

Syllabus under Outcome-Based Education

B.Sc. ENVIRONMENTAL SCIENCES

**For the Students Admitted in the
Academic Year 2021-2022**

**Courses of study, Schemes of Examinations & Syllabi
(Under 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 during 2021-2024)

Structure of the Curriculum

Parts of the Curriculum		No. of Courses	Credits
PART – I	Language	04	12
PART – II	English	04	12
PART – III MAJOR			
	CORE Theory	10	41
	CORE Practical	04	12
	ELECTIVE	03	12
PART – III ALLIED			
	ALLIED Theory	04	12
	ALLIED Practical	03	07
	Internship	05	10
	Group Project	01	05
PART – IV			
	SBEC	03	06
	NMEC	02	04
	VLOC	01	02
	Environmental Studies	01	02
	SBC	01	01
PART – V			
	Extension Activities	01	01
	Gender Studies	01	01
Total		48	140

B.Sc. Environmental Sciences (2021-2024) – Programme Description

Sem	Part	Course	Course Code	Course Title	Pre requisites	Hrs. / week	Credits	Marks		
								CIA	ESA	Total
I	1	Tamil I	U18TM1L1	செய்யுள், இலக்கிய வரலாறு, உரைநடை, மொழிப்பயிற்சியும், படைப்பாக்கமும்		6	3	25	75	100
	2	English I	U21EGNL1	Language through Literature: Prose and Short Stories		6	3	40	60	100
	3	Core I	U20ES101	Fundamentals of Environmental Sciences		5	4	25	75	100
		Allied I	U20ESBY1	Environmental Botany		4	3	25	75	100
		Allied Prac.I	U20ESBP1	Environmental Botany Lab		3	2	40	60	100
		PS – Internship I	U20ES1F1	Explore Your Environment – Flora, Fauna & Environment Assessment		2	2	--	--	100
4	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	U18TM2L2	செய்யுள், இலக்கிய வரலாறு, சிறுகதைத் திரட்டு, மொழிப்பயிற்சி மற்றும் படைப்பாக்கமும்		6	3	25	75	100
	2	English II	U21EGNL2	Language through Literature: Poetry and Shakespeare		6	3	40	60	100
	3	Core II	U20ES202	Fundamentals of Ecology		5	4	25	75	100
		Core Prac. I	U20ES2P1	Basic Field Ecology		4	3	40	60	100
		Allied II	U20ESZY2	Environmental Zoology		4	3	25	75	100
		Allied Prac. II	U20ESZP1	Environmental Zoology Lab		3	2	40	60	100
	PS- Internship II	U20ES2F2	Environmental Monitoring and Assessment		2	2	--	--	100	
III	1	Tamil III	U18TM3L3	செய்யுள்-காப்பியம், புராணம், சிற்றிலக்கியம், இலக்கிய வரலாறு, நாவல், மொழிப்பயிற்சி		6	3	25	75	100
	2	English III	U21EGNL3	English for Competitive Examinations		6	3	40	60	100
	3	Core III	U21ES303	Environmental Microbiology and Biotechnology		5	4	25	75	100
		Core Prac. II	U20ES3P2	Practical in Environmental Microbiology and Biotechnology		3	3	40	60	100
		Allied III	U19ESCY3	Allied Chemistry- I		4	3	25	75	100
		PS- Internship III	U20ES3F3	Environmental Audit – Domestic / Campus		2	2	--	--	100
4	SBEC I	U20ES3S1	Field Environmental Geology and Mapping		2	2	25	75	100	
	NMEC I	U20ES3E1	Global warming and Climate Change		2	2	25	75	100	
IV	1	Tamil IV	U18TM4L4	செய்யுள் (மேற்கணக்கு,கீழ்கணக்கு), இலக்கிய வரலாறு , நாடகம், மொழிப்பயிற்சி		5	3	25	75	100
	2	English IV	U16EGNL4	English through Literature		5	3	40	60	100
	3	Core IV	U20ES404	Environmental Pollution		4	4	25	75	100
		Core V	U20ES405	Statistics for Environmental Sciences		4	4	25	75	100
		Allied IV	U19ESCY4	Chemistry for Environmental Sciences		3	3	25	75	100
		Allied Prac. III	U19ESCP3	Allied Chemistry Practical		3	3	40	60	100
		PS- Internship IV	U20ES4F4	Green Initiatives in Industrial Processes and Pollution Control		2	2	-	-	100
	4	NMEC II	U20ES4E2	Environmental Safety, Health and Management		2	2	25/ 40	75/ 60	100
		Soft Skills	U16LFS41	Life Skills		2	1	100	-	100
5	Extension Activities	U16ETA41	NCC, NSS, Rotaract, Leo Club, Etc.		-	1	-	-	-	

V	3	Core VI	U20ES506	Biodiversity and Conservation	U20ES202 U20ESBY1 U20ESZY2	5	5	25	75	100
		Core VII	U20ES507	Tools and Techniques for Environmental sciences		5	4	25	75	100
		Core Prac. III	U20ES5P3	Water Quality analysis		4	3	40	60	100
		Elective I	U20ES5:1	Concepts of Energy and Resources		5	4	25	75	100
		Elective II	U20ES5:2	Waste Management		5	4	25	75	100
		PS- Internship V	U20ES5F5	Ecosystem and Biodiversity		2	2	-	-	100
	4	SBEC II	U20ES5S2	Field Application of 4R Strategies		2	2	25	75	100
		SBEC III	U20ES5S3	Environmental Education and Awareness		2	2	25	75	100
VI	3	Core VIII	U20ES608	Research Methodology and Computational Skills for Environmental Sciences	U20ESCY3 U20ES404	5	4	25	75	100
		Core IX	U21ES609	Environmental Management and Sustainable Development		5	4	25	75	100
		Core X	U20ES610	Environmental Legislation and Environmental Impact Assessment		5	4	25	75	100
		Core Prac. IV	U20ES6P4	Air and Soil Analysis		5	3	40	60	100
		Elective III	U20ES6:3	Basic Principles of Remote Sensing and GIS		5	4	25	75	100
		Core Project	U20ES6PJ	Project Work		5	5	-	-	100
	5	Gender Studies	U16GST61	Gender Studies		-	1	-	-	100
Total Credits								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	U21SK1L1	U21FR1L1	Semester III	U18HD3L3	U21SK3L3	U21FR3L3
Semester II	U18HD2L2	U121SK2L2	U21FR2L2	Semester IV	U18HD4L4	U21SK4L4	U121FR4L4

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

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

PROGRAMME ARTICULATION MATRIX - BSc. Environmental Sciences (2021-2024)

Course Code	Course Name	Correlation with Program Outcomes and Program Specific Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	
U20ES101	Fundamentals of Environmental Sciences	H	H	L	L	L	L	L	L	L	L	H	L	L	L
U20ESBY1	Environmental Botany	H	M	M	L	M	L	M	M	M	M	M	M	M	M
U20ESBP1	Environmental Botany Lab	M	M	M	-	L	M	-	L	L	H	L	M	M	
U20ES1F1	Explore Your Environment – Flora, Fauna & Environment Assessment	M	H	L	M	L	M	L	L	L	L	M	M	L	
U16EST11	Environmental Studies	H	H	L	L	L	L	L	L	L	H	L	L	L	
U20ES202	Fundamentals of Ecology	H	H	M	H	H	H	H	L	L	H	L	-	L	
U20ES2P1	Basic Field Ecology	H	H	H	H	H	H	L	L	L	M	M	-	L	
U20ESZY2	Environmental Zoology	H	H	L	H	H	L	M	M	-	H	H	-	H	
U20ESZP2	Environmental Zoology Lab	H	H	L	L	H	M	M	H	M	H	H	M	L	
U20ES2F2	Environmental Monitoring and Assessment	H	H	M	L	L	L	L	L	L	H	L	L	L	
U21ES303	Environmental Microbiology and Biotechnology	M	L	L	L	-	-	-	-	-	L	L	L	L	
U20ES3P2	Practical in Environmental Microbiology and Biotechnology	L	L	L	L	L	L	-	-	-	L	L	L	L	
U19ESCY3	Allied Chemistry- I	H	M	M	M	M	-	M	H	H	M	L	L	M	
U20ES3F3	Environmental Audit – Domestic / Campus	-	L	H	H	H	H	H	H	M	L	L	L	H	
U20ES3S1	Field Environmental Geology and Mapping	M	L	M	M	M	M	M	M	M	H	L	L	L	
U20ES3E1	Global warming and Climate Change	H	H	L	L	L	L	L	L	L	H	L	L	L	
U20ES404	Environmental Pollution	H	L	M	L	M	L	L	M	M	L	M	L	L	
U20ES405	Statistics for Environmental Sciences	H	L	M	L	M	L	L	L	L	L	M	-	-	
U19ESCY4	Chemistry for Environmentalists	M	M	M	M	M	M	M	M	M	H	H	H	H	
U19ESCP3	Allied Chemistry Practical	M	M	M	L	M	M	L	M	-	H	H	H	M	
U20ES4F4	Green Initiatives in Industrial Processes and Pollution Control	H	H	L	L	L	L	L	L	L	H	M	L	L	
U20ES4E2	Environmental Safety, Health and Management	H	M	L	L	L	L	L	L	L	H	M	L	M	
U20ES506	Biodiversity and Conservation	M	M	L	M	M	L	L	L	L	M	L	L	L	
U20ES507	Tools and Techniques for Environmental sciences	H	H	L	L	L	L	L	L	L	H	L	L	M	
U20ES5P3	Water Quality analysis	H	H	M	L	L	L	L	L	L	H	M	M	M	
U20ES5:1	Concepts of Energy and Resources	H	H	L	L	L	L	L	L	L	H	M	L	L	
U20ES5:2	Waste Management	H	M	L	L	L	L	L	L	L	H	L	L	M	
U20ES5F5	Ecosystem and Biodiversity	M	H	L	M	L	L	L	L	L	L	M	M	L	
U20ES5S2	Field Application of 4R Strategies	H	L	M	M	L	L	M	M	L	M	M	L	L	
U20ES5S3	Environmental Education and Awareness	H	H	M	H	H	H	H	H	H	H	M	L	M	
U20ES608	Research Methodology and Computational Skills for Environmental Sciences	L	L	M	M	M	L	L	-	-	L	L	L	L	
U21ES609	Environmental Management and Sustainable Development	M	M	L	L	L	L	L	L	L	M	L	L	L	
U20ES610	Environmental Legislation and Environmental Impact Assessment	H	M	L	L	L	L	L	L	L	H	L	L	L	
U20ES6P4	Air and Soil Analysis	M	M	M	M	L	L	L	L	L	M	M	M	M	
U20ES6:3	Basic Principles of Remote Sensing and GIS	-	L	L	L	M	M	L	L	M	M	L	L	L	

L: Low; M-Medium; H-High correlation

Core I - FUNDAMENTALS OF ENVIRONMENTAL SCIENCES

Semester: I
Credits: 4

Code: U20ES101
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	Recognize the physical environment encompassing atmosphere, hydrosphere, lithosphere and biosphere.	K1	I
CO2	Relate the variations in radiation-balance and temperature with latitude and seasonal changes of the earth	K2	II
CO3	Categorize the spheres of atmosphere based on their physical attributes and processes	K2	II
CO4	Illustrate the hydrological cycle, ocean currents and lithosphere	K2	III & IV
CO5	Justify the variations in biomes based on atmospheric, hydrological and geological differences	K5	V
CO6	Classify the living organisms based on their geographical distribution based on climatic, edaphic, and hydrological factors	K2	V

2. A. Syllabus

Unit I Environment and Components of Environment

(20 Hrs.)

Importance, scope and principles of environmental sciences; Atmosphere, hydrosphere, biosphere, lithosphere and their interrelationships. Physical geography: Concept of continental drift and plate tectonics; Continents and oceans; Geographical coordinates – concept of latitude, longitude and altitude. Geographical zones of the earth; Earth's planetary motions – rotation and revolution, seasonality, solstices and equinoxes.

Unit II Structure and Composition of Atmosphere

(20 Hrs.)

Vertical Stratification – Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere; Physical properties - pressure and thickness, temperature and speed of sound, density and mass. Optical properties - scattering, absorption, emission, refractive index. Circulation - latitudinal circulation features, longitudinal circulation features. Radiation and heat balance - energy transfer, conduction, convection, radiation, latent and sensible heat. evapotranspiration, longwave and shortwave radiation, albedo, earth's energy balance.

Unit III Hydrosphere

(15 Hrs.)

Sources and importance of water; Distribution of water and hydrologic cycle. Humidity and Condensation: Precipitation: Forms and types of precipitation. Weather phenomena - Thunderstorm; Thunder & Lightning; Tornado Oceanic properties – physical and chemical Oceanic dynamics – concepts and implications of waves, circulation, tides, current, gyres, upwelling, oceanic landforms and plate tectonics.

Unit IV Lithosphere

(10 Hrs.)

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

Unit V Biosphere

(10 Hrs.)

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

B. Topics for Self-study

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

C. Text Books

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

D. Reference Books

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

E. Web links

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

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Environment and Components of Environment			
1.1	Importance, scope and principles of environmental sciences	Explain the Principles and Scope of Environmental Sciences	K2
1.2	Atmosphere, hydrosphere, biosphere, lithosphere and their interrelationships.	Illustrate various spheres of environment	K2
		Establish the relationships among various spheres	K3
1.3	Physical geography: Concept of continental drift and plate tectonics	Illustrate the concept of continental drift and plate tectonics	K3
1.4	Continents and oceans	Compare the features of Continents and Oceans	K4
1.5	Geographical coordinates – concept of latitude, longitude and altitude	Apply the concept of geographical coordinates in real world	K3
1.6	Geographical zones of the earth	Classify the Geographical zones	K2
1.7	Earth's planetary motions – rotation and revolution, seasonality, solstices and equinoxes	Explain and Illustrate various Planetary motions	K2
		Relate them to the seasons	K3
Unit II Structure and Composition of Atmosphere			
2.1	Vertical Stratification – Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere	Illustrate vertical stratification	K3
		Classify the atmospheric layers	K4
2.2	Physical properties - pressure and thickness, temperature and speed of sound, density and mass	Explain various physical properties of pressure and thickness, temperature and speed of sound,	K2
2.3	Optical properties - scattering, absorption, emission, refractive index	Enumerate various optical properties of atmosphere - scattering, absorption, emission, refractive index	K2
2.4	Circulation - latitudinal circulation features, longitudinal circulation features	Demonstrate the atmospheric circulation	K2
2.5	Radiation and heat balance	Illustrate radiation and heat balance	K2
2.6	energy transfer, conduction, convection, radiation, latent and sensible heat. evapotranspiration, longwave and shortwave radiation, albedo, earth's energy balance	Relate all these processes and probe the weather phenomena	K1
Unit III Hydrosphere			
3.1	Sources and importance of water	Classify the sources and establish the importance of water	K2

3.2	Distribution of water and hydrologic cycle.	Explain hydrologic cycle.	K2
3.3	Humidity and Condensation: Precipitation: Forms and types of precipitation.	Examine various processes leading to Precipitation	K4
3.4	Weather phenomena Thunderstorm; Thunder & Lightning;	Explain the weather phenomena	K2
3.5	Tornado Oceanic properties	Recall Tornado	K1
3.6	physical and chemical Oceanic dynamics	Illustrate the concepts	K2
3.7	concepts and implications of waves, circulation, tides, current, gyres, upwelling, oceanic landforms and plate tectonics	Relationships among them	K4
Unit IV	Lithosphere		
4.1	Earth's layer and internal structure of the earth	Illustrate the earth's layer	K2
4.2	Different types of rocks and different types of soils	Categorize and identify the types of rocks and soils	K4
4.3	Process of soil formation and soil profile.	Explain the process of soil formation and soil profile	K2
Unit V	Biosphere		
5.1	Concept and evolution of life	Explain the concept & evolution of life	K2
5.2	Types of Biomes and their distribution	Classify the types and relate them to the climatic and other features	K2
5.3	Phytogeographic realms (10 zones from tropic, temperate, subarctic and arctic regions)	Demonstrate the features of phytogeographic realms	K2
		Compare the different Phytogeographic realms	K4
5.4	Zoogeographic realms – 8 zones.	Demonstrate the features of zoogeographic realms	K2
		Compare the different Zoogeographic realms	K4

4. Mapping Scheme (POs, PSOs and COs)

U20ES101	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

ALLIED I: ENVIRONMENTAL BOTANY

Semester: I
Credits: 3

Code: U20ESBY1
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

- <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)

U20ESBY1	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. A. Vijayan

Allied Practical I: ENVIRONMENTAL BOTANY LAB

Semester: I
Credits: 2

Code: U20ESBP1
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- Chlamydomonas; 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. Mehrotra, 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, Nagercoil.
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., Nagercoil.
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 longifolia</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)

U20ESBP1	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. A. Vijayan

Practice School I - EXPLORE YOUR ENVIRONMENT – FLORA, FAUNA AND ENVIRONMENT ASSESSMENT

Semester: I
Credits: 2

Code: U2OES1F1
Hours/Week: 2

1. Course Outcomes

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

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

2. A. Syllabus

List of Activities

- 1. Introduction to PS (2 Hrs.)**
Plant habitat categories with diagrams and description
- 2. Know your Environment -campus (4 Hrs.)**
 - a. Area Mapping - Mapping of the campus
 - b. Assessment of flora in campus (Description of any five species in each category)
 - i. Trees
 - ii. Shrubs
 - iii. Herbs and grasses;
 - iv. Vines
- 3. Know your Domestic Environment (6 Hrs.)**
 - a. Area Mapping - Mapping of the neighbour-hood
 - b. Assessment of flora in neighbour-hood
 - i. Trees;
 - ii. Shrubs;
 - iii. Herbs and grasses;
 - iv. Vines
- 4. Know your environment (4 Hrs.)**
 - a. Assessment of fauna of the campus - Identification and Methods
 - i. Butterflies;
 - ii. Birds;
 - iii. Reptiles and
 - iv. Mammals
- 5. Know your Domestic environment (6 Hrs.)**
 - a. Assessment of fauna of the neighbour-hood - Identification and Methods
 - i. Butterflies;
 - ii. Birds;
 - iii. Reptiles and
 - iv. Mammals

6. Peoples Biodiversity Register (4 Hrs.)

- a. Flora:
 - i. Trees;
 - ii. Shrubs;
 - iii. Herbs;
 - iv. Medicinal plants;
 - v. Agricultural Crops;
 - vi. Recently lost/ changes of flora
- b. Fauna
 - i. Wild animals;
 - ii. Vertebrate mammals, birds, reptiles, others;
 - iii. Domestic Animals;
 - iv. Recently lost/ changes of fauna

7. Participatory Rural Appraisal (4 Hrs.)

- a. Introduction to PRA
- b. Village profile
- c. Transect walk outcome
 - i. Resource mapping;
 - ii. Assets mapping;
 - iii. Social mapping
- d. Management plan
- e. Conclusion

C. Text Books

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. <http://www.fao.org/3/w2352e/W2352E06.htm>
2. <http://ecologicalfootprint.com/>
3. http://nbaindia.org/uploaded/pdf/PPT_PBRs_Guidelines.pdf

3. Specific Learning Outcome

Activities & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
1	Know your Environment		
1.1	Plant habit categories with diagrams and description	Identify the plants in local environment	K3
2	Know your Environment - Campus		
2.1	Know your Environment i. Area Mapping - Mapping of the campus	Illustrate the college area map. Students will learn the name and location	K2
2.2	Assessment of flora in campus (Description of any five species in each category a) Trees; b) Shrubs; c) Herbs and grasses; d) Vines	Identify the college floral diversity	K3
3	Know your Domestic Environment		
3.1	Know your Domestic Environment i. Area Mapping - Mapping of the neighborhood	develop an area for a community	K3
	ii. Assessment of flora in neighborhood a) Trees; b) Shrubs; c) Herbs and grasses; d) Vines	Discover the floral diversity in a local environment	K4
4	Know your Environment		
4.1	Know your environment i. Assessment of fauna of the campus - Identification and Methods a) Butterflies; b) Birds; c) Reptiles and d) Mammals	Students will be a identify and develop a list of different fauna in the campus	K3 & k6
5	Know your Domestic Environment		
5.1	Know your Domestic environment i. Assessment of fauna of the neighborhood - Identification and Methods a) Butterflies; b) Birds; c) Reptiles and d) Mammals	Students will be a apply the developed skill in college campus in their community	K3
6	Peoples Biodiversity Register		
6.1	Peoples Biodiversity Register Flora: a) Trees; b) Shrubs; c) Herbs; d) Medicinal plants; e) Agricultural Crops; f) Recently lost/ changes of flora	Students will be a apply and discover the developed skill in college and their community at a forest or ecosystem	K3 & K4

6.2	Fauna: a) Wild animals; b) Vertebrate mammals, birds, reptiles, others; c) Domestic Animals; d) Recently lost/ changes of fauna	Students will be able to apply and discover the developed skill in college and their community at a forest or ecosystem	K3 & K4
7	Participatory Rural Appraisal		
7.1	Participatory Rural Appraisal i. Introduction to PRA ii. Village profile iii. Transect walk outcome a) Resource mapping; b) Assets mapping; c) Social mapping iv. Management plan Conclusion	Students will be able to compile all the data and prepare a report	K6

4. Mapping Scheme (POs, PSOs and COs)

U20ES1F1	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	H	M	-	M	-	-	-	H	M	H	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Reports, Spot Evaluation and Viva-voce

Indirect

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

Course Coordinator: Dr.R. Carlton

COURSE: ENVIRONMENTAL STUDIES

Semester: I
Credits: 2

Code: U20EST11
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, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case Studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources of sustainable lifestyles.

Unit III Ecosystems

(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 loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity In-situ conservation of biodiversity.

Unit V Environmental Pollution

(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 warming, 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)

U20EST11	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.D.Mahamuni

Core II - FUNDAMENTALS OF ECOLOGY

Semester: II
Credits: 4

Code: U20ES202
Hours/Week: 5

1. Course Outcomes

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

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

2. A. Syllabus

Unit I Ecosystem and its Components

(15 Hrs.)

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

Unit II Structure and Function of the Ecosystem

(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 – biogeochemical cycle in an ecosystem – N, P, C and O cycles.

Unit III Attributes of Ecosystem

(20 Hrs.)

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

Unit IV Habitat Ecology

(13 Hrs.)

Concepts, features and adaptations of Aquatic: Freshwater – lentic, lotic; Marine - neritic, estuarine - mangrove, intertidal, tidal flats, seagrass bed, coral bed; Oceanic – pelagic, benthic. Terrestrial habitat - major terrestrial biomes.

Unit V Ecological Tools

(12 Hrs.)

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

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.
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.

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>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Ecosystem and its Components			
1.1	Components of an ecosystem	Describe the various components of an ecosystem	K1
1.2	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 of an ecosystem	K2
	Biogeochemical cycles	Illustrate the biogeochemical cycles of an ecosystem	K2
Unit III Attributes of Ecosystem			
3.1	Attributes of Ecosystem - Population Ecology	Summarize the attributes of population in an ecosystem	K3
3.2	Community Ecology	Summarize the attributes of a community in an ecosystem	K3
3.3	Ecological pyramid	Construct the ecological pyramids in an ecosystem	K3
3.4	Ecological succession	Theorize the concept of ecological succession	K3
Unit IV Habitat Ecology			
4.1	Habitat Ecology- Concepts, features and adaptations of Aquatic habitat Lentic Lotic Marine	Distinguish, categorize and conclude the concepts of habitat ecology	K4
4.2	Concepts, features and adaptations of Terrestrial habitat	Distinguish, categorize and conclude the concepts of habitat ecology	K4
Unit V Ecological Tools			
5.1	Ecological tools – Sampling methods in ecology	execute the ecological tools in the field	K3
5.2	Quantitative assessment of diversity		K4

4. Mapping Scheme (POs, PSOs and COs)

U20ES202	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.D.Mahamuni

Core Practical I -BASIC FIELD ECOLOGY

Semester: II
Credits: 3

Code: U20ES2P1
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%2Drecapture%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	K4
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)

U20ES2P1	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.C.Sukumar

Allied – II ENVIRONMENTAL ZOOLOGY

Semester: II
Credits: 3

Course Code: U20ESZY2
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 up to 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- Pigeon. Economic importance of beneficial insects - Social life of honey bees. Brief study of Vermiculture, vermicomposting and its applications. Parasitology-Vector borne diseases–Malaria, Dengue.

Unit III 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. Bio indicators- microbes.

Unit IV Animal Behaviour and Pheromones

(12 Hrs.)

Animal Behaviour: Stereotyped behaviour- instincts and motivation; Acquired behaviour: Pavlovian learning, trial and error learning. 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 Book

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

D. References

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 Upadhay 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., Vermicology: 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	Pigeon	Explain the morphological characters of Pigeon	K4
2.4	Social life of honey bee	Predict the social life of honey bees	K5
2.5	Vermiculture	Explain in detail the vermiculture. Compare the different types of vermicomposting	K4 K4
2.6	Vectorborne diseases- M Dengue	Examine the epidemiology of viral diseases	K4

Unit III Migration in Animals 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)

U20ESZY2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
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 Assessment Test I, II
2. Assignment Group Presentation, Poster preparation,
3. End Semester Examination

Indirect

1. Course-end survey

Course Coordinator: Dr. Susan G. Suganya

Allied Practical – II: ENVIRONMENTAL ZOOLOGY LAB

Semester: II
Credits: 2

Course Code: U20ESZP1
Hours/Week: 3

1. Course Outcomes

At the end 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

I. VIRTUAL DISSECTION OF COCKROACH

Digestive system, Nervous system, male and female reproductive systems

II. DISSECTION

Earthworm : Digestive system and Nervous system

MOUNTINGS

1. Mosquito : Mouth parts
2. House fly : Mouth parts
3. Earthworm : Body setae
4. Shark : Placoid scale

III. SPOTTERS

- Amoeba, Paramecium, Obelia colony, Tapeworm, Ascaris, Leech, Millipede, Centipede, Freshwater mussel, Starfish, Shark, Calotes, Pigeon, Rabbit,
 - *Eudriluseugeniae*, 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.pdf0](http://library.uniteddiversity.coop/Beekeeping/A%20Practical%20Manual%20of%20Beekeeping.pdf0))
- **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))

References:

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)

Experiment	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 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			
	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)

U20ESZP1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
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: Dr. N. Benjamin

Practice School II - ENVIRONMENTAL MONITORING AND ASSESSMENT

Semester: II
Credits: 2

Code: U2OES2F2
Hours/Week: 2

1. Course Outcomes

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

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

2.A. Syllabus

List of Activities

1. Environmental Monitoring of Micro-Meteorological parameters: Temperature, humidity, atmospheric pressure, wind velocity, wind direction, sunshine. **(2 Hrs.)**
2. Ambient Air/Indoor and Noise Quality monitoring: Principles of sampling; analysis and instrumentation for air quality-Particulates; Gases and Noise. **(11 Hrs.)**
3. Water Quality Monitoring Protocol 2006 and Sampling techniques of water: Preservation of water samples for the analysis of various parameters; Standard methods for the Examination of water and wastewater; Water quality standards. **(5 Hrs.)**
4. Soil Identification: Type, Structure, Classification, Texture; Standard Classification – India (IS 1498 - 1970), USDA soil taxonomy and FAO (1974 – 1978). **(5 Hrs.)**
5. Geology: Geological Time Scale; Weathering and its classification; Fossils and Mineral Deposits; Archaeological Evidences/sites; Slope, Terrain, Drainage system and Contour, Map Projections; Georeferencing and Area Calculation using GIS techniques. **(8 Hrs.)**

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

3. Specific Learning Outcomes

Activities & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
1	Micro-Meteorological parameters		
1.1	Environmental Monitoring of Micro-Meteorological parameters	Define Environmental Monitoring	K1
1.2	Temperature, humidity, atmospheric pressure, wind velocity, wind direction, sunshine	Explain Micro - Meteorological parameter and its uses in studying the environment.	K2
2	Air Quality Monitoring		
2.1	Ambient Air and Indoor air quality monitoring; Principles of sampling; analysis and instrumentation for air quality-Particulates; Gases and Noise.	Define air pollution	K1
		Compare indoor and outdoor air pollution	K2
		Explain - effects of indoor air pollution	K1
		Classify the types of air pollutants in the environment	K2
		Define noise pollution and principle of noise measurements in the atmosphere	K1
3	Water Quality Monitoring		
3.1	Water Quality Monitoring Protocol 2006 and Sampling techniques of water	Define water pollution	K1
		Explain water quality monitoring	K2
3.2	Preservation of water samples for the analysis of various parameters	Explain preservation of water samples for the analysis of various parameters.	K2
3.3	Standard methods for the Examination of water and Wastewater.	List out the suitable methods adopted for various water quality parameter for the analysis of water samples	K1
3.4	Water quality standards.	Compare/relate various water quality standards for water quality analysis	K2
4	Soil Identification		
4.1	Soil Identification: Type, Structure, Classification, Texture	Explain types of soil and structure of soil in the environment	K2
4.2	Standard Classification – India (IS 1498 - 1970), USDA soil taxonomy and FAO (1974 – 1978).	Recall the soil classification and texture	K1
5	Geology		
5.1	Geology: Geological Time Scale	Define geological time scale	K1
5.2	Weathering and its classification	Explain weathering and its classification.	K2
5.3	Fossils and Mineral	Explain about fossils	K2

	Deposits; Archaeological Evidences/sites	Explain mineral deposits	K2
5.4	Slope Terrain, Drainage system and Contour, Map Projections	Explain slop Terrain, Drainage system and Contour	K2
		Illustrate Map Projection	K3
5.5	Geo referencing and Area Calculation using GIS techniques.	Discuss Geo referencing and Area calculation using GIS techniques	K2

4. Mapping Scheme (POs, PSOs and COs)

U20ES2F2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	-	-	-	-	-	-	-	H	M	-	L
CO2	H	H	M	M	L	-	L	-	L	H	L	-	-
CO3	H	H	M	-	-	L	-	-	-	H	-	M	L
CO4	H	H	M	M	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. Reports, Spot Evaluation and Viva-voce

Indirect

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

Course Coordinator: Dr.R.Teneson

Core III – ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Semester: III
Credits: 4

Code: U21ES303
Hours/Week: 5

1. Course Outcomes

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

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

2. A. Syllabus

Unit I Environmental Microbiology

(15 Hrs.)

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

Unit II Microorganisms in Industry

(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 –Microorganisms in food: milk, fruits, egg and Fish-Principles of food spoilage and food preservation; Microorganisms and sanitation.

Unit III Microorganism in Atmosphere

(15 Hrs.)

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. Production of lactic acid, Amino acid, Alcohol fermentation, Penicillin Production.

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

D. Reference Books

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

E. Web Links

1. <http://www.eolss.net/Sample-chapters/C10/E5-12-02.pdf>
2. <https://www.toppr.com/guides/biology/biotechnology-principles-and-process/tools-of-biotechnology/>
3. https://fire.biol.wvu.edu/cmoyer/zztemp_fire/biol346_W06/labman_week4.pdf
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 – Microorganisms in food: milk, fruits, egg and Fish	Identify and review the use of microorganisms in the food industries	K2
2.5	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 Atmosphere		
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

4.3	Production of lactic acid, Amino acid, Alcohol fermentation, Penicillin Production	Apply the knowledge of industrial scale production of various biotechnology products	K3
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)

U21ES303	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. 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 Practical II - PRACTICAL IN ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Semester: III
Credits: 3

Code: U20ES3P2
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	Estimate Coliform Group of Bacteria with the help of MPN Technique	K4	6 & 7
CO5	Demonstrate the Gel Electrophoresis and PCR	K2	8
CO6	Describe the Blood Serum Separation and Blood Grouping	K2	9 & 10

2. A. Syllabus

List of Experiments

1. Demonstration of Microscope **(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. Isolation of Bacteria from Water/Wastewater – Serial Dilution Technique. **(6 Hrs.)**
7. Estimation of Coliform Group of Bacteria – MPN Technique- Presumptive Test. **(6 Hrs.)**
8. Demonstration of Gel Electrophoresis and PCR **(3 Hrs.)**
9. Blood Serum Separation **(3 Hrs.)**
10. Blood Grouping **(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 Link

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.	Isolation of Bacteria from Water/Wastewater – Serial Dilution Technique.	Perform a culture development of bacterial culture from water samples for identification	K4
7.	Estimation of Coliform Group of Bacteria – MPN Technique- Presumptive Test.	Estimate the coliform bacteria and correlate with water quality	K4
8.	Demonstration of Gel Electrophoresis and PCR	Choose suitable molecular tools for DNA isolation and multiplication	K3
9.	Blood Serum Separation	Perform a serum separation from any blood sample	K3
10.	Blood Grouping	Differentiate the blood groups	K4

4. Mapping Scheme (POs, PSOs and COs)

U20ES3P2	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. 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.M.Sheela Mary

Allied III: ALLIED CHEMISTRY I

Semester: III
Credits: 3

Code: U19ESCY3
Hours/Week: 4

Course Outcomes:

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

CO No.	Outcomes	K-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.)

Ionic bond- Nature of Ionic bond-structure of NaCl, KCl & CsCl- Factors influencing the formation of ionic bond. Covalent bond- nature of covalent bond-VSEPR theory - shapes of BeCl_2 , BF_3 , CH_4 , PCl_5 , IF_7 , NH_3 & H_2O . Coordinate Bond-Nature of coordinate bond, Werner's theory and structure of some complexes - $\text{Ni}(\text{CO})_4$, $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$, $\text{K}_4[\text{Fe}(\text{CN})_6]$. 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.)

Types of chemical reactions, Types of intermediates- Electrophiles - nucleophiles - free radicals. 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). Reactions (Formation of Poly vinyl Chloride) - Reduction reactions (Hydrogenation of oil)- Oxidation Reactions (Conversion of benzaldehyde to benzoic acid).

UNIT III Solutions

(12 Hrs.)

Types of Solutions - Homogeneous and Heterogeneous, saturated and unsaturated, Mole Concept, Normality, Molarity, Molality and Parts per Million-**Problems**. Primary and secondary standards and preparation of standard solutions -**Problems**. Acids and bases: Arrhenius, Lowry- Bronsted, Lewis concepts- strong and weak acids and Bases-pH, pK_a , pK_b , buffer solutions, Derivation of Henderson - Hassel Balch equation.

Unit IV Chemical Kinetics and Catalysis

(12 Hrs.)

Chemical kinetics: rate of reaction, order, molecularity, first order rate law, half-life period and derivation of the first order rate equation. Catalysis-homogeneous and heterogeneous catalysis, intermediate complex formation theory and adsorption theory, Positive and Negative Catalysts, Promoters and poisons, Auto catalysis, applications. Enzyme catalysis - Mechanism and Michaelis-Menton Equation (No derivation)- Factors affecting enzyme catalysis.

Unit V Colloids

(12 Hrs.)

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

B. Topics for Self-study:

- **Chemical Bonding** (https://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/syllabus/MIT3_091SCF09_aln02.pdf)
- **Organic Reactions** (https://profiles.uonbi.ac.ke/sderese/files/h-sch_102_-_types_of_organic_reactions_and_mechanisms.pdf)
- **Type of Solutions** (<https://www.askiitians.com/revision-notes/chemistry/solutions/>)
- **Catalysis** (<https://www.britannica.com/science/catalysis>)
- **Colloids** (<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 & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	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 II	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 IV	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 aid of Lewis acid base theory	K2
3.3	Buffer solutions Henderson-Hasselbalch equation	Predict the pH of the buffer solution based on Henderson-Hasselbalch equation	K2
Unit IV	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 V	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. 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. S. Ambika

Practice School III - ENVIRONMENTAL AUDIT – DOMESTIC/CAMPUS

Semester: III
Credits: 2

Code: U2OES3F3
Hours/Week: 2

1. Course Outcomes

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

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

2. A. Syllabus

Lit of Activities

1 Water Audit-Importance and objectives–Methodology–Assessment-Result and inference-Conservation measures (**7 Hrs.**)

2 Energy Audit-Importance and objectives–Methodology–Assessment-Result and inference-Conservation measures (**7 Hrs.**)

3 Waste Audit- Importance and objectives-Methodology Assessment-Result and inference-Conservation measures (**8 Hrs.**)

4 Carbon footprint- Carbon footprint calculation; Result and inference; Carbon offset measures (**8 Hrs.**)

C. Text Books

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

D. Reference Books

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

E. Web Link

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

3. Specific Learning Outcomes

Activities & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
1	Water Audit		
1.1	Water Audit	Describe the emphasis of water scarcity and water conservation	K1
	Importance of water audit	Explain the essential of water in past, present and future generation. Explain the water scarcity	K2
	Objective of water audit	Calculate the water utilization and establish water conservation techniques	K3
1.2	Methodology	Explain preparation of questionnaire	K5
1.3	Assessment	Assess the water utilization Demonstrate water conservation techniques	K6
1.4	Result and Inference	Calculate the liters <i>per capita per day</i> (lpcd)	K4
1.5	Conservation measures	Explain Three 'R' (Reduce, Reuse and Recycle) approach Recycling of waste water	K5
2	Energy Audit		
2.1	Energy Audit	Describe the energy scarcity and energy conservation	K1
	Importance of water audit	Explain the essential of renewable energy resources	K2
	Objective of water audit	Calculate the energy utilization and establish energy conservation techniques	K3
2.2	Methodology	Explain the preparation of questionnaire	K5
2.3	Assessment	Assess the energy utilization	K6
2.4	Result and Inference	Calculate the energy utilization unit/month/house	K4
2.5	Conservation measures	Explain the alternative energy resources And reduce non-renewable energy usage	K5
3	Waste Audit		
3.1	Waste Audit	Explain the classification of solid and liquid waste	K1
	Importance of waste audit	Explain the causes and effects of waste	K2
	Objective of water audit	Calculate the waste generation and establish waste management techniques	K3
3.2	Methodology	Explain the collection, segregation and disposal methods	K3
3.3	Assessment	Assess the waste generation	K6
3.4	Result and Inference	Calculate type of waste generate Kg/day	K4
3.5	Conservation measures	Explain Three 'R' (Reduce, Reuse and Recycle) approach	K5

4	Carbon footprint		
4.1	Carbon footprint	Explain the carbon footprint	K1
4.2	Carbon footprint calculation	Explain the importance carbon footprint and emission of carbon dioxide	K2
4.3	Result and inference	Calculate the carbon footprint/home using online calculator	K4
4.4	Carbon offset measures	Reduce the emission of greenhouse gases in the short- or long-term	K5

4. Mapping Scheme (POs, PSOs and COs)

U20ES3F3	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	-	L	-	H
CO3	-	-	H	H	H	H	H	H	M	M	L	-	H
CO4	-	-	H	H	H	H	H	H	M	-	L	H	H
CO5	-	M	H	H	H	H	H	H	M	-	L	M	H
CO6	-	-	H	H	H	H	H	H	M	-	-	-	H

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Reports, Spot Evaluation and Viva-voce

Indirect

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

Course Coordinator: Dr.D.Udhaya Banu

SBEC 1 - FIELD ENVIRONMENTAL GEOLOGY AND MAPPING

Semester: III
Credits: 2

Code: U2OES3S1
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	Acquire the expertise in Topographical Map on different themes.	K1	I
CO2	Demonstrate the 3D representation of the earth's surface.	K2	II
CO3	Describe the Satellite Images interpretation	K2	III
CO4	Explain the Identification of Minerals and the risk of mining industry	K2	IV
CO5	Apply the EIA procedure identification near the mine.	K2	IV
CO6	Outline the Groundwater Targeting / Fluctuation Survey.	K5	V

2. A. Syllabus

Unit I Topography

(6 Hrs.)

Interpretation of Topographical Map - Understanding Map - Direction, Legend, Scale, Grid System, Scale -Types of map and Ground distance, Direction and Bearings, Grid Reference - Topographical map - Natural features like relief, elevation, drainage, vegetation, Hill, River etc., - Contour - Contour Lines and Its Types, Characteristics and Uses in Surveying

Unit II Advanced Topology

(6 Hrs.)

3D Vision Technology - Stereoscope- Aerial photograph - Orientation of Photographs and use of Stereo Pairs - Practice to three-dimensional effect - 3D representation of the earth's surface - depth perception and Parallax and Altitude Determination.

Unit III Image Interpretation

(6 Hrs.)

Visually Interpreting Satellite Images-Satellite imagery basic information study (acquisition date, Path and Row, resolution) - Interpretation Keys - Identification of various features on the terrain - Generation of Thematic Maps

Unit IV Mapping for Mining

(6 Hrs.)

Identification of Minerals in Opencast Mine Visit - Property of Minerals formation of mineral - methods of mineral extraction, - mining industry risk challenge and solution observation - EIA procedure identification near the mine.

Unit V Mapping for Water Management

(6 Hrs.)

Groundwater Targeting/Fluctuation Survey - Estimated groundwater depth level using geophysical instrument - groundwater level fluctuations and method of estimating - conduct survey groundwater level fluctuation using Piezometer (Groundwater level Recorder).

C. Text Books

1. Lillesand, T.M. and Kiefer, P. W. Remote Sensing and Image Interpretation. John Wiley & Sons, New York. ThirdEdition,2007.
2. Anji Reddy. Text book of Remote Sensing and GIS. Fourth Edition, BS Publication, Hyderabad,2014.
3. Richard G. Ray. Aerial Photographs in Geologic Interpretation and Mapping. Washington, U.S. Govt. Print. Off.,1960.
4. Peter Jackson. An introduction to cultural Geography. Unwin Hyman Ltd, Taylor & Francis e-Library,2003.

D. Reference Books

1. Richard, H. Groshong, Jr. 3-D Structural Geology A Practical Guide to Quantitative Surface and Subsurface Map Interpretation. Springer-Verlag Berlin Heidelberg, Netherlands2006.
2. Edgar W. Spencer. Geologic Maps A Practical Guide to Preparation and Interpretation.

- (Third Edition) Waveland Press, Inc, United States of America,2018.
3. Thomas, M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, Remote Sensing and Image Interpretation (7thEdition), Wiley United State of America,2015.
 4. Paul Aplin. Advances in Photogrammetry, Remote Sensing and Spatial Information: 2008 ISPRS Congress Book.
 5. Ronald Louis Benefits. Nature Guide Rocks and Minerals. Dorling Kindersley Limited, 2012.

E. Web Links

1. <https://ncert.nic.in/ncerts/l/kegy305.pdf>
2. http://elearning.uou.ac.in/pluginfile.php/1365/mod_resource/content/1/MGIS_06.pdf
3. http://environmentclearance.nic.in/writereaddata/form-1a/homelinks/miningofminerals_10may.pdf

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Topography		
1.1	Interpretation of Topographical Map - Understanding Map - Direction, Legend, Scale, Grid System, Scale	Explain and Illustrate various properties of Toposheet	K2
1.2	Types of map and Ground distance, Direction and Bearings, Grid Reference	Relate map and relationship between a map distance and a ground distance.	K3
1.3	Topographical map - Natural features like relief, elevation, drainage, vegetation, Hill, River etc.	Explain variety of symbols to describe both natural and human made features	K2
	Contour - Contour Lines and Its Types, Characteristics	Classify the contouring in different groups	K2
	Uses in Surveying	Illustrate Learn survey data collection methods	K3
Unit II	Advanced Topology		
2.1	3D Vision Technology - Stereoscope- Aerial photograph	Demonstrate the Photographs overlap one another to a certain extent when oriented under the lens stereoscope	K2
2.2	Orientation of Photographs and use of Stereo Pairs	Explain the concept & orientation procedure of aerial photographs	K2
	Practice to three-dimensional effect -3D representation of the earth's surface	Explain how Aerial Photos are Turned into 3D Models	K2
2.3	depth perception and Parallax and Altitude Determination	Apply the concept of hilly area height calculation method	K4
Unit III	Image Interpretation		
3.1	Visually Interpreting Satellite Images	Explain and Illustrate various satellite imagery	K2
		Relate them to the accuracy	K3

3.2	Satellite imagery basic information study (acquisition date, Path and Row, resolution)	Evaluate properties of satellite imagery	K5
	- Interpretation Keys - Identification of various features on the terrain	Interpret satellite imagery reading techniques	K5
3.3	Generation of Thematic Maps	Apply the general procedure of thematic map production and focuses on using GIS technology.	K3
Unit IV	Mapping for Mining		
4.1	Identification of Minerals in Opencast Mine Visit - Property of Minerals - formation of mineral	Explain methods to identify a mineral are the geological field techniques.	K2
4.2	Methods of mineral extraction	Explain primary methods used to extract minerals from the ground	K2
4.3	mining industry risk challenge and solution observation	Relate mining process and mining risk factors	K2
4.4	EIA procedure identification near the mine	Illustrate environmental impact assessment identifies, analyzes and evaluates	K2
Unit V	Mapping for Water Management		
5.1	Groundwater Targeting / Fluctuation Survey - Estimated groundwater depth level using geophysical instrument	Elaborate Geophysical survey is the systematic collection of geophysical data for spatial studies	K6
5.2	groundwater level fluctuations and method of estimating	Relate them to the seasons	K3
5.3	conduct survey groundwater level fluctuation using Piezometer (Groundwater level Recorder)	Explain measure pore-water pressure and ground water levels.	K2

4. Mapping Scheme (POs, PSOs and COs)

U20ES3S1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	M	M	M	H	M	L	M	H	L	L	H
CO2	M	-	H	H	H	M	L	-	L	H	L	-	-
CO3	H	L	M	H	M	H	H	M	H	H	M	-	M
CO4	-	H	L	L	L	L	-	L	L	M	-	-	L
CO5	L	H	M	-	H	M	H	H	H	H	L	-	L
CO6	M	-	H	M	H	M	L	H	H	M	M	-	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.S.Sukumar

NMEC I - GLOBAL WARMING AND CLIMATE CHANGE

Semester: III

Credits: 2

Course Code: U20ES3E1

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, Joint Implementation. Annex I, Annex II and Annex B countries and their commitments / role; Basket of gases; Lima Call for Climate Action	Describe Clean Development Mechanism	K2
		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)

U20ES3E1	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.D.Mahamuni

Core IV - ENVIRONMENTAL POLLUTION

Semester: IV
Credits: 4

Code: U20ES404
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	List out different types of pollution.	K1	I
CO2	Classify the different types of pollutants.	K2	II
CO3	Identify the types of pollutants with regard to air, water and soil.	K3	II & IV
CO4	Analyze the impacts of pollution on Environment	K4	III
CO5	Relate the disaster to the types of Pollution.	K2	V
CO6	Explain the pollutants and its impacts	K2	V

2. A. Syllabus

Unit I Air Pollution

(12 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; acid rain. Indian air quality standards. Bhopal Gas disaster.

Unit II Water Pollution

(12 Hrs.)

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

Unit III Soil pollution

(12 Hrs.)

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

Unit IV Thermal and Oil pollution

(12 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 on flora and fauna.

Unit V Noise pollution

(12 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. Indian noise level standards.

B. Topics for Self-study

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

C. Text Books

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

D. Reference Books

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

E. Web links

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

3. Specific Learning Outcome

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	K1
	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 given soil sample	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 amount 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
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)

U20ES404	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.R.Carlton

Core V - STATISTICS FOR ENVIRONMENTAL SCIENCES

Semester: IV
Credits: 4

Code: U20ES405
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	Define statistics and explain its applications.	K1	I
CO2	Articulate a data collection	K3	II
CO3	Summarize the data and present it.	K2	II & III
CO4	Measure of central tendency and dispersion	K3	II & IV
CO5	Apply correlation and regression analysis.	K4	III
CO6	Explain the concepts of Probability and its rules	K2	V

2. A. Syllabus

Unit I Introduction

(11 Hrs.)

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

Unit II Central Tendency

(12 Hrs.)

Measures of Central Tendency

Unit III Measures of Dispersion

(12 Hrs.)

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

Unit IV Measures of Deduction

(13 Hrs.)

Correlation and Regression Analysis.

Unit V Probability

(12 Hrs.)

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

C. Text Books

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

D. Reference Books

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

E. Web Links

1. <https://www.umass.edu/landeco/teaching/ecodata/schedule/statistics.pdf>
2. <http://www.fao.org/3/X2465E/x2465e09.htm>
3. https://www.youtube.com/watch?v=_WM8vzYSQhs

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Introduction			
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
1.2	Data Structure – Data Sources – Data Collection Techniques – Data Presentation.	Illustrate the data with suitable tabular and diagrammatic representation	K3
Unit II Central Tendency			
2.1	Measures of Central Tendency	Analyze the data for computation of measures of central tendency	K4
Unit III Measures of Dispersion			
3.1	Dispersion – Introduction – Range – Quartile Deviation – Mean Deviation – Standard Deviation – Relative Measures of Dispersion.	Interpret the data based on measures of dispersion	K6
Unit IV Measures of Deduction			
4.1	Correlation and Regression Analysis.	Calculate regression and correlation and interpret the results	K4
Unit V Probability			
5.1	Probability – Definition – Meaning of Probability – Addition rules – Multiplication rules – Baye's Theorem (only problem)	Explain probability and its theorems	K2

4. Mapping Scheme (POs, PSOs and COs)

U20ES405	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	L	-	L	-	-	-	-	L	L	-	-
CO2	-	-	M	H	H	M	-	-	L	-	M	-	-
CO3	H	L	L	-	L	M	L	L	-	L	M	-	-
CO4	H	L	M	-	L	M	L	L	-	L	M	-	-
CO5	H	H	M	-	M	M	L	L	-	L	M	-	-
CO6	H	L	L	-	L	-	-	-	-	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. D. Mahamuni

Allied IV- CHEMISTRY FOR ENVIRONMENTAL SCIENCES

Semester: IV
Credits: 3

Code: U19ESCY4
Hours/Wee: 3

1. Course Outcomes

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

CO	Course Outcomes	K-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.)

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. 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.)

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). Water Softening methods - Zeolite process, Reverse Osmosis. Preparation of De-ionized water- Distilled water–Double Distilled water–Packaged drinking water.

Unit III Basics of Quantitative Analysis

(12 Hrs.)

Error analysis: accuracy, precision, determinate and indeterminate errors, relative error, absolute error. Quantitative analysis: Titrimetry- principle, acid-base titrations and redox titrations with examples -End point and equivalence point. Theory of Indicators- Types of indicators - Quinonoid theory.

Unit IV Analytical Techniques

(12 Hrs.)

Chromatography-introduction-principle, sampling and applications of paper, thin layer and column chromatography. Photochemistry: Laws of Photochemistry, components of a colorimeter (Block diagram), application (estimation of iron). Purification methods – Steam distillation, Vacuum Distillation, Fractional Distillation, Solvent extraction, Crystallization and Sublimation.

Unit V Industrial Chemistry

(12 Hrs.)

Synthetic Polymers: Preparation, Properties and uses of Teflon, Polyester, Nylon-66 PVC, Polyethylene. Halogen containing compounds: Preparation and uses of Freons, CH₂Cl₂, CHCl₃, CCl₄, Pesticides- DDT, BHC- Preparation and uses. Fuel gases: Water gas, Producer gas, LPG, Gobar gas, Natural Gas- Manufacture and uses. 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. Topics 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*-23 rd 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*, 23 rd edition, New Delhi, Shoban Lal Nagin Chand & Co, 1993(Unit-II).

D. Reference Books:

1. I.R.T. Morrison & R.N. Boyd, *Study Guide to Organic Chemistry*, Prentice Hall, New Delhi, 2000.
2. 2000.
3. 2.R.L. Madan and G.D.Tuli, *Inorganic Chemistry*, S. Chand Co., Ltd., New Delhi, 2003 7.
4. 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 & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I Chemistry of Atmosphere			
1.1	Chemical constituents of atmosphere.	Discuss the chemical constituents of atmosphere	K2
1.1	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
1.2	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
1.3	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 Column 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	-	-	-	-	-	-	-	-	-	-	-

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. N. Mohan

Allied Practical III: ALLIED CHEMISTRY PRACTICAL

Semester: II
Credits: 3

Code: U19ESCP3
Hours/Week: 3

1. Course Outcomes

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

CO	Course Outcomes	K-level	Unit
CO1	Relate the basic principles and types of volumetric analysis	K2	I-III
CO2	Infer the redox reaction concept	K3	
CO3	Estimate the strength of the given solution	K3	
CO4	Apply complexation concept to check water quality in various Industries, and laboratories	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

1.Preparation of standard solution (Molar, ppm & Normal) & basic principles of organic analysis (6 Hrs.)

2.Volumetric Analysis (18 Hrs.)

- a. Acidimetry and Alkalimetry
 - i. Estimation of hydrochloric acid
 - ii. Estimation of sodium hydroxide
- b. Permanganometry
 - i. iii) Estimation of oxalic acid using KMnO_4
 - ii. iv) Estimation of ferrous sulphate using KMnO_4

3.Organic Analysis

(21 Hrs.)

- a. Analysis of organic compounds with the following tests for
 - i. Aromatic/ Aliphatic nature
 - ii. Saturation / unsaturation
 - iii. solubility in common solvents and
 - iv. presence of nitrogen
 - v. Carbohydrate,
 - vi. Diamide
 - vii. Aldehyde
 - viii. Ketone
 - ix. Acid

B. Topics for Self-study:

1. **Preparation of a standard solution** (<https://www.aplustopper.com/prepare-standard-solution/>)
2. **Qualitative Analysis of Organic Compounds** (http://wwwchem.uwimona.edu.jm/lab_manuals/c10expt25.html)

C. Text Book

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

E. Web Link

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

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Volumetric Analysis			
	Estimation of Hydrochloric acid	Infer the acid base neutralization reaction	K4
		Select indicators for acid base titration with different pH value	K2
	Estimation of oxalic acid using KMnO_4	Infer the redox reaction concept	K4
	Estimation of ferrous sulphate using KMnO_4	Estimate the strength of the given Oxalic acid/ FeSO_4 solution	K4
Demonstrative Experiments			
	Determination of total hardness of water	Infer the formation of complex between Magnesium and EDTA	K4
		Apply this method to check water quality in various Industries, and laboratories	K3
	Determination of calcium in commercial milk powder by EDTA method	Infer the formation of complex formation between calcium and EDTA	K4
		Determine the amount of Calcium in milk powder	K3
Organic Analysis			
	Analysis of organic compounds with the following tests for i. Aromatic/ Aliphatic nature ii. Saturation/ unsaturation iii. solubility in common solvents iv. presence of nitrogen	Infer aromatic substitution reaction	K4
		Relate addition reaction to saturation test	K2
		Analyse unknown samples systematically and report the same	K3
Demonstration			
	Preparation of standard solution (Molar, ppm & Normal)	Identify primary standard solutions	K1
		Prepare standard solutions in different concentration units	K6

4. Mapping Scheme (POs, PSOs and COs)

U19ESCP3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	M	-	M	M	L	M	-	H	H	H	H
CO2	M	-	M	-	M	M	L	M	-	H	M	M	M
CO3	M	-	M	-	M	M	L	M	-	H	H	H	M
CO4	H	M	M	L	M	L	L	M	-	H	H	H	-
CO5	M	-	M	-	H	M	L	-	-	H	H	-	H
CO6	M	-	M	-	-	L	L	M	-	H	H	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. Course-end Survey

Course Coordinator: Dr. S. Priscilla Prabhavathy

**Practice School IV –
GREEN INITIATIVES IN INDUSTRIAL PROCESSES AND POLLUTION CONTROL**

Semester: IV
Credits: 2

Code: U20ES4F4
Hours/Week: 2

1. Course Outcomes

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

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

2. A. Syllabus

List of Activities

1 Industrial Exposure

(7 hrs.)

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

2 Waste Management Facilities

(7 hrs.)

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

3 Green Energy technologies and Green Buildings

(8 hrs.)

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

4 Environmental Management System

(8 hrs.)

Environmental Management System in Industries; 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

C. Text Books

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

D. Reference Books

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

E. Web links

1. https://www.who.int/water_sanitation_health/medicalwaste/decisionmguide_rev_0ct06.pdf
2. <https://nptel.ac.in/courses/105/102/105102195/>
3. <http://mohua.gov.in/upload/uploadfiles/files/Part2.pdf>

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

3. Specific Learning outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Industrial Exposure		
1.1	Industrial Exposure Training - Apparel Industries: Tannery and Textiles units; Agro Industries; Sugar, Distillery; Pulp and Paper; Edible oil; Dairy Sago units; Cement and Thermal Power Plants; Mining activity - Limestone mining	State out different processes taking place in various industries	K1
Unit II	Waste Management Facilities		
2.1	Common Waste management facility - Visit / Observation; Biomedical waste /Municipal Solid waste /Sewage Treatment Plants / Effluent Treatment Plant / E Waste Management facility /Treatment processes, Recycling, Reuse and up cycling practices	Explain common waste management facilities.	K2
Unit III	Green Energy technologies and Green Buildings		
3.1	Green Energy technologies and Green Buildings: Sources of energy in the anthroposphere, Green technology and energy conversion efficiency.	Recall green energy technology	K1
3.2	Energy conservation and renewable energy sources (list of sources only). Green Composites for buildings: Concepts of Green Composites.	Discuss energy sources in the atmosphere	K2
		Explain renewable and non-renewable sources of energy	K2
3.3	Water Utilization in Buildings and Low Energy Approaches to Water Management. Management of Solid Wastes, sewage and sullage.	Describe low energy approaches to water management.	K2

3.4	Urban Environment and Green Buildings. Green Cover and Built Environment	Explain green building technology	K2
Unit IV	Environmental Management System		
4.1	Environmental Management System in Industries; Environmental Management Policy of the organization;	Illustrate Environmental Management Systems in Industries	K3
		Explain Environmental Management Policy	K2
4.2	Environmental Compliance; ISO 140001 and 18001 Certification;	Distinguish ISO 140001 and 18001 certifications	K4
4.3	Environmental Resource Auditing in industries. Waste management practices: Wastewater and Solid waste	Illustrate waste and waste water management in Industries	K3

4. Mapping Scheme (POs, PSOs and COs)

U20ES4F4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	-	L	-	M	-	-	-	H	M	-	M
CO2	H	H	-	M	L	-	M	-	L	H	M	-	-
CO3	H	H	M	-	-	L	-	-	-	H	-	-	L
CO4	H	H	M	L	L	L	-	L	L	H	M	M	L
CO5	H	H	-	-	-	L	L	L	L	H	M	-	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. Reports, Spot Evaluation and Viva-voce

Indirect

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

Course Coordinator: Dr.C.Sukumar

NMEC II: ENVIRONMENTAL SAFETY, HEALTH AND MANAGEMENT

Semester: IV
Credits: 2

Code: U20ES4E2
Total Hours: 30

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/dormintory-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	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.D.Udhaya Banu

Core VI - BIODIVERSITY AND CONSERVATION

Semester: V
Credits: 5

Code: U20ES506
Hours/Week: 5

1. Course Outcomes

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

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

2. A. Syllabus

Unit I Introduction to Biodiversity

(20 Hrs.)

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

Unit II Indian Biogeography

(10 Hrs.)

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

Unit III Strategies of Conservation

(18 Hrs.)

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

Unit IV Sustainable Management

(13 Hrs.)

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

Unit -V Biodiversity Conservation Regulations

(14 Hrs.)

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

B. Topics for Self-study

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

C. Text Books

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

D. Reference Books

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

E. Web links

1. <http://www.iucnredlist.org/https://www.unenvironment.org/>
2. <https://cpb.ucdavis.edu/news/resources-teaching-ecology-and-evolution>
3. <https://www.esa.org/programs/ecology-education/#gsc.tab=0>
1. <https://www.ugc.ac.in/oldpdf/modelcurriculum/Chapter4.pdf>
2. http://www.keralabiodiversity.org/images/pdf/book_english.pdf
3. <http://www.fao.org/3/i6855en/I6855EN.pdf>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Introduction to Biodiversity			
1.1	Introduction to Biodiversity: Levels of biodiversity; Biodiversity at Global, National and local levels	Recall and Relate the levels of Biodiversity	K1
1.2	The mega-biodiversity countries of the world; Hot spots of biodiversity	Relate the diversity	K1
1.3	IUCN categories of species - Red list; Endangered and endemic species of India.	Analyze the list of fauna in IUCN list	K4
1.4	Values and threats of biodiversity: Values - consumptive use - productive use – social- ethical - aesthetic and optional values; Threats to biodiversity-HIPPO - Habitat loss, Invasive species, population, pollution and over exploitation;	Assess the values and threats to environment	K5
Unit II Indian Biogeography			
2.1	Indian biogeography: Bio geographical classification of India (10 zones)	Classify of Indian landscape	K4
2.2	Major forests in India – 16 Forest type groups – salient features.	Analyze the forest and determine the type and asses the diversity	K4
Unit III Strategies of Conservation			
3.1	Strategies of Conservation: In-situ conservation–IUCN conservation categories;	Develop methods for conserving resources in its environment	K3
3.2	Conservation approach: Strategic Species approach - key stone species, flagship species, umbrella species; Ecosystem approach.	Compare the different important species in a ecosystem	K5
3.3	Ex-situ conservation-Conservation of plants and animals - Botanical gardens, Arboretum, Seed banks, Gene banks, zoos, aquaria, inter specific pregnancy	Develop other strategies for conservation	K6
Unit IV Sustainable Management			
4.1	Concept and importance of traditional knowledge and sacred groves.	Discuss the importance of the sacred grooves	K2
4.2	Sustainable wildlife management–Principles and techniques;	Illustrate the concept the sustainable wildlife management	K3
4.3	Management of forest fire, human animal conflict, invasive alien species;	Develop management plan various threats to biodiversity	K6

4.4	Concept of sustainable hunting; sustainable grazing, ecotourism;	Analyze and give solutions for controlling these activities for sustainability	K4
Unit V Biodiversity Conservation Regulations			
5.1	Laws and policies pertaining to conservation: Salient features of the laws -Indian Forest Act, 1927; Wildlife Protection Act, 1972; Forest Conservation Act, 1980, Biological diversity Act, 2002; Salient features of National Forest Policy 1988 -	Relate and compare the different forest policy	K4
5.2	Joint Forest Management, 1990; Social forestry.	Discover the other management practices	K4
5.3	Conservation Efforts: Objectives and activities - Major conservation agencies - WWF, IUCN, Conservation International, WCMC; International Conventions: Out comes - Conventions on Biological Diversity (CBD), CITES, CMS, Ramsar convention;	Recall all the important agencies pertaining to wildlife and biodiversity	K1

4. Mapping Scheme (POs, PSOs and COs)

U20ES506	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	L	M	H	M	-	M	-	H	M	-	L
CO2	H	H	-	H	-	-	M	-	-	H	-	M	-
CO3	-	M	L	-	-	L	-	-	-	M	-	-	M
CO4	-	-	M	H	-	H	M	H	-	H	-	-	M
CO5	-	H	M	M	H	-	M	-L	-	-	H	M	-
CO6	H	-	M	-	H	-	M	-	L	H	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.R.Teneson

Core VII - TOOLS AND TECHNIQUES FOR ENVIRONMENTAL SCIENCES

Semester: V
Credits: 4

Code: U20ES507
Hours/Week: 5

1. Course Outcomes

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

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

2. A. Syllabus

Unit I Environmental Monitoring of Micro-Meteorological parameters (18 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 (17 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 (18 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 (10 Hrs.)

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

Unit V Environmental Management Plan (12 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., 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

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/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: 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 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)

U20ES507	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.C.Sukumar

Core Practical III - WATER QUALITY ANALYSIS

Semester: V
Credits: 3

Code: U20ES5P3
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	List the water pollution problems	K1	1-11
CO2	Analyze the water samples with the various physico-chemical parameters	K1	
CO3	Label the water samples from the various sources	K4	
CO4	Compare the results with the standards	K4	
CO5	Identify the pollution indicators	K3	
CO6	Recommend preventive and alternate practices to reduce pollution	K5	

2. A. Syllabus

List of Experiments

1. Estimation of pH - metric method **(4 Hrs.)**
2. Estimation of EC – Conductivity method **(4 Hrs.)**
3. Estimation of Turbidity -Nephelometric method **(4 Hrs.)**
4. Estimation of Total Dissolved Solids (TDS)- Gravimetric and Filtration method **(4 Hrs.)**
5. Estimation of Dissolved Oxygen- (DO) - Winkler's method **(4 Hrs.)**
6. Estimation of Total Hardness **(4 Hrs.)**
7. Estimation of Chloride **(4 Hrs.)**
8. Estimation of Phosphorous **(4 Hrs.)**
9. Estimation of Nitrite **(4 Hrs.)**
10. Estimation of Nitrate **(4 Hrs.)**
11. Identification of 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 - metric method; Estimation of EC – Conductivity method and Estimation of Turbidity - Nephelometric method	Explain the principles, concept and Importance	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
3-4	Estimation of Total Dissolved Solids (TDS)- Gravimetric and Filtration method	Explain the concept and Importance of TDS	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
5	Estimation of Dissolved Oxygen- (DO) - Winkler's method	Explain the concept and Importance of DO	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

6-10	Estimation of Total Hardness, Chloride, Phosphorous, Nitrite and Nitrate	Explain the principles, concept and Importance	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
11	Identification of Pollution Indicators – (Plants, Planktons and Microbes)	Define Pollution Indicators	K1
		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)

U20ES5P3	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.R.Teneson

Elective I - CONCEPTS OF ENERGY AND RESOURCES

Semester: V
Credits: 4

Code: U2OES5:1
Hours/Week: 5

Course Outcomes

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

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

2. A. Syllabus

Unit I Fundamentals and Types of Energy (15 Hrs.)

Energy - Law of Conservation of energy - Energetics - Energy transformation - Energy condition - Energy transition - Energy level - Energy system - Mass - Mass-energy equivalence. Kinetic - Internal - Thermal - Potential - Gravitational - Elastic - Electric potential energy - Mechanical - Interatomic potential - Electrical - Magnetic - Ionization - Radiant - Binding - Nuclear binding energy - Gravitational binding energy - Sound energy - Surface energy - Mechanical wave - Sound wave - Vacuum energy - Zero-point energy.

Unit II Thermodynamic Concepts (15 Hrs.)

Power - Thermodynamics - Laws of thermodynamics - Thermodynamic system - Thermodynamic state - Thermodynamic potential - Thermodynamic free energy - Irreversible process - Thermal reservoir - Heat transfer - Heat capacity - Volume (thermodynamics) - Thermodynamic equilibrium - Thermal equilibrium - Thermodynamic temperature - Isolated system - Entropy - Free entropy - Entropic force - Negentropy - Work - Energy - Enthalpy

Unit III Energy resources and carriers (15 Hrs.)

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

Unit IV Energy system components (15 Hrs.)

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

Unit V Measurement, Use and Supply of Energy (15 Hrs.)

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

C. Text Books

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

D. Reference Books

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

E. Web links

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

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Fundamentals and Types of Energy		
1.1	Fundamentals and Types of Energy	Apply understand the need of energy conversion and the various methods of energy storage	K3
1.2	Energy - Law of Conservation of energy - Energetics - Energy transformation - Energy condition - Energy transition - Energy level - Energy system - Mass - Mass-energy equivalence.	Define energy and identify the different types that exist	K1
1.3	Kinetic - Internal - Thermal - Potential - Gravitational - Elastic - Electric potential energy - Mechanical - Interatomic potential - Electrical - Magnetic - Ionization - Radiant - Binding - Nuclear binding energy - Gravitational binding energy - Sound energy - Surface energy - Mechanical wave - Sound wave - Vacuum energy - Zero-point energy.	Define potential and kinetic and all other energy	K1
Unit II	Thermodynamic Concepts		
2.1	Thermodynamic Concepts:	Relate appreciate concepts learnt in fundamentals laws of thermodynamics from which learning ideas how to sustain in energy crisis and think beyond curriculum in the field of alternative and renewable sources of energy.	K2
2.2	Power - Thermodynamics - Laws of thermodynamics - Thermodynamic system - Thermodynamic state - Thermodynamic potential	Explain the role of engineering in finding and testing various energy sources for electricity production	K2
2.3	Thermodynamic free energy - Irreversible process - Thermal reservoir - Heat transfer - Heat capacity - Volume (thermodynamics)	Classify that there are different types and sources of energy	K2
2.4	Thermodynamic equilibrium - Thermal equilibrium - Thermodynamic temperature - Isolated system - Entropy - Free entropy - Entropic force - Negentropy - Work - Energy - Enthalpy	be able to identify different forms of energy	K3

Unit III Energy resources and carriers			
3.1	Energy resources and carriers: Resources:	Analyze and Gain the knowledge about working principle of various energy systems	K4
3.2	Primary energy – Secondary energy - Renewable Energy Source - Non-renewable Energy Source - Fossil fuel – Coal - Petroleum - Natural gas - Nuclear fuel - Natural uranium - Radiant energy - Solar - Wind - Hydropower - Marine energy - Geothermal - Bioenergy - Gravitational energy	To be aware of how everyday energy conversions can be made more efficient	K1
3.3	Carriers: Conduction – convection - Radiation – Enthalpy - Fuel - fossil fuel - Heat - Latent heat - Work - Electricity - Battery - Capacitor	Explain how the depletion of fossil fuels is a serious global issue.	K2
Unit IV Energy system components			
4.1	Energy system components	Acquire and Apply knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.	K3
4.2	Energy engineering - Electric power - Fossil fuel power station - Cogeneration - Integrated gasification combined cycle – Nuclear power - Nuclear power plant - Radioisotope thermoelectric generator	Identify different forms of energy	K3
4.3	Solar power - Photovoltaic system - Concentrated solar power - Solar thermal energy - Solar power tower - Solar furnace - Wind power - Wind farm - Airborne wind energy - Hydropower - Hydroelectricity - Wave farm – Tidal power - Geothermal power - Biomass	Explain the use of solar energy and the various components used in the energy production with respect to applications	K2
Unit V Measurement, Use and Supply of Energy			
5.1	Measurement, Use and Supply of Energy	Develop and apply the knowledge of mathematics, science and engineering fundamentals to model the energy conversion phenomenon.	K6

5.2	Fundamentals of energy and measurements: — Units of expressions – (Joule, Kelvin, Joule/Kelvin, calorie kilo calorie, watt, watt/second, kilowatt – kilowatt hour)– Reading through energy meter – Electrical energy - power, phases, reactive power, apparent power, power law - carbon cycle- Carbon Emission - Carbon footprint.	Examine and to know the need of renewable energy resources, historical and latest developments.	K4
5.3	Use and supply: Energy consumption - Energy storage - World energy consumption - Energy security - Energy conservation -Efficient energy use -Transport - Agriculture - Renewable energy - Sustainable energy - Energy policy – Energy development - Worldwide energy supply.	Explain a mathematical model of a real-life phenomenon. Analyze the environmental aspects of renewable energy resources.	K4

4. Mapping Scheme (POs, PSOs and Cos)

U20ES5:1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	M	-	M	L	-	-	-	H	M	-	L
CO2	H	M	-	L	L	-	L	M	L	H	L	-	-
CO3	H	M	-	L	L	-	L	M	L	H	L	-	-
CO4	H	H	L	L	-	L	-	-	-	H	-	-	M
CO5	H	M	L	M	L	M	-	L	L	H	M	M	L
CO6	H	H	M	-	-	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.C.Sukumar

Elective II- WASTE MANAGEMENT

Semester: V
Credits: 4

Code: U2OES5:2
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	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 Municipal Solid Waste

(15 Hrs.)

Introduction to 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 II Collection and Transfer Collection

(15 Hrs.)

Collection of Solid waste – collection services – collection system, equipments – time and frequency of collection – labour requirement – factors affecting collection – analysis of collection system – collection routes – preparation of master schedules. Transfer and Transport: Need for transfer operation – transfer stations – types – transport means and methods – location of transport stations -Transfer stations – selection of location, types & design requirements, operation & maintenance.

Unit III Waste Recovery

(15 Hrs.)

Processing Techniques and Recovery of Energy Processing techniques – purposes mechanical volume reduction – necessary equipments – chemical volume reduction – incinerators – mechanical size reduction selection of equipments – components separation – methods – drying and dewatering. Recovery of Resources, conversion products and energy recovery – recoverable materials – processing and recovery systems – incineration with heat recovery.

Unit IV Waste Disposal

(15 Hrs.)

Disposal of Solid Wastes Refuse disposal – various methods – incinerations – principle features of an incinerator – site selection and plant layout of an incinerator - sanitary landfill-methods of operation – advantages and disadvantages of sanitary land fill - site selection – reactions accruing in completed landfills – gas and leachate movement and control – equipments necessary.

Unit V Institutional Aspects

(15hrs)

Governmental organization – Central and State governmental agencies – Non-governmental organization– concepts Joint venture of Community and ULBs – Role of rag pickers – Public awareness. Lab scale study on vermicomposting, Lab scale study of aerobic and anaerobic digesting of municipal solid wastes.

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 Municipal solid waste -Definition - Sources and types of solid waste- composition and its determinants of Solid waste	Identify solid wastes and its source, composition and determinants of Solid waste	K1
1.2	Factors influencing generation- quantity assessment of solid wastes-methods of sampling and characterization.	Assess the factors influencing waste generation and its quantity, apply the sampling methods and characterization of solid waste	K5
Unit II			
Collection and Transfer Collection			
2.1	Collection of Solid waste – collection services – collection system, equipment – time and frequency of collection – labour requirement – factors affecting collection – analysis of collection system – collection routes – preparation of master schedules.	Explain the collection of solid wastes, factors affecting collection and master schedules	K2
2.2	Transfer and Transport: Need for transfer operation – transfer stations – types – transport means and methods – location of transport stations -Transfer stations. Selection of location, types & design requirements, operation & maintenance	Select the location and the transfer operation and design requirements for operation and maintenance.	K3

Unit III		Waste Recovery	
3.1	Processing Techniques and Recovery of Energy Processing techniques – purposes mechanical volume reduction – necessary equipment – chemical volume reduction – incinerators – mechanical size reduction selection of equipment – components separation – methods – drying and dewatering.	Apply the various techniques for energy processing and operation of various equipment and different adapted methods for separating components like drying and dewatering	K3
3.2	Recovery of Resources, conversion products and energy recovery – recoverable materials – processing and recovery systems – incineration with heat recovery.	Utilize the resource recovery, recoverable materials and recovery systems	K3
Unit IV		Waste Disposal	
4.1	Disposal of Solid Wastes Refuse disposal – various methods – incinerations – principle features of an incinerator – site selection and plant layout of an incinerator	Sketch land and plan for a plant layout for Incinerations	K3
	Sanitary landfill-methods of operation – advantages and disadvantages of sanitary land fill - site selection – reactions accruing in completed landfills – gas and leachate movement and control – equipment necessary.	Adapt the various method for the sanitary land filling, site selection	K6
Unit V		Institutional Aspects	
5.1	Institutional aspects Governmental organization – Central and State governmental agencies – Non-governmental organization– concepts Joint venture of Community and ULBs.	Employ joint operations of various organizations with communities and urban local bodies	K3
5.2	Role of rag pickers – Public awareness. Lab scale study on vermicomposting, Lab scale study of aerobic and anaerobic digesting of municipal solid wastes.	Recognize the role of rag-pickers and apply the knowledge of lab-scale studies of solid waste management in the fields	K4

4. Mapping Scheme (POs, PSOs and COs)

U20ES5:2	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	-	-	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: Dr.M.Sheela Mary

Practice School V- ECOSYSTEM AND BIODIVERSITY

Semester: V
Credits: 2

Code: U20ES5F5
Hours/Week: 2

1. Course Outcomes

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

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

2. A. Syllabus

List of Activities

1 Natural Ecosystem Biodiversity (6 Hrs.)

Montane ecosystem - visit and description

- a) Thorn forest; b) Deciduous and c) Evergreen

2 Natural Ecosystem Biodiversity (6 Hrs.)

Littoral forests- visit and description

- a) Grassland; b) Swamp; c) Mangrove and d) Dry evergreen forest

3 Diversity of Artificial Ecosystems (6 Hrs.)

Visit, description, impacts and mitigation

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

4 Conservation of Biodiversity (6 Hrs.)

Visit, list and description

1. In-situ conservation
a. Wildlife Sanctuaries
b. National Parks
c. Biosphere Reserves
d. Conservation Reserves
e. Community Reserves

5 Conservation of Biodiversity (6 Hrs.)

Visit, list and description

1. Ex-situ Conservation
a. Botanical gardens
b. Medicinal garden
c. Arboretum
d. Zoological parks
e. Aquaria
f. Butterfly Park
g. Crocodile bank

E. Reference Books

- Chapman, J. Land Reiss, M. J. Ecology-Principles and Applications. Cambridge University Press (Low price edition), 1995.
- Melchias, G. Biodiversity and Conservation. Oxford IBH. New Delhi. 236Pp, 2001.
- Groombridge, B. Editor. Global Biodiversity- Status of the Earth's living resources. Chapman & Hall, London, 1994.
- Levin, S. A. Encyclopedia of Biodiversity: Second Edition. Academic Press 5 Vols, 2000.
- 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://www.youtube.com/watch?v=Z8jOcYEtyc0>
2. <https://nptel.ac.in/content/storage2/courses/105105110/pdf/m3103.pdf>
3. [https://dducollegedu.ac.in/Datafiles/cms/ecourse%20content/PK%20\(AECC-EVS\)%20Chapter%20-%204%20Biodiversity.pdf](https://dducollegedu.ac.in/Datafiles/cms/ecourse%20content/PK%20(AECC-EVS)%20Chapter%20-%204%20Biodiversity.pdf)

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Natural Ecosystem Biodiversity			
1.1	Natural ecosystem biodiversity– Montane ecosystem - visit and description a) Thorn forest; b) Deciduous and c) Evergreen	Identify the different forests	K1
Unit II Natural Ecosystem Biodiversity			
2.1	Natural ecosystem biodiversity – Littoral forests- visit and description a) Grassland: b) Swamp; c) Mangrove and d) Dry evergreen forest	Analyze different ecosystems and compare the features	K4
2.2	Inventory of flora in campus Description of any five species in each category a) Trees; b) Shrubs; c) Herbs and grasses; d) Vines	Identify the college floral diversity	K1
Unit III Diversity of Artificial Ecosystems			
3.1	Diversity of artificial ecosystems – Visit, description, impacts and mitigation e. Plantation Crops: Arecanut, Coffee, Tea and cardamom f. Commercial Crops: Cotton, Sugarcane, Tobacco, Cashew nut g. Forest Plantation: Wattle, Eucalyptus, Acacia and Teak h. Food crops: Paddy, Wheat, Maize and Potato	List out the different types of crops in different areas	K1
Unit IV Conservation of Biodiversity			
4.1	Conservation of Biodiversity – Visit, list and description h. In-situ conservation i. Wildlife Sanctuaries ii. National Parks iii. Biosphere Reserves iv. Conservation Reserves v. Community Reserves	Distinguish the different category of forest protection	K2
Unit V Conservation of Biodiversity			
5.1	Conservation of Biodiversity – Visit, list and description 2. Ex-situ Conservation vi. Botanical gardens vii. Medicinal garden viii. Arboretum ix. Zoological parks x. Aquaria xi. Butterfly Park xii. Crocodile bank	Formulate management strategies	K6

4. Mapping Scheme (POs, PSOs and COs)

U20ES5F5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	M	-	M	H	H	-	-	M	M	-	-	M
CO2	-	H	-	H	-	M	-	L	-	-	M	H	-
CO3	M	H	-	H	-	-	L	L	-	-	H	H	-
CO4	-	H	-	H	-	M	-	L	-	-	M	H	-
CO5	L	H	M	H	H	H	-	-	M	M	L	-	L
CO6	H	H	M	-	M	M	L	M	H	M	H	-	L

L-Low; M-Medium; H-High

5. Course Assessment Method

Direct

1. Reports, Spot Evaluation and Viva-voce

Indirect

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

Course Coordinator: Dr.R.Carlton

SBEC II - FIELD APPLICATIONS OF 4 R STRATEGIES

Semester: V
Credits: 2

Code: U20ES5S2
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	Recall about waste & its characteristics, Global & Indian scenario of wastes	K1	I
CO2	Give example of reduce and reuse at the different sources	K2	II
CO3	Relate Recycle and Recovery of wastes	K2	II
CO4	Explain the aerobic methods	K2	III & IV
CO5	Prepare waste into compost	K5	V
CO6	Illustrate the Vermicomposting technologies	K2	V
CO7	Analyze the cost-benefit and marketing	K4	V
CO8	Appraise the energy recovery process from the wastes	K5	V
CO9	Demonstrate the Biogas production through anaerobic digestion	K2	V

2. A. Syllabus

Unit I Introduction

(6 Hrs.)

Identification, characterization and quantification of types and sources of Solid Wastes in a community: Biodegradables, non-biodegradables, domestic hazardous wastes, e-wastes, plastic wastes. Development of source segregation and collection strategies of a community.

Unit II Reduce and Reuse

(6 Hrs.)

Scoping – reduction and reuse potential for wastes at source - domestic, institutional, organizational, commercial etc., at community – residential complex, street, local and municipal level and industrial level.

Unit III Recycle and Recovery

(6 Hrs.)

MRF (Material Recovery Facility) – Evaluation of flow of materials through MRF. Fate of materials. Biomining. Recycling of Materials – Plastics, construction and demolition wastes, paper wastes and other wastes.

Unit IV Bioconversion

(6 Hrs.)

Conversion into Bio-compost using aerobic methods; Wastes into compost – preparation of wastes, conversion processes into compost – Windrow method, vermicomposting method. Estimation of NPK of final product. Cost -benefit analysis and marketing

Unit V Energy Recovery

(6 Hrs.)

Energy Recovery; WTE processes. Biogas production through anaerobic digestion/bio-methanation, Energy from incineration, gasification, pyrolysis, palletization - RDF (Refuse Derived Fuels). Techniques

C. Text Books

1. Anand, S. Solid Waste Management. Mittal Publications, Delhi. 2010
2. Ramachandra, T.V. Management of Municipal Solid Wastes. Commonwealth of Learning, TERI, New Delhi. 2009.

D. Reference Books

1. Peavy, H. S. Rowe, D. R and Tchobanoglous, G. Environmental Engineering. McGraw Hill Book Co., New York, 1986.
2. Piers, A., Martinho, G., Rodrigues, S and Gomes, M.S. Sustainable Solid waste Collection and Management. Springer.

E. Web Links

1. <https://nptel.ac.in/courses/105/103/105103205/>
2. <http://mohua.gov.in/upload/uploadfiles/files/Part2.pdf>
3. <https://www.tandfonline.com/doi/full/10.1080/10962247.2017.1316326>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Introduction		
1.1	Introduction, Identification, characterization and quantification of types and sources of Solid Wastes in a community	Define solid waste	K1
		Identify the different types of wastes	K3
		Classify the different types of solid wastes	K4
		Measure the quantity of waste	K5
1.2	Biodegradables, non-biodegradables, domestic hazardous wastes, e-wastes, plastic wastes.	Categorize the different types of wastes	K4
		Estimate the different types of wastes	K5
1.3	Development of source, segregation and collection strategies of a community.	Demonstrate the methods of collection and segregation	K2
		Develop the strategies of collection and segregation	K6
		Apply the different strategic methods of collection and segregation	K3
Unit II	Reduce and Reuse		
2.1	Reduce and Reuse; Scoping – reduction and reuse potential for wastes at source etc., Domestic, institutional, organizational, commercial etc., at community – residential complex, street, local and municipal level and industrial level.	Relate the reduce and reuse of wastes	K1
		Explain the importance of reduce and reuse of wastes.	K2
		Recommend these techniques at the different community level	K5

Unit III	Recycle and Recovery		
3.1	Recycle and Recovery; MRF (Material Recovery Facility) – Evaluation of flow of materials through MRF.	Categories the recycle and recovery of waste materials	K4
		Evaluate the materials of recovery of wastes.	K5
3.2	Fate of materials: Biomining.	Explain the fate of waste materials	K2
		Construct the bio-mining techniques	K3
3.3	Recycling of Materials – Plastics, construction and demolition wastes, paper wastes and other wastes.	Define recycling of materials	K1
		Illustrate the recycling of materials	K2
		Appraise the recycling materials	K5
Unit IV	Bioconversion		
4.1	Conversion into Bio-compost using aerobic methods;	Explain the bio-compost methods	K2
		Illustrate the aerobic methods	K2
		Experiment with the conversion into bio-compost using aerobic methods	K3
		Evaluate bio-compost using aerobic methods;	K5
		Elaborate bio-compost using aerobic methods	K6
4.2	Wastes into compost – preparation of wastes, conversion processes into compost – Windrow method, Vermicomposting method.	Explain the waste into compost	K2
		Illustrate the conversion processes into compost	K2
		Test the windrow methods	K5
		Discuss vermicomposting methods	K6
4.3	Estimation of NPK of final product. Cost - benefit analysis and marketing	Estimate the NPK of final product	K5
		Discuss the cost-benefit analysis and marketing	K6
Unit V	Energy Recovery		
5.1	Energy Recovery; WTE processes.	Explain the Energy recovery with WTE	K5
5.2	Biogas production through anaerobic digestion/bio-methanation,	Discuss the anaerobic digestion / bio-methanation	K6
5.3	Energy from incineration, gasification, pyrolysis, palletization - RDF (Refuse Derived Fuels). Techniques	Discuss the various techniques of energy recovery	K6
		Elaborate the energy from Incineration, gasification, palletization	K6
		Recommend the of techniques RDF	K6

4. Mapping Scheme (POs, PSOs and COs)

U20ES5S2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	-	-	-	-	-	L	L	M	L	-	L
CO2	L	L	-	M	L	-	M	-	-	L	H	L	M
CO3	H	L	L	M	-	L	L	L	L	L	M	-	L
CO4	H	H	H	H	M	M	M	H	H	H	M	M	M
CO5	H	L	H	M	M	M	L	M	M	L	L	M	L
CO6	H	H	H	H	M	M	M	H	H	H	M	M	M
CO7	H	-	M	L	L	M	M	L	-	H	M	M	L
CO8	H	-	M	L	L	M	M	L	-	H	M	M	L
CO9	H	H	H	H	M	M	M	H	H	H	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.R.Teneson

SBEC III - ENVIRONMENTAL EDUCATION AND AWARENESS

Semester: V
Credits: 2

Code: U20ES5S3
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	Recall The history of environmental education	K1	I
CO2	List and analyze the different environmental organizations	K2	I
CO3	Summarize the concept of environmental education	K2	I
CO4	Categorize the different forms of education	K4	II
CO5	Plan and design the environmental education programs for various target groups	K5	II, IV & V
CO6	Execute and review the environmental education programs for various target groups	K6	III, IV & V

2. A. Syllabus

Unit I 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 and Silent Valley.

Unit II 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 Environmental Awareness

(6 Hrs.)

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

Unit IV Environmental Awareness for Urban Community

(4 Hrs.)

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

Unit V Environmental Awareness for General Public

(4 Hrs.)

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

C. Text Books

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

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	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)

U20ES5S3	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.D.Udhaya Banu

Core VIII - RESEARCH METHODOLOGY AND COMPUTATIONAL SKILLS FOR ENVIRONMENTAL SCIENCES

Semester: VI
Credits: 4

Code: U20ES608
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	Define data and list the sources	K1	I
CO2	Explain the sampling design and Techniques	K1	II
CO3	Outline research methods	K4	III
CO4	Categorize the data Processing and Analysis	K2	IV
CO5	Illustrate the basic analytical tools	K2	IV
CO6	Prepare Report and Article writing	K3	V
CO7	Interpret data presentation	K3	V

2. A. Syllabus

Unit I Data

(10 Hrs.)

Data; Primary and secondary sources; Collection of Data - Organizing Survey and Interviews; reviews, monographs, patents, research databases, web as a source, searching the web.

Unit II Basis of Research

(15 Hrs.)

Research; Generating Research Ideas, Hypothesis - Formulation and Testing; research proposal, Sampling design and Techniques. objectivity in research.

Unit III Research Methods

(15 Hrs.)

Research methods - basic and applied research; qualitative, quantitative; descriptive, analytical, applied, fundamental, conceptual, historical, theoretical and empirical.

Unit IV Data Processing and Analysis

(20 Hrs.)

Data Processing and Analysis - Classification and analysis of data; Basic analytical tools; Correlation - Regression. Representation of Data (Graphical and Diagrammatic).

Unit V Report and Article writing

(15 Hrs.)

Report and Article writing; Preparing Tables, Figures and Reference lists; Data Presentation; MS-Office- MS-Word; MS- Excel; MS-Power point.

C. Text Books

1. Gurumani, N. Research Methodology for Biological Sciences. MJP Publishers, Chennai, 2007
2. Gupta, S. P. Statistical Methods. Sultan Chand and Sons, New Delhi, 2004.

D. Reference Books

1. Day, R. A. How to write and publish a scientific paper. 5th Edition. Orynx Press Phoenix, 1998.

E. Web Links

1. <https://www.sciencedirect.com/topics/social-sciences/data-collection-technique>
2. https://nptel.ac.in/content/storage2/courses/121106007/week2/data_analysis_web.pdf
3. <http://www.iitk.ac.in/doaaold/thesisguide.pdf>

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Data			
1.1	Data; Primary and secondary sources	Classify the data types	K1
1.2	Collection of Data - Organizing Survey and Interviews	Perform a data collection	K3
1.3	Reviews, monographs, patents, research databases, web as a source, searching the web	Use various sources of data for intended research	K3
Unit II Basis of Research			
2.1	Research; Generating Research Ideas	Outline a research topic	K4
2.2	Hypothesis - Formulation and Testing	Select suitable hypothesis testing tools	K4
2.3	Research proposal	Articulate a research proposal	K3
2.4	Sampling design and Techniques	Choose a right sampling technique for the intended population	K3
2.5	Objectivity in research	Identify and List out the objectives	K1
Unit III Research Methods			
3.1	Research methods - basic and applied research; qualitative, quantitative	Distinguish different methods of research	K2
3.2	Descriptive, analytical, applied, fundamental, conceptual, historical, theoretical and empirical	Distinguish different methods of research	K2
Unit IV Data Processing and Analysis			
4.1	Data Processing and Analysis - Classification and analysis of data	Analyze the collected data using suitable tools	K4
4.2	Basic analytical tools; Correlation - Regression	Perform basic analytics using available data	K4
4.3	Representation of Data (Graphical and Diagrammatic)	Interpret right mode of presenting the available analytical findings	K3
Unit V Report and Article Writing			
5.1	Report and Article writing; Preparing Tables, Figures and Reference lists	Outline a report with appropriate formatting techniques	K4
5.2	Data Presentation; MS-Office-MS-Word; MS- Excel; MS-Power point	Choose right mode of presenting the available analytical findings	K3

4. Mapping Scheme (POs, PSOs and COs)

U20ES608	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	-	M	H	-	-	-	-	-	L	L	-	-
CO2	M	L	L	L	-	-	-	-	-	M	M	-	-
CO3	L	L	H	L	M	-	-	-	-	M	M	-	-
CO4	-	-	M	M	M	-	-	-	-	L	M	-	-
CO5	-	-	M	M	M	-	-	-	-	-	L	-	-
CO6	-	-	-	-	M	H	L	-	-	-	-	M	L
CO7	-	-	-	-	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.D.Mahamuni

Core IX - ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT

Semester: VI
Credits: 4

Code: U21ES609
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 Sustainable Water Management and Land Management Strategies	K3	II
CO3	Apply the Sustainable Agriculture practices	K6	III
CO4	Apply the Sustainable Land resources management	K6	III
CO5	Justify the Forest Management through Social Forestry and Joint Forest Management	K5	IV
CO6	Explain the Disaster Management Strategies	K6	V

2. A. Syllabus

Unit I Resource Management and Sustainability

(15 Hrs.)

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

Unit II Global Conventions

(15 Hrs.)

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

Unit III Sustainable Management

(15 Hrs.)

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

Unit IV Sustainable Agriculture

(15 Hrs.)

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

Unit V Disaster Management

(15 Hrs.)

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

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

E. Web Links

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

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Resource Management and Sustainability		
1.1	Global consumption patterns of natural resources; Environmental issues in the world; Approaches to Environmental Management;	Identify the Global consumption patterns of Natural resources and approaches to Environment Management	K1
1.2	Environmental Management Strategy - Prevention – Enforcement – Monitoring – Education & Partnership; Sustainable development – history, concept and goals; strategies; circle of sustainability	Relate the Environment Management and Sustainable Development with its history, concept and goals and strategies, Circles of sustainability	K3

Unit II	Global Conventions		
2.1	Global conventions – Stockholm Conference, Brundtland commission, Rio Summit, Rio+10, Rio+20, Montreal Protocol, Kyoto protocol, Copenhagen summit	Explain the various protocol and summit.	K2
2.2	Global organizations – IPCC, UNEP, IUCN, WWF, Greenpeace International; National organizations – ATREE, BNHS, BSI, BVIEER, CEE, CSE, NEERI, NCF, SACON, TERI, WII, ZSI (Major objectives, activities and achievements).	Compare Global and National Organizations with their major objectives, activities and achievements	K5
Unit III	Sustainable Management		
3.1	Sustainable Water Management (SWM)- Water resources; Methods of water management: Conservation including rain water harvest and watershed management), Allocation, retrofit program and Behavioral practices;	Adapt the various method for water management. Plan to allocate, retrofit program and behavioral practices.	K6
3.2	Sustainable Land Management (SLM): Land use pattern; Land degradation – types, causes, impacts and control measures.	Evaluate the Land use Pattern and Land degradation such as types, causes impacts and control.	K5
Unit IV	Sustainable Agriculture		
4.1	Sustainable Agriculture: Factors affecting sustainability; Impacts of unsustainable agriculture; Intensification, water efficient agriculture, soil and nutrient amendments, integrated pests and weed management, crop rotation, polyculture / inter cropping, organic agriculture, alternative agriculture – urban agriculture, regenerative agriculture, integrated farming;	Dissect the impacts of factors affecting sustainability and unsustainable agriculture, Integrated pests and weed management. Examine the crop rotation, polyculture/inter cropping, organic agriculture, alternative agriculture- urban agriculture, regenerative agriculture, integrated farming.	K4
4.2	Sustainable Forest Management (SFM): Principles and Techniques; Forest management in India – Social Forestry Schemes; Joint Forest Management.	Interpret the principles and techniques of sustainable forest management. Examine the Social Forestry Schemes and Joint Forest management in India	K3
Unit V	Disaster Management		
5.1	Disaster management: Types of disaster – Natural and Manmade; Complex Emergencies, Environmental Disaster and Pandemic Emergencies; Disaster Management Strategy: Prevention, Preparedness, Response and Recovery; Management– Flood, Earthquakes, Cyclone;	Classify the types of Environmental Disaster and Pandemic emergencies. Able to Interpret the Disaster Management Strategies.	K2
5.2	Disaster management in India: National Disaster Management Authority (NDMA), State Disaster Management Authorities (SDMAs), District Disaster Management Authorities; Disaster Management Plan.	Propose a plan for the Disaster Management.	K6

4. Mapping Scheme (POs, PSOs and COs)

U21ES609	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: Dr.M.Sheela Mary

Core X – ENVIRONMENTAL LEGISLATIONS AND ENVIRONMENTAL IMPACT ASSESSMENT

Semester: VI
Credits: 4

Code: U20ES610
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	Recognize the processes and scope of Environmental Impact Assessment	K3	I
CO2	Discuss about various processes of Environmental Impact Assessment and Risk identification.	K3	II
CO3	Relate global and national legislative efforts towards environmental protection.	K6	III
CO4	Describe the history and outcomes of various government and non-governmental efforts towards environmental protection.	K5	IV
CO5	List and mark sanction and enforcement bodies of environmental laws.	K6	V
CO6	Relate the Legislation and EIA	K6	V

2. A. Syllabus

Unit I Environmental Impact Assessment

(15 Hrs.)

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

Unit II Environmental Impact Statement

(15 Hrs.)

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

Unit III Legislative Framework

(15 Hrs.)

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

Unit IV Environmental Laws

(15 Hrs.)

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

Unit V Environmental Acts and Rules

(15 Hrs.)

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

C. Text Books

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

D. Reference Books

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

E. Web links

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

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Environmental Impact Assessment			
1.1	Environmental Impact Assessment- Introduction; Types of EIA- Rapid, Comprehensive and Strategic EIA; Processes of EIA- Project Screening; Objectives and Alternatives in EIA	Relate the Assessment of Environmental Impact and it's strategic. Learn and Identify the objectives and alternatives in environmental impacts.	K3
1.2	Project Planning and processes, Baseline information, Impact prediction, Decision making; EIA Notifications of MoEF.	Rate the baseline information, Impact prediction, Decision making in EIA Notifications.	K5
Unit II Environmental Impact Statement			
2.1	Environmental Impact Statements (EIS); Environmental Risk Assessment and Management; Hazard Identification and Characterization; Health Risk Assessment; Disaster Management; Environmental Management Plan (EMP)	Identify the EIS and Environmental Risk Assessment and Management, Hazard Identification and Characterization; Health Risk Assessment. Explain the Disaster Management and EMP	K3
Unit III Legislative Framework			
3.1	National policy statement of environment and development; 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
3.2	International treaties on Environmental protection: 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.	K4
Unit IV Environmental Laws			
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 Movements: 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 V	Environmental Acts and Rules		
5	Water (Prevention and control of Pollution Act, 1974), Forest (Conservation) Act (1980); Air (Prevention and control of Pollution Act, 1981), Environment (protection) Act (1986); National Environment Policy (2006); Coastal Regulation Zone (CRZ) Notifications.	Recognize the various Environment Acts and rules of Water Act, Air Act, Environment Protection Act, National Environment Policy and Coastal Regulation Zone Notifications.	K1

4. Mapping Scheme (POs, PSOs and COs)

U20ES610	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	L	-	-	-	-	-	M-	-	H	M	-	L
CO2	H	M	-	H	L	-	-	L	L	H	M	-	-
CO3	M	-	M	-	-	M	-	-	-	H	-	-	M
CO4	H	M	L	-	M	L	-	H	L	H	M	M	L
CO5	H	H	M	L	-	L	M	L	L	-	L	-	-
CO6	M	H	M	L	M	L	M	-	L	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.D.Udhaya Banu

Core Practical IV - AIR AND SOIL ANALYSIS

Semester: VI
Credits: 3

Code: U20ES6P4
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	Explain the collection, handling and preservation of the environmental samples	K2	I
CO2	Assess the PM ₁₀ in the ambient air	K5	I
CO3	Demonstrate SO ₂ and NO _x in the ambient air	K2	I
CO4	Measure the ambient noise level.	K5	I
CO5	Analyze the physico- chemical parameters of soil	K4	II
CO6	Compare the results with the standards	K5	II

2. A. Syllabus

List of Experiments

I Air Analysis

(15 Hrs.)

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

II Soil Analysis

(60 Hrs.)

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

C. Text Books

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

D. Reference Books

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

E. Web Links

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

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I Air Analysis			
1.1	Air Analysis Estimation of PM ₁₀ in the ambient air	Estimate PM ₁₀ in ambient air	K4
1.2	Demonstration of SO ₂ NO _x in the ambient air	Analyze SO ₂ and NO _x in the ambient air	K4
1.3	Measurement of Ambient noise level	Estimate ambient noise level	K5
Unit II Soil Analysis			
2.1	Estimation of pH - pH metric method and EC - Conductivity method	Determine pH and EC of the soil sample	K4
2.2	Estimation of Alkalinity	Analyze the different water samples	K4
2.3	Estimation of Total Organic Matter, Phosphorous and Sodium and Potassium	Estimate Total Organic Matter, Phosphorous and Sodium and Potassium	K4

4. Mapping Scheme (POs, PSOs and COs)

U20ES6P4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	L	L	-	-	-	-	L	L	L	M	M
CO2	L	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	H	M	M	L	L	L	H	L	M	M
CO6	H	H	M	L	L	L	L	L	L	H	L	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

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

Course Coordinator: Dr.R.Teneson

Elective III - BASIC PRINCIPLES OF REMOTE SENSING AND GIS

Semester: VI
Credits: 4

Code: U20ES6:3
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	Define remote sensing and explain Principles of EMR	K1	I
CO2	Describe the components of EM Spectrum Interpret the interaction of EMR with Atmosphere, vegetation, soil and water	K4	I
CO3	Explain the satellite platforms and sensors	K4	II
CO4	Specify the resolution and its types.	K5	III
CO5	Develop the skills on geographic co-ordinate system and maps	K4	IV
CO6	Apply the techniques of GIS	K4	V

2. A. Syllabus

Unit I Remote Sensing

(15 Hrs.)

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

Unit II Satellite Platforms

(15 Hrs.)

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

Unit III Resolution

(15 Hrs.)

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

Unit IV Geographic Co-ordinate & Information System

(15 Hrs.)

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

Unit V Remote Sensing and GIS Applications

(15 Hrs.)

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

C. Text Books

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

D. Reference Books

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

E. Web links

1. <https://ncert.nic.in/textbook/pdf/kegy307.pdf>
2. https://www.patnauniversity.ac.in/e-content/social_sciences/geography/MAGeog71.pdf
3. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/resource/tutor/fundam/pdf/fundamentals_e.pdf
4. <https://www.patnauniversity.ac.in/e-content/science/geology/MScGeology34.pdf>
5. http://ags.geography.du.ac.in/Study%20Materials_files/Punyatoya%20Patra_AM.pdf

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	Remote Sensing		
1.1	An introduction; History; Definition – Components and Fundamental Principle of Remote sensing	Recognize Sensing; Principles of Remote Sensing; Types of Remote Sensing; Advantages	K1
1.2	The Electromagnetic radiation: Wave model, Particle theory – Electromagnetic spectrum - Energy interaction with the atmosphere:	Illustrate the concepts of remote sensing and the physical basis	K2

1.3	Scattering (Types of Scattering), absorption and refraction - interactions of energy with earth Surface: Reflection.	Examine various processes leading to satellite camera observations	K4
Unit II	Satellite Platforms		
2.1	Definition and Types of platforms (Ground Based, Airborne and Space borne)	Explain satellite platform and satellite imagery processing methods	K2
2.2	Satellite orbits: Definition and Types (Polar, Geo-stationery and Sun-synchronous)	Relationships among them	K4
2.3	Types of Sensors: Active and Passive	Compare the different type of remote sensing technology	K4
2.4	GPS and its applications	Illustrate Global Positioning System working methods and uses of different field	K2
Unit III	Resolution		
3.1	Definition and Types – Spatial, Spectral, Radiometric and Temporal.	Classify the types and relate them to the potential detail provided by the satellite imagery	K2
3.2	Significance of Satellites - LANDSAT Series, SPOT Satellite and IRS Satellites.	Classify the types and relate them to the different satellite platform and satellite imagery details	K2
Unit IV	Geographic Co-ordinate & Information System		
4.1	Geographic Co-ordinate System: Definition, Latitude and longitude	Recall the reference system for identifying earth locations	K1
4.2	Map: Definition and types. Significance of Geo-referencing map	Define map properties and uses	K1
4.3	Topo sheets - Definition and its uses. Map scale.	Explain the legend of topo sheets	K2
4.4	Geographical Information System: Definition - Components of GIS Hardware and software	Illustrate the concepts	K2
4.5	Raster and Vector Data structure.	distinguish between raster map and vector map properties	K4
Unit V	Remote Sensing and GIS Applications		
5.1	Remote sensing and GIS applications	Explain Geographic information system (GIS) uses and applications	K4

4. Mapping Scheme (POs, PSOs and COs)

U20ES6:3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	-	M	-	-	-	M	-	-	-	-	-	-	-
CO2	-	M	-	-	-	M	-	-	-	-	-	-	-
CO3	-	-	-	H	M	-	-	-	-	-	-	-	-
CO4	-	-	M	-	H	H	M	-	H	H	-	H	H
CO5	-	H	M	M	H	M	H	M	H	H	L	-	L
CO6	-	-	H	H	H	H	M	-	H	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
3. Course-end Survey

Course Coordinator: Dr.S.Sukumar

NMEC OFFERED BY THE DEPARTMENT
NMEC I - GLOBAL WARMING AND CLIMATE CHANGE

Semester:
Credits: 2

Code: U20ES3E1
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 Mitigation 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

4. Saha, T.K, Ecology and Environmental Biology. Books and Allied (P) Ltd. Kolkata,2008.
5. Annon, Intergovernmental Panel on Climate Change (IPCC) Climate Change 2001. Third Assessment Report (Volume I), Cambridge University Press, Cambridge,2001.
6. Annon. World Health Organization, Climate and Health, Fact sheet, July, 2005.

D. Reference Books

5. Annon, Climate Change 1995: Adaptation and Mitigation of Climate Change-Scientific Technical Analysis. Cambridge University Press, Cambridge, 1996.
6. Gosain, A.K. and Rao, S. Climate Change and India: Vulnerability Assessment and Adaptation. Eds. Shukla, P.R., Universities Press Pvt. Ltd., Hyderabad, 2003.
7. Houghton, J. Global Warming: The Complete Briefing, Cambridge University Press, Cambridge, 2005.

8. 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		Global 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		Mitigation Measures	
5.1	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	Describe Clean Development Mechanism	K2
		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)

U20ES3E1	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.D. Mahamuni

NMEC II - ENVIRONMENTAL SAFETY, HEALTH AND MANAGEMENT

Semester: IV
Credits: 2

Code: U2OES4E2
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	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.

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	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