V	Remote Sensing		
5	Remote sensing: Principle – Types - GIS-Components - Types of maps –Digitizer – Scanner - Scale of measurements	Propose the Principle, Types- GIS & Its Components	K6

4. Mapping Scheme (POs, PSOs and COs)

U17ES608	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	H	H	H	H	H	H	M	L	M
CO2	H	H	M	H	H	H	H	H	H	H	M	L	M
CO3	H	H	M	H	H	H	M	M	H	H	M	L	M
CO4	M	M	L	H	H	H	M	M	H	H	M	L	M
CO5	M	M	M	H	H	H	H	H	H	H	M	L	M
CO6	M	M	M	H	H	H	H	H	H	H	M	L	H

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Ms. D. Udhaya Banu

Core IX: SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL LEGISLATION
Semester: VI **Course Code: U17ES609**
Credits: 4 **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	Analyze global consumption patterns of natural resources	K2	I
CO2	Explain the Disaster Management Strategies	K6	I
CO3	Relate global and national legislative efforts towards environmental protection.	K3	II
CO4	Apply the Sustainable Agriculture practices	K3	III
CO5	Describe the history and outcomes of various government and non-governmental efforts towards environmental protection.	K5	IV
CO6	List and mark sanction and enforcement bodies of environmental laws.	K6	V

2.A. Syllabus

Unit I

Sustainable Development: Definitions and Goals, global energy policies and resources; Green movements; Green and Eco philosophy; Ecological-footprints; corporate response to sustainable development – Brundtland Commission; Human Development Index; Living Plant Index

Unit II

National policy statement of environment and development; National Environment Policy 2006: an overview; Legislative framework of environmental protection, historical perspectives and Indian constitutional provisions.

Unit III

Environmental Acts and rules - Water (Prevention and control of Pollution Act, 1974), Air (Prevention and control of Pollution Act, 1981), Environment (protection) Act 1986, International treaties on Environmental protection: Ramsar Convention, Montreal protocol, Kyoto protocol, Convention on International trade of endangered species.

Unit IV

Sanction and enforcement bodies of environmental laws: role of high court (green bench), supreme court, State and Central Pollution Control Boards. National Environmental Movement: Silent valley movement, Chipko movement, Narmada movement, Appiko movement, Almatti dispute and Tehri dam movement.

Unit V

Disaster Management: Introduction –Natural disaster: Cyclone – Tsunami – flood – Landslides – earth quake; Environmental Disaster: Assessment, Planning – mitigation program – preparedness – resettlement rehabilitation – role of NGOs, GOs.

C. 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.

D. Reference Books

1. Nandhitha krishna. 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-10:978812041606

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit 1			
1.1	Sustainable Development: Definitions and Goals, global energy policies and resources; Green movements; Green and Eco philosophy; Ecological-footprints;	Identify the Global consumption patterns of Natural resources and approaches to Environment Management	K1
1.2	corporate response to sustainable development – Brundt and Commission; Human Development Index; Living Plant Index	Relate the Environment Management and Sustainable Development with its history, concept and goals and strategies, Circles of sustainability	K3
Unit 2			
2.1	National policy statement of environment and development; National Environment Policy 2006: an overview; Legislative framework of environmental protection, historical perspectives and Indian constitutional provisions.	Recommend the Legislative frame work of environmental protection in historical perspectives and Indian constitutional provisions	K5
Unit 3			
3.1	Environmental Acts and rules - Water (Prevention and control of Pollution Act, 1974), Air (Prevention and control of Pollution Act, 1981), Environment (protection) Act 1986, International treaties on Environmental protection:	Recognize the various Environment Acts and rules of Water Act, Air Act, Environment Protection Act, National Environment Policy and Coastal Regulation Zone Notifications.	K1
3.2	Ramsar Convention, Montreal protocol, Kyoto protocol, Convention on International trade of endangered species.	Inspect the International treaties on Environmental Protections such as Ramsar Convention, Montreal protocol, Kyoto protocol, Convention on International trade of endangered species. Dispute and Tehri Dam Movement	K5

Unit 4			
4.1	Sanction and enforcement bodies of environmental laws: role of high court (green bench), supreme court, State and Central Pollution Control Boards.	Examine the sanctioned and environment bodies of environmental laws. Justify the Role of High courts, Supreme court, State and Central Pollution Control Boards.	K5
4.2	National Environmental Movement: Silent valley movement, Chipko movement, Narmada movement, Appiko movement, Almatti dispute and Tehri dam movement.	Value the National Environmental Movements such as Appiko and Chipko Movements, Silent Valley Movement, Almatti Dispute and Tehri Dam Movement	K5
Unit 5			
5.1	Disaster Management: Introduction Natural disaster: Cyclone – Tsunami – flood – Landslides – earth quake;	Classify the types of Environmental Disaster and Pandemic emergencies. Able to Interpret the Disaster Management Strategies.	K2
5.2	Environmental Disaster: Assessment, Planning – mitigation program – preparedness – resettlement rehabilitation – role of NGOs, GOs.	Propose a plan for the Disaster Management.	K6

4. Mapping Scheme (POs, PSOs and COs)

U17ES609	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	-	-	-	-	M-	-	H	M	-	L
CO2	H	M	-	H	L	-	-	L	L	H	M	-	-
CO3	H	H	M	-	-	M	-	-	-	H	-	-	M
CO4	H	H	M	-	-	M	-	-	-	H	-	-	M
CO5	H	M	L	L	M	L	-	H	L	H	M	M	L
CO6	H	H	M	L	-	L	M	L	L	H	L	-	M

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Prof. A. Alagappa Moses

CORE X - GLOBAL WARMING AND CLIMATE CHANGE

Semester: VI
Credits: 4

Course Code: U17ES610
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	I
CO3	Prove the global warming through the Trends in temperature changes and in CO ₂ 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

(15 Hrs.)

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

(15 Hrs.)

Global warming – Trends in temperature changes and in CO₂ and other GHGs. Global Warming Potential of GHGs. Effects of Global Warming – melting polar ice, sea level rise, positive feedback

Unit III Climate Change

(15 Hrs.)

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

Unit IV Global Initiatives

(15 Hrs.)

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

(15 Hrs.)

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, Intergovernmental Panel on Climate Change (IPCC) Climate Change 2001. Third Assessment Report (Volume I), Cambridge University Press, Cambridge,2001.
3. 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. Houghton, J. Global Warming: The Complete Briefing, Cambridge University Press, Cambridge, 2005.
4. 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.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Introduction		
1.1	Introduction to Climate - Role of ozone in environment and its depletion	Describe the role of ozone in the Environment.	K2
		Explain ozone depletion	K2
		Define Greenhouse effect	K1
1.2	Green House Effect and global warming - role of fossil fuels	Describe global warming, causes and impacts	K2
		Explain temperature change and CO ₂ and other GHGs	K2
Unit II	Global Warming		
2.1	Global warming – Trends in temperature changes and in CO ₂ and other GHGs.	Classify the difference between climate change and global warming	K4
		Distinguish between weather and climate	K2
		Explain Global Warming Potential	K2
2.2	GWP of GHGs. Effects of Global Warming – melting polar ice, sea level rise, positive feedback	Explain the causes global warming?	K2
		Explain sea level raising	K2
		Explain impacts of polar ice melting and sea level rise	K2
Unit III	Climate Change		
3.1	Climate change and its socioeconomic and environmental implications (environment, biodiversity, agriculture, land use etc.)	Explain economic impacts of global climate change	K2
		Describe social economic and environmental impacts of climate change	K2
		Explain the international agreements to control global warming	K2
Unit IV	International Initiatives		
4.1	International Initiatives in combating global warming – UN Conferences formation of UNEP, IPCC and UNFCCC, Kyoto Protocol	Describe Kyoto Protocol	K2
		What can be done to combat global warming?	K1
		Describe the role of Ministry of Environment, Forest and Climate change.	K2
4.2	Indian Government's commitment and initiatives – role of Ministry of Environment, Forest and Climate Change.	Recognize various environmental reform initiatives taken in India	K1
		Explain Kyoto Mechanisms	K2

Unit V	Treaties & Measures		
5.1	Kyoto Mechanisms: Emission trading, Clean Development Mechanism,	Describe Clean Development Mechanism	K2
	Joint Implementation. Annex I, Annex II and Annex B countries and their commitments / role; Basket of gases; Lima Call for Climate Action	Explain Annex I, Annex II and Annex B countries and their commitments	K2
		Discuss Lima Call for Climate Action	K2

4. Mapping Scheme (POs, PSOs and COs)

U17ES610	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	-	-	-	M	-	-	-	H	M	-	L
CO2	H	H	-	M	L	-	M	-	L	H	M	-	-
CO3	H	H	M	-	-	L	-	-	-	H	-	-	L
CO4	H	H	L	L	L	L	-	L	L	H	M	M	L
CO5	H	H	M	L	-	L	L	L	L	H	L	-	L
CO6	H	H	M	L	L	L	L	-	L	H	L	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Dr. R. Carlton

Core Practical IV: AIR AND SOIL POLLUTION LAB

Semester: VI

Credits: 3

Code: U17ES6P4

Hours/Week: 5

1. Course Outcomes

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

CO No.	Course Outcome	K-Level	Experiment
CO1	Select appropriate technique to analyse environmental samples	K4	1-10
CO2	Analyse particulate matter in ambient air	K4	1
CO3	Analyse gaseous pollutants in ambient air	K4	2-3
CO4	Assess the noise level in ambient environment	K4	4
CO5	Analyse and evaluate soil samples using various parameters	K4	5-10
CO6	Create evaluation report of quality of air quality and Soil quality	K6	1-10

2.A. Syllabus

Air Analysis

1. Estimation of PM₁₀ in the ambient air
2. Estimation of SO₂ in the ambient air
3. Estimation NO_x in the ambient air
4. Measurement of ambient noise level

Soil Analysis

5. Estimation of pH - pH metric method
6. Estimation of EC – Conductivity method
7. Estimation of Alkalinity
8. Estimation of Total Organic Matter
9. Estimation of Phosphorous
10. Estimation of Sodium and Potassium

b. References

1. Trivedy R K, GoelPK and Trisall, Practical Methods in ecology and Environmental Sciences, Environmental Publications, Karad, 1987.
2. Margesin R and Schinner, Manual of Soil Analysis – Monitoring and Assessing Bioremediation, Springer –Verlag Berlin Heidelberg, 2005.
3. James P. Lodge, Methods of Air Sampling and Analysis, Inter Society Committee Publicaion, 1988.
4. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering, 2017
5. Sawyer, C.N. and Mc Carty, P. L, Chemistry for Environmental Engineering, McGraw Hill International, 1978.
6. Standard Method for Examination of Water and Wastewater, APHA –AWWA – WPCF, 1989.
7. Standard Method for Examination of Water and Wastewater, APHA –AWWA – WEF, 1998.

3. Specific Learning Outcomes

Experiments	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
I Air Analysis			
1	Estimation of PM ₁₀ in the ambient air	Analyse PM ₁₀ in the ambient air	K4
2	Estimation of SO ₂ in the ambient air	Analyse SO ₂ in the ambient air	K4
3	Estimation of NO _x in the ambient air	Analyse NO _x in the ambient air	K4
4	Measurement of ambient noise level	Analyse ambient noise level	K4
II Soil Analysis			
5	Estimation of pH - pH metric method	Analyse acidity of the soil samples	K4
6	Estimation of EC – Conductivity method	Analyse the ionic status of soil samples	K4
7	Estimation of Alkalinity	Analyse Alkalinity in different soil samples	K4
8	Estimation of Total Organic Matter	Analyse Total Organic Matter	K4
9	Estimation of Phosphorous	Analyse Phosphorous content in soil samples	K4
10	Estimation of Sodium and Potassium	Analyse Sodium and Potassium of soil samples	K4

4. Mapping Scheme (POs, PSOs and COs)

U17ES6P4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	L	L	H	H	M	-	L	H	M	H	M	L
CO2	L	L	-	H	H	L	-	-	M	L	H	L	-
CO3	L	L	-	H	H	L	-	-	M	L	H	L	-
CO4	L	L	-	H	H	L	-	-	M	L	H	L	-
CO5	L	L	-	H	H	L	-	-	M	L	H	L	-
CO6	L	L	M	H	H	H	L	L	M	M	H	L	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. End-semester Examinations (ESE)
3. Reports, Observation Register, Record Note Books and Viva-voce

Indirect

1. Overall performance assessment, Discussions and co-curricular activities

Course Coordinator: Dr. R. Carlton

Elective III: ECOTOURISM

Semester: VI
Credits: 4

Code: U17ES6:3
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	Recognize the importance of ecotourism, its components, impacts and management.	K1	I
CO2	Relate the ecotourism and sustainability.	K2	II
CO3	Explain the land, people, flora and fauna and climatic variations	K2	III
CO4	Identify the environmental issues with tourism.	K2	IV
CO5	Review the eco certification, ecotels and eco-morals.	K2	V
CO6	Apply management practices towards sustainable ecotourism.	K3	V

2.A. Syllabus

Unit I

(15 Hrs.)

Scope and definitions; Objectives of tourism (geographical, social, economic, religious, cultural and environmental); Components of tourism (information services, transport and accommodation).

Unit II

(15 Hrs.)

Ecotourism–definition and characteristics features (Ecosystem & biodiversity, support to local economy, conservation of biosphere, learning experience); Goals (social, economic and environmental); criteria (conservation, low impact and green efforts, sustainability, recreation, community involvement and environmental education and interpretation.

Unit III

(15 Hrs.)

Ecotourism in India – India a land of pluralism: land, people, flora and fauna and climatic variations; Biogeographic classification of India (10 regions); Ecosystem types available (terrestrial and aquatic including coastal mangrove and deep sea) – Contrast from tropics to snow.

Unit IV

(15 Hrs.)

Impacts of tourism on environment: population growth and carrying capacity leading to environmental pressures; biophysical, socio psychological, resource exploitation, poor management, pollution and environmental disturbances.

Unit V

(15 Hrs.)

Management of ecotourism: Development of information services, transport and accommodation; Regulation of funds (for operational facilities and administration); equitable management and distribution of resources and waste management; Eco certification, policies and regulations; Ecotels & Eco morals– Sustainable ecotourism.

b. References

1. Agarwal, A. N, Indian Agriculture, Vikas publishing House, New Delhi, 1980.
2. Weaver, D. B, The Encyclopaedia of Ecotourism, CABI, Publishing, U.K, 2001.
3. Sinha, P. C, Encyclopaedia of Ecotourism, Vol – I, II & III, Anmol publications Pvt. Ltd, New Delhi,2003.
4. Bhatia, A. K, Tourism in India, Sterling Publishers, NewDelhi, 1978.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I			
1.1	Scope and definitions; Objectives of tourism (geographical, social, economic, religious, cultural and environmental);	Recall scope and definitions of ecotourism	K1
		Illustrate the objectives of ecotourism	K2
	Components of tourism (information services, transport and accommodation).	Discuss the components of ecotourism	K6
Unit II			
2.1	Ecotourism–definition and characteristics features (Ecosystem & biodiversity, support to local economy, conservation of biosphere, learning experience);	Recall definition of ecotourism	K1
		Illustrate characteristics features of ecosystem	K2
	Goals (social, economic and environmental); criteria (conservation, low impact and green efforts, sustainability, recreation, community involvement and environmental education and interpretation.	Explain social, economic and environmental goal of ecotourism	K2
		Discuss the importance of community involvement and environmental education and interpretation	K6
Unit III			
3.1	Ecotourism in India – India a land of pluralism: land, people, flora and fauna and climatic variations	Explain – India land of pluralism	K2
	Biogeographic classification of India (10 regions)	Illustrate biogeographical classifications of India.	K2
	Ecosystem types available (terrestrial and aquatic including coastal mangrove and deep sea) – Contrast from tropics to snow.	Discuss various types of ecosystem	K6
Unit IV			
4.1	Impacts of tourism on environment: population growth and carrying capacity leading to environmental pressures	Illustrate environmental impacts of ecotourism	K2
	Biophysical, socio psychological, resource exploitation, poor management, pollution and environmental disturbances.	Explain pollution and environmental distribution of ecotourism	
Unit V			
5.1	Management of ecotourism: Development of information services, transport and accommodation	Explain the management of ecotourism	K2

	Regulation of funds (for operational facilities and administration)	Discuss management of funds in operational facilities and administration	K6
	Equitable management and distribution of resources and waste management	Illustrate equitable management in ecotourism	K2
	Eco certification, policies and regulations	Explain eco certification, policies and regulations	
	Ecotels & Eco morals- Sustainable ecotourism.	Discuss Ecotels and Eco morals in sustainable ecotourism	K6

4. Mapping Scheme (POs, PSOs and COs)

U17ES6:3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
C01	H	H	-	-	-	-	-	-	-	H	M	-	L
C02	H	H	M	M	L	-	L	-	L	H	L	-	-
C03	H	H	M	-	-	L	-	-	-	H	-	M	L
C04	H	H	M	M	L	L	-	L	L	H	M	M	L
C05	H	H	M	L	-	L	L	L	L	H	L	-	L
C06	H	H	M	L	L	L	L	-	L	H	L	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Continuous Internal Assessment (CIA)-T1 & T2
2. Assignments, Seminars and Quizzes
3. Pre-semester and End-semester Examinations (ESE)
4. Open Book Test

Indirect

1. Student Participation in co-curricular activities
2. Course-end Survey

Course Coordinator: Prof. A. Alagappa Moses