Syllabus under Outcome-Based Education

M.Sc. ENVIRONMENTAL SCIENCES

For the Students Admitted in the Academic Year 2019-2020

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

DEPARTMENT OF ENVIRONMENTAL SCIENCES

BISHOP HEBER COLLEGE (AUTONOMOUS)

(Affiliated to Bharathidasan University
Nationally reaccredited with 'A' Grade by NAAC
Recognized by UGC as "**College of Excellence**"
"Star College" Status Awarded by the DBT
DST-FIST Sponsored College)
Tiruchirappalli – 620 017
Tamil Nadu. India

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Vision

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

Mission

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

Program Outcomes

On successful completion of M.Sc. Environmental Sciences Program the post-graduate will be able to

Knowledge:

PO1: Exhibit advanced comprehensive knowledge in the field of Environmental Sciences through Inter-Disciplinary approaches

PO2: Critically analyze the relationships existing among various spheres of Natural Environment and Impact of Anthropogenic Activities

PO3: Identify and recognize appropriate scientific, research outcomes and environmental standards towards mitigation of consequences of environmental problems

Skill:

PO4: Utilize a broad spectrum of tools and techniques of qualitative and quantitative nature with the aid Computational Modeling

PO5: Assess and evaluate the results obtained from data analyses to arrive conclusions prepare the Report for dissemination

PO6: Develop multidisciplinary approaches towards designing technologies to resolve the environmental problems related but not restricted to water, wastewater treatment, air pollution, noise pollution and solid waste management strategies

Attitude:

PO7: Demonstrate leadership qualities and social responsibilities, willingness to collaborate with governmental and non-governmental agencies addressing environmental issues

PO8: Develop environmental responsibilities and disseminate environmental ethics to build a sustainable society through mass awareness programs with appropriate communication services

PO9: Infer social and professional ethics towards the development of environmental consciousness

Program Specific Outcomes

PSO1: Comprehend the principles and concepts of functioning of the environment and relate the theoretical knowledge in the field / real world with a multi-disciplinary / inter-disciplinary approach

PSO2: Determine the properties of the environment qualitatively and quantitatively and their compliance to the environmental standards and to justify the importance of Environmental Protection

PSO3: Assess the status of environment using guidelines devised by regulatory bodies towards natural resources conservation, pollution management and sustainable development

PSO4: Relate the theoretical knowledge with field applications, develop new ideas and strategies with creativity in relevant subject(s) related to Environment and contribute in various domains of the environment

Structure of the Curriculum 2019-2021
M.Sc. Environmental Sciences

Curricular Component	No. of Courses	Credits
Core (Theory)	11	44
Core (Practical)	05	17
Elective	05	21
Project	01	06
VLOC	01	02
Total	**23**	**90**

M.Sc. Environmental Sciences- Core and Elective papers offered by the Department for the students admitted during 2019-2020

Sem.	Course Type	Course Code	Course Title	Hours per Week	Credits	Marks		
						CIA	ESA	Total
I	Core I	P16ES101	Fundamentals of Physical Environment	5	4	25	75	100
	Core II	P16ES102	Fundamentals of Ecology	5	4	25	75	100
	Core III	P16ES103	Environmental Chemistry	5	4	25	75	100
	Core IV	P16ES104	Environmental Microbiology and Biotechnology	5	4	25	75	100
	Core Practical I	P16ES1P1	Ecology and Environmental Chemistry	5	4	40	60	100
	Elective I	P16ES1:1	Energy and Environment	5	4	25	75	100
II	Core V	P16ES205	Environmental Toxicology and Bioremediation	4	4	25	75	100
	Core VI	P16ES206	Research Design and Instrumental Methods	4	4	25	75	100
	Core VII	P16ES207	Mathematical Models in Environmental Sciences	4	4	25	75	100
	Core Practical II	P16ES2P2	Environmental Microbiology, Biotechnology and Toxicology	4	4	40	60	100
	Core Practical III	P16ES2P3	Mathematical Models in Environmental Sciences	3	3	40	60	100
	Elective II	P19ES2:2	Environmental Management, Sustainable Development and Biodiversity Conservation	5	4	25	75	100
	Elective III	P19ES2:3	Green Science and Technology	4	4	25	75	100
	VLOC	P17VL1:1 P17VL1:2	RI/MI	2	2	25	75	100
III	Core VIII	P16ES308	Environmental Pollution	5	4	25	75	100
	Core IX	P16ES309	Environmental Engineering	5	4	25	75	100
	Core X	P16ES310	Industrial Pollution and Safety Management	5	4	25	75	100
	Core XI	P16ES311	Environmental Impact Assessment	5	4	25	75	100
	Core Practical IV	P16ES3P4	Water Pollution and its control Engineering	5	4	40	60	100
	Elective IV	P19ES3:4	Remote Sensing and GIS for Environmental Sciences	5	4	25	75	100
IV	Core Practical V	P16ES4P5	Air and Soil Pollution and Air Pollution control Engineering	5	4	40	60	100
	Elective V	P19ES4F1	Internship and Field Work	5	4	-	-	100
	Project	P19ES4PJ	Project	20	5	-	-	100
	Total Credits			**90**				

Programme Articulation Matrix – M.Sc. Environmental Sciences (Students admitted during 2019-2020)

Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
P16ES101	Fundamentals of Physical Environment	H	H	H	M	M	M	H	H	M	M	M	M	H
P16ES102	Fundamentals of Ecology	H	H	M	L	L	L	L	M	L	H	M	M	L
P16ES103	Environmental Chemistry	H	M	M	M	M	M	M	M	L	M	H	M	M
P16ES104	Environmental Microbiology and Biotechnology	H	H	M	M	L	L	L	M	M	H	L	M	M
P16ES1P1	Ecology and Environmental Chemistry	H	H	H	-	H	M	L	-	M	-	H	H	-
P16ES1:1	Energy and Environment	H	H	M	L	L	L	L	L	L	H	M	M	L
P16ES205	Environmental Toxicology and Bioremediation	H	H	M	M	L	L	L	M	M	H	L	M	M
P16ES206	Research Design and Instrumental Methods	M	M	M	M	M	H	H	M	M	H	M	M	M
P16ES207	Mathematical Models in Environmental Sciences	H	H	M	H	M	M	M	M	M	H	L	-	M
P16ES2P2	Environmental Microbiology, Biotechnology and Toxicology	H	H	L	L	L	L	L	L	L	H	L	L	M
P16ES2P3	Mathematical Models in Environmental Sciences	H	H	H	H	H	H	M	M	L	H	L	H	H
P19ES2:2	Environmental Management, Sustainable Development and Biodiversity Conservation	L	-	H	-	-	M	M	L	H	M	-	M	M
P19ES2:3	Green Science and Technology	H	H	M	M	L	L	M	M	L	H	L	-	M
P16ES308	Environmental Pollution	M	M	M	M	M	H	H	M	M	H	M	M	M
P16ES309	Environmental Engineering	H	L	L	M	M	M	L	L	L	H	M	M	M
P16ES310	Industrial Pollution and Safety Management	M	M	H	M	M	H	L	L	L	M	M	M	M
P16ES311	Environmental Impact Assessment	M	L	M	M	L	L	M	M	L	H	L	M	H
P16ES3P4	Water Pollution and its control Engineering	H	M	M	M	M	M	L	M	L	H	H	H	M
P19ES3:4	Remote Sensing and GIS for Environmental Sciences	H	M	H	M	M	H	-	L	-	H	H	H	M
P16ES4P5	Air and Soil Pollution and Air Pollution control Engineering	H	L	M	M	H	M	L	L	L	M	H	H	M
P19ES4F1	Internship and Field Work	M	H	H	-	-	M	M	H	M	M	H	H	M

Core I: FUNDAMENTALS OF PHYSICAL ENVIRONMENT

Semester: I **Code: P16ES101**
Credits: 4 **Hours/ Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Recall the atmosphere layers, radiation and heat balance	**K1**	**I**
CO2	Relate the global surface circulation model with climate change and Indian monsoon	**K4**	**I**
CO3	Demonstrate the hydrological cycle, types of precipitation and oceanic circulation	**K2**	**II**
CO4	Illustrate the structure of lithosphere and explain the soil formation	**K5**	**III**
CO5	Examine the development of biosphere with the different biogeographic regions of the world	**K5**	**IV**
CO6	Explain the biogeographical classification with the major forests in India.	**K4**	**V**

2.A. Syllabus

Unit 1 Introduction **(19 Hrs)**

Definition, principles & scope of Environmental Sciences.

Atmosphere: Structure and composition of atmosphere – Radiation and heat balance. Global Surface Circulation model, actual surface circulation, secondary surface circulation, Climate and Climate change (El-Nino, ENSO) Indian monsoon, Tropical cyclone.

Unit 2 Hydrosphere: **(15 Hrs)**

Hydrological cycle – Surface water, ground water, infiltration, Floods and droughts; Precipitation-Convectional precipitation, orographic precipitation; Oceanic circulation – an over view.

Unit 3 Lithosphere: **(12 Hrs)**

Earth's structure - internal layer, outer layer; Rock types, Soil formation, types of soil, soil horizon

Unit 4 Biosphere: **(12 Hrs)**

The development of Biosphere on Earth, Biogeographic regions of the world – Phyto-geographic (10 zones from tropic, temperate, sub arctic and arctic regions) and Zoogeographic realms – 8 zones.

Unit 5 Indian biogeography: **(17 Hrs)**

Biogeographical classification of India (10 zones); major forests in India – 16 Forest type groups.

B. Topics for Self-study

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

C. Text Books

1. Miller GT, Environmental Sciences, 10th Edition. Thomson Brooks /Cole, 2004
2. Edward A, Keller, Introduction to Environmental Geology, 4/E, Edward A. Keller, ISBN:10:0132251507ISBN-13:9780132251501, Pearson Prentice Hall, 2008.
3. Peter O. Muller, Harm J. de Blij, Richard S. Williams, Environmental Geography, Oxford University Press, USA, 2004.
4. Singh JS, Singh SP and Gupta SR, Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi, 2006.
5. Strahler and Strahler, Environmental Geology, Willey and Sons, NY, 1970.

D. Reference Books

1. Bailey Ronald Albert, Chemistry of the Environment, Academic Press, New York, 1978.
2. Carla W, Montgomery, Environmental Geology, McGraw Hill Publishers, ISBN: 0073661953, 9780073661957, 2002.
3. Johnson DO, Netteville JT, Wood JC and James M, Chemistry and the Environment, W.B. Saunders Co., Philadelphia, 1973.
4. Sawyer CN, Mc Carty PL and Perkinn GF, Chemistry for Environmental Engineering, II edition. McGraw Hill, 1994.
5. Sharma BK and Kaur H, Environmental Chemistry, Goel Publishing House, Meerut, 1994.

E. Web Links

1. https://niwa.co.nz/education-and-training/schools/students/layers#:~:text=The%20atmosphere%20is%20comprised%20of,surface%20is%20called%20the%20exosphere.
2. https://scied.ucar.edu/learning-zone/how-weather-works/global-air-atmospheric-circulation#:~:text=Air%20in%20the%20atmosphere%20moves,pattern%20called%20global%20atmospheric%20circulation.&text=This%20pattern%2C%20called%20atmospheric%20circulation,the%20equator%2C%20warm%20air%20rises.
3. https://www.nationalgeographic.org/topics/resource-library-ocean-currents/?q=&page=1&per_page=25
4. https://www.nature.com/scitable/knowledge/library/earth-s-earliest-climate-24206248/
5. https://www.google.com/search?sa=X&q=Beyond+the+Atmosphere:+Early+Years+of+Space+Science+Homer+E.+Newell+Jr.&stick=H4sIAAAAAAAAAGWUTWjUQBiGN6vdtmmr-
6. https://www.google.com/search?sa=X&q=Hydrosphere:+Freshwater+Systems+and+Pollution+Dana+Desonie&stick=H4sIAAAAAAAAAGWST2jTUBzHm-
7. https://www.google.com/search?q=The+Lithosphere:+An+Interdisciplinary+Approach&stick=H4sIAAAAAAAAAGVTT2jTUBxuquu2bJM2UxjFQ-
8. https://www.google.com/search?q=Ecology:+From+Ecosystem+to+Biosphere&stick=H4sIAAAAAAAAAGWUT2jTUBzHm-

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	**Atmosphere**		
1.1	Atmosphere: Components of environment – atmosphere, hydrosphere, biosphere, lithosphere and their interrelationships	Recall various components of environment	K1
		Illustrate the interrelationships among the Spheres	K2
1.2	Atmosphere: Structure and composition of atmosphere; Vertical Stratification – Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere;	Explain the Structure and vertical layers of Atmosphere & relate with height and temperature variations	K2
1.3	Physical properties, Optical properties; Circulation - Latitudinal circulation features Longitudinal circulation features, Radiation and heat balance	Relate the optical properties of atmosphere with the net radiation	K1
		Examine the association between the circulation features and radiation / heat balance	K4
Unit II	**Air Pressure and Winds**		
2.1	Air Pressure and Winds: Coriolis Force; Types of Winds: Permanent, Secondary & Local Winds; Geostrophic Wind,	Demonstrate the formation of winds and their causes and classify them at local, regional & global levels	K3
2.2	Jet Streams & Rossby Waves; Major Jet Streams: Subtropical Jet Stream & Polar Jet Stream; Fronts: Types of Fronts: Stationary Front, Warm Front, Cold Front & Occluded Front.	Explain the major Jet Streams, and Fronts	K2
2.3	Circulation pattern of the atmosphere-Model surface circulation, actual surface circulation, Secondary surface circulation, circulation of the upper atmosphere	Illustrate Atmospheric Circulation Model	K2
		Distinguish between model and the real circulation Discriminate the surface circulation from upper circulation Analyze their relationships with Climate, rainfall and precipitation	K4
Unit III	**Interaction of Atmosphere and Hydrosphere**		
3.1	Interaction of Atmosphere and Hydrosphere: Distribution of water, hydrologic cycle and water	Relate the atmospheric phenomena with hydrosphere	K3

	budget; Ocean currents–based on temperature & based on depth. Role of Ocean currents in affecting the weather and climate.	Formulate hypotheses from the concepts learned	K5
3.2	Cloud and Precipitation formation; Energy and moisture transformation within weather systems	Demonstrate the formation of Clouds and Precipitation Categorize the types of Precipitation	K2
Unit IV	**Weather Systems**		
4.1	Weather Systems: At low latitudes and middle and high latitudes Meteorological scales: micro scale, mesoscale, synoptic scale and global scale;	Classify the Weather features at various scales Relate their impact on environment	K2
4.2	Cyclogenesis - Tropical cyclone-hurricanes, cyclones, typhoons and tornadoes, subtropical cyclone, Extra tropical cyclones	Illustrate the formation of Cyclones	K2
		Compare the cyclones at different latitudes	K2
Unit V	**Earth's Climate and Climate Change**		
5.1	Earth's Climate & Climate Change: Koppen climate classification system;	Recall the Koppen Classification of Climate System	K1
5.2	*El Nino*; ENSO; *La Nina*; Modoki; Indian Ocean Dipole (IOD);	Interpret the theories of formation of *El Nino*; ENSO; *La Nina*; Modoki; Indian Ocean Dipole (IOD)	K2
5.3	Polar Vortex & Ozone Hole (Ozone Depletion); Madden Julian Oscillation.	Relate the phenomena of polar vortex with ozone depletion	K1
		Examine the causes of Madden Julian Oscillation	K4
	Climate Change: forcing mechanisms – internal variability & external climate forcing; Evidence and consequences; the climate since the Earth's formation; past and modern climate change.	Demonstrate the causes of Climate change and relating with various forcing mechanisms	K2

4. Mapping Scheme (POs, PSOs and COs)

P16ES101	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	M	L	M	L	M	M	M	H	L	M	M
CO2	H	H	H	M	H	H	M	H	M	H	M	M	H
CO3	H	H	H	H	H	L	M	H	M	H	M	M	H
CO4	H	H	H	M	M	M	L	L	L	L	M	M	H
CO5	H	H	M	-	L	L	H	H	H	M	-	M	M
CO6	H	H	M	-	L	L	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. Carlton

Core II: FUNDAMENTALS OF ECOLOGY

Semester: I **Code: P16ES102**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Describe the concept, principles and dynamics of ecosystem	K2	I
CO2	Classify and compare the different types of ecosystems	K2	II
CO3	Summarize and theorize the attributes of population and analyze and relate the biotic interactions	K4	III
CO4	Summarize and theorize the attributes of community and the implications	K3	IV
CO5	Execute the ecological tools in the field and analyse and interpret the data.	K4	V
CO6	Appraise and conclude the obtained ecological information	K6	V

2.A. Syllabus

Unit 1 Structure, principles and concepts of ecosystem: (15 Hrs.)

Components of ecosystem - biotic and abiotic factors- producers, consumers, and decomposers, food chain, food web; Dynamics of Ecosystems - energy flow –primary productivity and secondary productivity; Biogeochemical cycles – Carbon, Nitrogen, Phosphorus cycles.

Unit 2 Ecosystem (15 Hrs.)

Ecosystem Types: (Classification, basic concepts & adaptations) Aquatic– Freshwater–lentic, lotic; Marine – neritic - estuarine – mangrove, intertidal zones, tidal flats, seagrass bed, coral bed; oceanic – pelagic, benthic; Terrestrial ecosystem – forest, grassland, desert.

Unit 3 Population (14 Hrs.)

Population: Definition, characteristics of population - density, natality, mortality, age distribution, growth patterns, population fluctuation, population equilibrium, biotic potentials, population dispersion, regulation of population; biotic interactions- intra-specific and inter-specific.

Unit 4 Community (14 Hrs.)

Community**:** Physical Structure: - structure, stratification; Biological structure: Species richness, Species diversity, Abundance, Dominance, Frequency, Importance value, Keystone species; Community characteristics: guild, ecotone, ecocline, edge effect, ecological niche, ecological equivalents, ecological pyramid, and ecological succession.

Unit 5 Ecological tools & Techniques (17 Hrs.)

Ecological tools & Techniques: Sampling plant populations: Qualitative assessment–Floristic composition, stratification; Quantitative assessment – Frequency, density, abundance, cover and basal area; Sampling phytoplankton, Sampling animal populations.

B. Topics for Self-study

- **Biogeographic zones** (https://portals.iucn.org/library/sites/library/files/documents/OP-018.pdf)
- **Biogeographic classification of India** (https://en.wikipedia.org/wiki/Biogeographic_classification_of_India)
- **Habitat Ecology (**https://www.biologydiscussion.com/ecology/top-4-types-of-habitat-ecology/59797)
- **Ecological modelling (**https://en.wikipedia.org/wiki/Ecosystem_model)

C. Text Books

1. Verma PS and Agarwal VK, Environmental Biology: Principles of Ecology, S Chand & Company Pvt Ltd., 1983, ISBN: 9788121908597.
2. Dash, M.C. and Dash, S.P. Fundamentals of Ecology, Tata McGraw-Hill Education Private Ltd., New Delhi, 2009, ISBN (13): 978-0-07-008366-0
3. Clarke GL, Elements of Ecology, Chapman & Hall, London John Wiley & Sons, New York, 1954. (ISBN – not available)
4. Barrick, M., Barrett, G.W., and Odum, E., Fundamentals of Ecology, 5th Edition, Cengage, 2005, ISBN: 9788131500200, 8131500209.
5. Sharma PD, Ecology and Environment, 7th Edition, Rastogi Publication, Meerut, 2003 ISBN: 978-93-5078-122-7

D. Reference Books

1. Chapman JL and Reiss MJ, Ecology-Principles and applications, second edition, Cambridge University Press (Low price edition), Cambridge, 2000, ISBN**:** 0521005752
2. Miller, G. Tyler and Spoolman, Scott, Environmental science, 16e, Boston, MA, USA: Cengage, 2019, ISBN: 1337569615, 9781337569613

E. Web Links:

1. https://libguides.brighton.ac.uk/ecology/webresearch
2. https://projects.ncsu.edu/cals/course/fw353/Estimate.htm#:~:text=In%20practice%2C%20population%20estimates%20are,%2C%20and%20mark%2Drecapture%20methods
3. https://www.questia.com/library/science-and-technology/environmental-and-earth-sciences/ecology

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	**Structure, principles and concepts of ecosystem**		
1.1	Ecosystem and its components Structure of the ecosystem	Recall various components of an ecosystem	K1
1.2	Dynamics of ecosystem, Energy flow in an ecosystem Biogeochemical cycle in an ecosystem	Illustrate the interrelationships among the components of the ecosystem	K2
Unit II	**Ecosystem types**		
2.1	Classification, basic concepts & adaptations of aquatic– Freshwater–lentic, lotic systems	Classify and sketch the aquatic ecosystems	K2
2.2	Classification, basic concepts & adaptations of marine – neritic - estuarine – mangrove, intertidal zones, tidal flats, seagrass bed, coral bed; oceanic – pelagic, benthic;	Classify and sketch the marine ecosystems	K2
2.3	Classification, basic concepts & adaptations of terrestrial ecosystem – forest, grassland, desert.	Classify and sketch the terrestrial ecosystems	K2
2.4	Ecological pyramid and ecological succession–models—facilitation, tolerance, and inhibition	Construct the ecological pyramids in an ecosystem and theorize the concept of ecological succession	K5
Unit III	**Population**		
3.1	characteristics of population - density, natality, mortality, age distribution, growth patterns, population fluctuation, population equilibrium, biotic potentials, population dispersion, regulation of population	Summarize and theorize the population attributes of an ecosystem	K4
3.2	biotic interactions- intra-specific and inter-specific.	Analyze the relationship among biotics	K4
Unit IV	**Community**		
4.1	Physical Structure: - structure, stratification; Biological structure: Species richness, Species diversity, Abundance, Dominance, Frequency, Importance value, Keystone species	Summarize and theorize the attributes of a community	K4

4.2	Community characteristics: guild, ecotone, ecocline, edge effect, ecological niche, ecological equivalents, ecological pyramid, and ecological succession.	Analyze and interpret the dynamics of a community	K5
Unit V	**Ecological Tools**		
5.1	Sampling plant populations: Qualitative assessment–Floristic composition, stratification	Execute the ecological tools in the field	K3
5.2	Sampling animal populations	Execute the ecological tools in the field	K3
5.3	Analysis of data; Quantitative assessment of diversity- Frequency, density, abundance, cover and basal area	Analyse, Appraise and conclude the obtained ecological information	K6

4. Mapping Scheme (POs, PSOs and COs)

P16ES102	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	L	L	L	L	M	M	H	M	M	L
CO2	H	H	L	L	L	L	L	M	M	H	M	M	L
CO3	H	H	H	L	L	L	L	M	M	H	M	M	L
CO4	H	H	H	L	L	L	L	M	L	H	M	M	L
CO5	M	M	L	L	L	L	L	M	L	H	M	M	L
CO6	M	H	M	L	L	L	L	M	L	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. A. Daisy Caroline Mary

Core III: ENVIRONMENTAL CHEMISTRY

Semester: I **Code: P16ES103**
Credits: 4 **Hours/ Week: 5**

1. Course Outcomes

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

CO No.	Course Outcomes	Level	Unit
CO1	Apply the concentration units for solutions.	**K3**	**I**
CO2	Compare thermochemical and photochemical reactions in the atmosphere.	**K2**	**II**
CO3	Determine water quality parameters.	**K5**	**III**
CO4	Outline the physico-chemical properties of soil.	**K2**	**IV**
CO5	Classify heavy metal speciation in water.	**K4**	**IV**
CO6	Discuss various biochemical reactions involved in living organisms.	**K6**	**V**

Unit 1 Fundamentals of Chemistry: (10 Hrs.)

Introduction to Modern Periodic table, elements, compounds, Types of chemical bonds. Avogadro's hypothesis. Molecular weight, equivalent weight, mole concept, Normality, molarity, molality, stoichiometry – concept. Volumetric analysis –principles of acid-base titrations; Primary and secondary standards - preparations, calculations of concentrations of solutions using specific gravities and molecular weights. Ionic product of water, pH and pOH, buffer solutions. Solubility product, solubility of gases in water, the carbonate system.

Unit 2 Chemical composition of Air: (10 Hrs.)

Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermo chemical and photochemical reactions in the atmosphere. Oxygen and ozone chemistry. Units of measurement – *ppm*(*v*/*v*), *ppb*(*v*/*v*), $\mu g/m^3$.

Unit 3 Water Chemistry: (10 Hrs.)

Physico-chemical characteristics of water. Sampling methods of water. Principles of Determination of DO, BOD, COD, pH, Electrical Conductivity, Dissolved solids, Hardness, Chloride, Fluoride, Sodium, Potassium, Phosphate.

Unit 4 Chemistry of the soil: (10 Hrs.)

Physico - Chemical properties of soil: Temperature, Texture, Structure, Minerals of soil - colloids in soil; ion exchange reactions in soil. Soil pH and its effects. Chemical speciation: Speciation scheme- classification of heavy metal speciation in water. Chemical speciation of copper, lead, mercury, arsenic, selenium and chromium. Trace elements and its significance (Molybdenum and zinc only).

Unit 5 Biochemistry: (10 Hrs.)

Classification and functions of carbohydrates, proteins and lipids. Metabolism - Glycolysis, Citric acid cycle, Electron transport, Oxidative phosphorylation and regulation of ATP production. Photosynthetic pathway.

B. Topics for Self-study:

- **pH and Buffer in living systems** (https://youtu.be/9-R98kRa9PI)
- **Organo Halogen compounds as Pollutants** (https://youtu.be/sJNjw09k_ms)
- **Properties of Water** (https://youtu.be/h0py6BFlFZw)
  Isomorphic Substitution (https://youtu.be/NMhcE5enGRk)
- **Balanced food** (https://youtu.be/fR3NxCR9z2U)

C. Text Books

1. Banerji SK, Environmental chemistry (2002). Prentice-Hall of India Private Limited, New Delhi.
2. De AK, Environmental Chemistry, 5th Ed. (2003). New Age International (P) Limited, Publishers, New Delhi, ISBN 8122414885.
3. Sharma BK and Kaur H, Environmental Chemistry (1994). Goel Publishing House, Meerut.
4. Manahan SE, Environmental Chemistry (2005). CRC Press.

D. Reference Books

1. Lehninger AL, Principles of Biochemistry (1982). CBS Publishers and Distributors. Delhi.
2. Bhatia SC, Environmental Chemistry (2002). CBS Publishers and Distributors. New Delhi.
3. Cunningham P, Cooper H, Eville G and Hepworth MT, Environmental Encyclopedia (1999). Jaico Publishing House, Mumbai.
4. Esmarch S. Gilreath, Fundamental Concepts of Inorganic Chemistry (1958). McGraw Hill Publishers, New York.
5. Don S, Essentials of Physical Chemistry (2011). CRC Press. ISBN: 9781439896938.
6. Johnson DO, Netteville JT, Wood JC and James M, Chemistry and the Environment (1973). W.B. Saunders Co., Philadelphia.
7. Williamson SJ, Fundamentals of Air Pollution (1971). Wesley Publishing Company.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	**Fundamentals of Chemistry**		
1	Introduction to Modern Periodic table, elements, compounds,	Classification of elements in periodic table	K2
	Avogadro's hypothesis, Molecular weight, equivalent weight, mole concept, Normality, molarity, molality, stoichiometry	Determination of concentration of solutions using different concentration terms	K3
	Volumetric analysis –principles of acid-base titrations; Primary and secondary standards - preparations, calculations of concentrations of solutions using specific gravities and molecular weights.	Explain the principle of Volumetric anlaysis and to determine the strengths of solutions	K3
	Ionic product of water, pH and pOH, buffer solutions. Solubility product, solubility of gases in water, the carbonate system.	Determination of Ionic Product and Solubility product of water Highlight the importance of pH and pOH Buffer solution and its types	K3 K3 K3
Unit II	**Chemical Composition of Air**		
2	Particles, ions and radicals in the atmosphere - Chemical processes for formation of inorganic and organic particulate matter	List of Particles, ions and radicals present in the atmosphere. Explain the process of formation of Inorganic and organic particulate matter	K2 K3
	Thermo chemical and photochemical reactions in the atmosphere	Compare thermochemical and photochemical reactions in the atmosphere.	K5
	Oxygen and ozone chemistry. Units of measurement – *ppm*(v/v), *ppb*(v/v), $\mu g/m^3$.	Highlight the chemistry of Oxygen and Ozone. Applying different units of measurements	K4 K3
Unit III			
3	Physico-chemical characteristic of water	Elaborate the physico-chemical characteristic of water	K6
	Water sampling- Sampling methods of water	Illustrate the water sampling methods	K2

	Principles of determination of parameters of water- DO, BOD, COD, pH, electrical conductivity, dissolved solids, hardness, chloride, fluoride, sodium, potassium and phosphate	Determine the water quality parameters	K5
Unit IV	**Chemistry of the soil**		
4	Introduction & physico-chemical properties of soil- soil temperature, texture, structure, minerals of soil, colloids in soil, ion-exchange reactions in soil, soil pH and its effects	Explain the physico-chemical properties of soil	K2
	Introduction of Chemical speciation in water- scheme of classification	Classify the chemical speciation in water.	K4
	Chemical speciation- speciation of copper, lead, mercury, arsenic, selenium, chromium,	Elaborate the speciation of Cu, Pb, Hg, As, Se and Cr	K6
	Trace elements and its significance- molybdenum and zinc	Describe the significance of trace elements	K2
Unit V	**Biochemistry**		
5	Classification and functions of carbohydrates, proteins and lipids	Classify carbohydrates, proteins and lipids and the functions of nutrients	K4
	Metabolism - Glycolysis, Citric acid cycle, Electron transport, Oxidative phosphorylation and regulation of ATP production. Photosynthetic pathway.	Designing of Mechanism of Metabolism and various biochemical processes	K6

4. Mapping Scheme (POs, PSOs and COs)

P16ES103	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	M	M	H	M	-	-	-	L	H	M	-
CO2	M	H	M	M	M	H	M	M	M	M	H	M	M
CO3	M	L	M	H	M	H	-	-	L	L	H	M	L
CO4	H	M	L	M	H	L	-	-	-	M	M	L	M
CO5	H	M	M	H	L	M	-	-	L	M	H	L	-
CO6	H	-	L	M	-	L	M	-	-	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. T. Nalini

Core IV: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Semester: I **Code: P16ES104**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Describe the Importance of microbial diversity at molecular level.	K5	I
CO2	Distinguish the various types of microbial growth and methods of microbial growth estimation	K4	II
CO3	Recollect the microbial ecology and relate their interactions	K3	III
CO4	Explain the principles in bioprocess technology	K3	IV
CO5	Identify the primary and secondary metabolites	K3	IV
CO6	Importance of molecular techniques in environmental management	K3	V

2.A. Syllabus

Unit I Microbial Diversity **(15 Hrs.)**

Microbial Diversity & Systematics: Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Unit II Microbial Growth **(15 Hrs.)**

Microbial Growth: Ultra structure of Archaea (Methanococcus); Eubacteria (E. coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell.

Unit III Microbial Interactions **(15 Hrs)**

Microbial Interactions and Infection Host–Pathogen interactions: Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence - Microbes and Environment- Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Prebiotics and Probiotics.

Unit IV Industrial Applications **(15 Hrs.)**

Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Bio technologically important intracellular products.

Unit V Molecular Techniques in Environmental Management **(15 Hrs.)**

Molecular probes – Bioluminescence – PCR- RFLP-RAPD- Immunological techniques – Hybridization techniques, R-DNA techniques.

B. Topics for Self-study:

- **Submerged Fermentation** (https://microbenotes.com/submerged-fermentation/)
- **Gene cloning** (https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/)

C. Text Books

1. Michael J. Pelczar, Microbiology, Tata McGraw-Hill, 2010
2. L.E Casida, JR, Industrial Microbiology, New Age International, PJ Limited, Publisher, 2015
3. G. Reed, 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. DP & SK Dwivedi, Environmental Microbiology and Biotechnology.1st Edition, New Age International (P) Ltd., Publishers, New Delhi, 2005.

D. Reference Books

1. Subba Rao NS, Soil Microbiology, 4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2004.
2. Robert L Tate, Soil Microbiology, 1st Edition, John Wiley & Sons, Inc. New York, 1995.
3. MitchellR,IntroductiontoEnvironmentalMicrobiology (1974),Prentice-Hall.Inc.EnglewoodCliffs,NewJersy, USA.
4. Alexander N. Glazer Hiroshi Nikaido, Microbial Biotechnology, WH Freeman and Company, NY, USA, 1995.
5. Bernaral R. Glick and Jack J. Pastemak, Molecular Biotechnogy: Principles and Applications of Recombinant DNA, ASM Press. Washingto n, DC USA, 1994.

E. Web Links

1. https://micro.magnet.fsu.edu/cells/bacteriacell.html
2. https://www.grains.k-state.edu/spirel/docs/research/heat-ipm/presentations/Thermal%20death%20kinetics.pdf
3. https://www.bgr.bund.de/EN/Themen/Min_rohstoffe/Biomining/biomining_node_en.html
4. https://acsess.onlinelibrary.wiley.com/doi/full/10.2134/csa2017.62.1202

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	**Microbial Diversity**		
1.1	Microbial Diversity & Systematics: Classical and modern methods and Concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual;	Define the application areas of microbiology taking part in Environmental Sciences. Learn the occurrence, abundance and distribution of microorganism in the environment.	K1
1.2	Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.	Explain the process protocol for the, synthesis and characterization of nanoparticles	K5

Unit II	**Microbial Growth**		
2.1	Microbial Growth: Ultra structure of Archaea (Methanococcus); Eubacteria (E. coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses);	Define general characteristics of bacteria, fungus, alga, protists and viruses.	K4
2.2	Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants,.	Define the concepts used in microbial control.	K1
2.3	Methods of growth estimation, stringent response, death of a bacterial cell	Categorize and define the techniques used at controlling microorganisms.	K2
Unit III	**Microbial Interactions**		
3.1	Microbial Interactions and Infection Host–Pathogen interactions: Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence - Microbes and Environment	Recollect the microbial ecology and relate their interactions	K1
3.2	Role of microorganisms in natural system and artificial system;	Emphasise the importance of microorganisms in the environment	K2
3.3	Influence of Microbes on the Earth's Environment and Inhabitants;	Explain the influence of microbes	K2
3.4	Prebiotics and Probiotics.	Find prebiotic organisms in food and benefits of probiotics	K1
Unit IV	**Industrial Applications**		
4.1	Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems;	Find assimilate the concepts and specific terminology of environmental Biotechnology	K1
4.2	Primary and secondary metabolites; Extracellular enzymes; Bio technologically important intracellular products.	Classify the basics and concepts of various biotechnological related terms	K2
Unit V	**Molecular Techniques in Environmental Management**		
5.1	Molecular Techniques in Environmental Management: Molecular probes – Bioluminescence	Discuss issues related to plant nutrition, quality improvement, environmental adaptation, transgenic crops and their use in agriculture	K6
5.2	– PCRRFLP-RAPD- Immunological techniques– Hybridization techniques, R-DNA techniques.	Analyze and elucidate the molecular techniques involved in gene manipulation and rDNA technology	K4

4. Mapping Scheme (POs, PSOs and COs)

P16ES104	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	L	-	-	L	-	-	-	H	L	-	M
CO2	H	H	M	-	L	L	L	-	-	H	L	L	L
CO3	H	H	H	L	L	M	-	M	M	H	M	-	M
CO4	H	H	H	L	L	M	-	M	M	H	M	-	M
CO5	H	M	H	M	M	L	L	-	L	H	L	M	L
CO6	M	H	L	M	-	-	-	-	L	H	L	-	-

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

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

Indirect

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

Course Coordinator: Dr. Sheela Mary

Core Practical I: ECOLOGY AND ENVIRONMENTAL CHEMISTRY

Semester: I **Code: P16ES1P1**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Examine and analyse the abiotic parameters on field	**K3**	**I**
CO2	Identify and list some local flora and fauna	**K1**	**II**
CO3	Describe the features of local flora and fauna	**K2**	**II**
CO4	Analyse, appraise and interpret the data	**K5**	**III**
CO5	Demonstrate titrimetric analysis	**K2**	**IV**
CO6	Demonstrate colourimetric analysis	**K2**	**V**

2.A. Syllabus

Unit 1: Abiotic Parameters **(10 Hrs.)**

1. pH, Temperature, Relative Humidity, Transparency, Estimation of Dissolved oxygen (All the above parameters (except Relative Humidity) to be analyzed in ground water, lentic, lotic, domestic sewage, hot water and cold water)
2. Morphometric studies of the pond – mapping – outline, mean length, breadth, width and depth

Unit 2: Biodiversity Assessment - Qualitative analysis **(25 Hrs.)**

1. Inventory of floral biodiversity of campus
2. Inventory of faunal biodiversity of campus

Unit 3: Biodiversity Assessment - Qualitative analysis **(10 Hrs.)**

1. Biotic index – Shannon – Weaver Index
2. Primary productivity in pond ecosystem
3. Primary productivity of standing crop in grassland

Unit 4: Titrimetry **(15 Hrs.)**

1. Acidimetry-Alkalimetry
   Estimation of HCl
2. Permanganome try Estimation of Mohr'ssalt.
3. Complexometry
   EDTA Vs $CaCO_3$ + $MgCO_3$

Unit 5: Colourimetric Analysis (Calibrationcurve) **(15 Hrs.)**

1. Estimation of Ferriciron
2. Estimation of Nickel

C. Text Books

1. Daisy A, 2010. Butterfly of Bishop Heber College, Heber Au Sable Institute of Environmental Studies, Trichy, ISBN 978 – 81 – 906267 – 9 –8.
2. Doughlas A. Skoog, West DM, Hollar FJ, Grouch SR. 2004. Fundamentals of Analytical chemistry, Thomas Books, Bangalore.
3. Gopalan R, Subramanian PS, Rengarajan K. 1997. Elements of Analytical Chemistry, Sultan Chand and sons,NewDelhi.
4. Prema Michael. 1984.Ecological Methods for Field and Laboratory Investigations, Tata McGraw Hill, 404 pages, ISBN 0074517651,9780074517659.
5. Relton A. 2010. Bird of Bishop Heber College, Heber Au Sable Institute of Environmental Studies, Trichy, ISBN 978–93–80767–00–0.
6. Sawyer CN, Mc Carty PL and Perkinn GF. 1994. Chemistry for Environmental Engineering, II edition. McGraw Hill.

7. Shailaja Ravindranath and Sudha Premnath. 1997. Biomass Studies – Field Methods for Monitoring Biomass, Centre for Environmental Education, Southern Regional Cell, Bangalore, ISBN –81– 2-4 – 1113 – 4.

D. Reference Books

1. Trivedy RK, Goel PK and Trisal CL, Practical Methods in Ecology and Environmental Science (1987). Environmental Publications, Karad.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	**Abiotic Factors**		
1.1	pH, Temperature, Relative Humidity, Transparency, Estimation of Dissolved oxygen (All the above parameters (except Relative Humidity) to be analyzed in ground water, lentic, lotic, domestic sewage, hot water and cold water)	Examine and analyse the abiotic parameters on field	K3
1.2	Morphometric studies of the pond – mapping – outline, mean length, breadth, width and depth	Examine and analyse the morphometric studies of a pond on field	K3
Unit II	**Biodiversity Assessment-Qualitative analysis**		
2.1	Inventory of floral biodiversity of campus	Identify, list and describe some local flora	K2
2.2	Inventory of faunal biodiversity of campus	Identify, list and describe some local fauna	K2
Unit III	**Biodiversity Assessment-Quantitative analysis**		
3.1	Biotic index – Shannon – Weaver Index	Quantitatively assess, analyse, appraise and interpret the data of the diversity indices	K5
3.2	Primary productivity in pond ecosystem Primary productivity of standing crop in grassland	Quantitatively assess, analyse, appraise and interpret the data of the Primary productivity	K5
Unit IV	Titrimetry		
4.1	Acidimetry –Alkalimetry Estimation of HCl Permanganometry -Estimation of Mohr's salt Complexometry - EDTA Vs $CaCO_3$ + $MgCO_3$	Demonstrate titrimetric analysis	K2
Unit V	**Colourimetric Analysis (Calibration curve)**		
5.1	Estimation of Ferric iron Estimation of Nickel	Demonstrate colorimetric analysis	K2

4. Mapping Scheme (POs, PSOs and COs)

P16ES1P1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	H	H	-	H	H	L	-	M	-	H	H	-
CO2	M	M	M	-	M	M	L	-	M	-	H	H	-
CO3	M	M	M	-	M	M	L	-	M	-	H	H	-
CO4	H	H	H	-	H	H	L	-	M	-	H	H	-
CO5	H	H	H	-	-	M	L	-	M	-	H	H	-
CO6	H	H	H	-	-	M	L	-	M	-	H	H	-

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

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

Indirect

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

Course Coordinator: Dr. A. Daisy Caroline Mary

Elective I: ENERGY AND ENVIRONMENT

Semester: I **Code: P16ES1:1**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Course Outcome	K-Level	Unit
CO1	Classify the energy sources (both renewable and non-renewable).	**K2**	**I**
CO2	Explain the physical basis of Energy, sources and applications.	**K2**	**II**
CO3	Analyze the pros and cons of alternative energy utilization.	**K4**	**III**
CO4	Review various techniques to avail non-polluting energy sources.	**K2**	**IV**
CO5	Apply the non-polluting energy sources in various fields	**K3**	**IV**
CO6	Develop green energy technologies.	**K6**	**V**

2.A. Syllabus

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

Origin of fossil fuel – Classification –Conventional, Non- conventional energy – Renewable, Non – renewable energy – Heat capacity of fuels – Units of expressions – (Joule, Joule/Kelvin, watt, watt/second, kilowatt – kilowatt hour). Electrical units – Reading through energy meter – power, phases, reactive power, apparent power, power law. Thermodynamic calculations, Assignment–Domestic power audit.

Unit II Sun as Source of Energy (15 Hrs.)

Solar radiation and its spectral characteristics; Estimation of solar radiation. Physical principles of the conversion of solar radiation into heat –Solar energy collectors: Flat plate collectors - Solar air Heaters – Concentrating collectors –Focusing type – Non - focusing type, Solar ponds – Applications of solar ponds, Solar photovoltaics – solar cell.

Unit III Wind Energy (15 Hrs.)

Introduction, Basic principles of wind energy conversion - wind data and energy estimation – site selection considerations – Basic components of a wind energy conversion system (WEC). Classification of WEC systems, Types of wind machines –Applications of wind energy – Environmental aspects. Energy from the Ocean: Ocean thermal energy conversion (OTEC) – Tidal Energy – Energy from ocean waves – micro –hydel power.

Unit IV Energy from Biomass (15 Hrs.)

Introduction-Biomass conversion technologies–Biogas generation-classification and types of biogas plants–construction: and Design considerations. Bio-energy resources: Petro-plants – Biodiesel from *Jatropha sp.*, Fuel cell, Principles, - Hydrogen fuel cell-Alcohol fuel cell-advantages and disadvantages, Briquetting of solid wastes, Pyrolysis, and combustion.

Unit V Nuclear Energy (15 Hrs.)

Nuclear reactors, nuclear agreements, List of nuclear power plants in India, safety measures, Disposal of radioactive wastes.

B. Topics for Self-study

- **Laws of Thermodynamics** (https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Thermodynamics/The_Four_Laws_of_Thermodynamics)
- **Creative Applications of Solar Energy** (https://www.asme.org/topics-resources/content/7-creative-applications-of-solar-energy)
- **Wind Energy In India** (https://indianwindpower.com/wind-energy-in-india.php)
- **Safety of Nuclear Reactors** (http://www.barc.gov.in/pubaware/snr.html)

C. Text books

1. Rai GD, Non-conventional energy sources, Khanna publishers, New Delhi,2001.
2. Lampety J, Desai AV and Owino F, Bio energy, Wiley Eastern Ltd., New Delhi.1990.
3. Raymond L Murray, Nuclear Energy– An Introduction to Concepts, Systems and Applications of Nuclear Processes, 6thEdition, Elsevier2009.
4. Sukhatme SP, Solar Energy, Tata McGraw Hill publishing company Ltd., New Delhi,1996.
5. Tyagi PD, Fuels from weeds and wastes, Batra Book Service Publishers,1989.

D. Reference Books

1. Anubha Maheswari and Geetha Parmar, A Text book of Energy, Ecology Environment and Society,Anmol Publications, New Delhi,2002.
2. Dunn PD, Appropriate Technology. Macmillan Education limited,1979.
3. Johnson Gary L, Wind Energy System Prentice - Hall Inc., NewDelhi,1985.
4. Trivedi PR and Sudarshan KN, Environment and natural resources conservation, Common Wealth Publishers, NewDelhi,1994.
5. Nathanson JA, Basic Environmental Technology: Water supply Management and Pollution, Prentice Hall,2003.

d. Web Link

1. https://www.osti.gov/servlets/purl/1678824
2. http://www.makeinindia.com/sector/renewable-energy
3. http://www.makeinindia.com/sector/renewable-energy

3. Specific Learning Outcomes (SLO)

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit 1	**Fundamentals of Energy and Measurements**		
1.1	Fundamentals of energy and measurements: Origin of fossil fuel – Classification – Conventional, Non-conventional energy – Renewable, Non – renewable energy – Heat capacity of fuels – Units of expressions – (Joule, Joule/Kelvin, watt, watt/second, kilowatt – kilowatt hour).	Explain the classification of fossil fuels classification, composition, physico-chemical characteristics	**K2**
	Electrical units – Reading through energy meter – power, phases, reactive power, apparent power, power law. Thermodynamic calculations, Assignment– Domestic power audit.	Relate the energy content of coal, petroleum and natural gas.	K4
Unit 2	**Sun as Source of Energy**		
2.1	Sun as source of energy: Solar radiation and its spectral characteristics; Estimation of solar radiation. Physical principles of the conversion of solar radiation into heat – Solar energy collectors:	Explain the principles and generation of solar power, Domestic and industrial solar panel specifications,	**K2**
2.2	Flat plate collectors - Solar air Heaters – Concentrating	Explain the impacts of large-scale exploitation	**K2**

	collectors –Focusing type – Non - focusing type, Solar ponds – Applications of solar ponds, Solar photovoltaics – solar cell.	of solar energy sources and the calculation and installation methods of solar panel	
Unit 3	**Wind Energy**		
3.1	Wind Energy: Introduction, Basic principles of wind energy conversion - wind data and energy estimation – site selection considerations – Basic components of a wind energy conversion system (WEC). Classification of WEC systems, Types of wind machines –Applications of wind energy – Environmental aspects.	Illustrate the basic principles of wind energy conversion. Explain wind data and wind energy estimation	**K3**
3.2	Energy from the Ocean: Ocean thermal energy conversion (OTEC) – Tidal Energy – Energy from ocean waves – micro –hydel power.	Discuss the impacts of large-scale exploitation of wind and hydro energy sources.	**K2**
Unit 4	**Energy from Biomass**		
4.1	Energy from Biomass: Introduction-Biomass conversion technologies– Biogas generation-classification and types of biogas plants–construction: and Design considerations.	Explain classification and types of biogas generation	**K5**
4.2	Bio-energy resources: Petro-plants – Biodiesel from *Jatropha sp.*, Fuel cell, Principles, - Hydrogen fuel cell-Alcohol fuel cell-advantages and disadvantages, Briquetting of solid wastes, Pyrolysis, and combustion.	Determine various methods to produce energy from biomass	**K3**
Unit 5	**Nuclear Energy**		
5.1	Nuclear energy – nuclear reactors, nuclear agreements, List of nuclear power plants in India, safety measures, Disposal of radioactive wastes.	Illustrate the principle and types of nuclear reactor	**K3**

4. Mapping Scheme (POs, PSOs and COs)

P16ES1:1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	-	-	-	L	-	-	-	H	M	-	L
CO2	H	H	-	M	L	-	L	-	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	M	L	-	L	L	L	L	H	L	-	L
CO6	H	H	M	L	L	L	L	-	L	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. DJS. Anand Karunakaran

Core V: ENVIRONMENTAL TOXICOLOGY AND BIOREMEDIATION

Semester: II **Code: P16ES205**
Credits: 4 **Hours/Week: 4**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Describe the Importance of microbes and their role in environment.	**K5**	**I**
CO2	Analyze the basic concepts of biotechnology in solving environmental issues (in treatment of wastes, bioremediation etc.).	**K4**	**II**
CO3	Choose the applications of microbial technology in solving environmental issues.	**K3**	**III**
CO4	Determine suitable industrial application for pollution-less production	**K3**	**III**
CO5	Evaluate the toxicity of different substances on humans	**K5**	**IV**
CO6	Develop and devise bioremediation method / technique for removal of toxicant and clean the environment	**K3**	**V**

2.A. Syllabus

Unit I **(12 Hrs.)**

Toxicology – Definitions, Classification, Origin and General Nature of Toxicants in Environment, Basic Probit analysis, concepts – Toxicants – Toxicity - Acute, sub-acute, chronic, dose effect, LD50, LC50 and response safe limits, Dose response relationship - graphs, concentration response relationship, Safe Limits - Biological, chemical factors that influence, Influence of route of administration abnormal response to chemicals; basis of selective toxicity; laboratory determination of toxicity of chemicals.

Unit II **(12 Hrs)**

Sources, transport, mobility, disposition and effect of pesticides – Organo chlorine pesticides, Organo phosphorous, Carbamate and Synthetic pyrethroids. Non-pesticidal organic chemicals – low molecular weight hydrocarbons, aromatic hydrocarbons, PCBs, chlorophenols, dioxins, furan, phthalate, esters, plasticizers, PAHs.

Unit III **(12 Hrs.)**

Sources, transport, mobility, disposition and effect of heavy metals – As, Hg, Cd, Cr, Pb, Se, Inorganic ions – nitrates, phosphates, fluorides, asbestos, SO_2, NOx, CO, H_2S.

Unit IV **(12 Hrs.)**

Bioremediation of xenobiotic compounds – organic (chlorinated hydrocarbons, substituted simple aromatic compounds, poly-aromatic hydrocarbons, pesticides, surfactants) and inorganic (metals, radionuclide, phosphates, nitrates).

Unit V **(12 Hrs.)**

Role of immobilized cells/enzymes in treatment of toxic compounds, Biopesticides – Bioreactors – Bioleaching – Biomining – Biosensors. Biotechniques for air pollution abatement and odour control.

B. Topics for Self-study:

- **Biopharmaceuticals** (https://www.intechopen.com/books/biopharmaceuticals/introductory-chapter-biopharmaceuticals)
- **Enzyme Technology** (https://microbenotes.com/enzyme-technology)

C. Text Books

1. Ronald L. Crawford and Don. L. Crawford, Bioremediation – Principles and applications, Cambridge University Press, 1996.
2. P. Rajendran and P. Gunasekaran, Microbial Bioremediation, MJP Publishers, Chennai, 2006.
3. Klassen, Curtis. D and John.B. Watkins Casarett and Doull's, The Basic Science of Poisons Companion Handbook, Toxicology 6th Ed, Newyork, N.Y: McGraw-Hill, 2001.

D. Reference Books

1. Ricci, P and Rowe, M.D., Health and Environmental Risk Assessment, Pergamon Press, New York, 1985.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I			
1.1	Toxicology – Definitions, Classification, Origin and General Nature of Toxicants in Environment, Basic Probit analysis, concepts – Toxicants – Toxicity - Acute, sub-acute, chronic, dose effect, LD50, LC50 and response safe limits, Dose response relationship - graphs, concentration response relationship,	Find toxicants in the food material, agricultural and industrial contaminants in food utilization of food waste for value added products and solid and liquid waste management strategies at the industrial level	K1
1.2	Safe Limits - Biological, chemical factors that influence, Influence of route of administration abnormal response to chemicals; basis of selective toxicity; laboratory determination of toxicity of chemicals.	Explain various production technologies for various industrial products where microbes are involved.	K2
Unit II			
2.1	Sources, transport, mobility, disposition and effect of pesticides – Organo chlorine pesticides, Organo phosphorous, Carbamate and Synthetic pyrethroids.	Categorize indicator and pathogen microorganisms and analysis techniques.	K4
2.2	Non-pesticidal organic chemicals – low molecular weight hydrocarbons, aromatic hydrocarbons, PCBs, chlorophenols, dioxins, furan, phthalate, esters, plasticizers, PAHs.	Categorize indicator and pathogen microorganisms and analysis techniques.	K4
Unit III			

3.1	Sources, transport, mobility, disposition and effect of heavy metals – As, Hg, Cd, Cr, Pb, Se,	Categorize indicator and pathogen microorganisms and analysis techniques.	K4
3.2	Inorganic ions – nitrates, phosphates, fluorides, asbestos, SO_2, NO_x, CO, H_2S.	Categorize indicator and pathogen microorganisms and analysis techniques.	K4
Unit IV			
4.1	Bioremediation of xenobiotic compounds – organic (chlorinated hydrocarbons, substituted simple aromatic compounds, poly-aromatic hydrocarbons, pesticides, surfactants) and inorganic (metals, radionuclide, phosphates, nitrates).	Choose the microbial application in engineering practice and solution.	K4
Unit V	**Bioremediation**		
5.1	Role of immobilized cells/enzymes in treatment of toxic compounds,	Examine the advantages and limitations of current tools for investigation of environmental microbiology	K3
5.2	Biopesticides; Bioreactors; Bioleaching; Biomining and Biosensors.	Apply and use the properties of microorganisms, principally bacteria, to remedy problems of contamination and other environmental impacts.	K3
5.3	Biotechniques for air pollution abatement and odour control.	Describe the properties of microorganisms with potential application to processes of environmental biotechnology.	K2

4. Mapping Scheme (POs, PSOs and COs)

P16ES205	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	L	-	-	L	-	-	-	H	L	-	M
CO2	H	H	M	-	L	L	L	-	-	H	L	L	L
CO3	H	H	H	L	L	M	-	M	M	H	M	-	M
CO4	H	H	H	L	L	M	-	M	M	H	M	-	M
CO5	H	M	H	M	M	L	L	-	L	H	L	M	L
CO6	M	H	L	M	-	-	-	-	L	H	L	-	-

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

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

Indirect

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

Course Coordinator: Dr. M. Sheela Mary

Core VI:
RESEARCH DESIGN AND INSTRUMENTAL METHODS

Semester: II **Code: P16ES206**
Credits: 4 **Hours/Week: 4**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Understand the writing of Research proposal and report, research designs.	K4	I
CO2	Chemical analysis with equipment, principle and application	K4	II
CO3	Analyze the results of chemical reactions using different instruments.	K5	III
CO4	Discuss application of microscope	K6	IV
CO5	Explain 2D electrophoresis	K4	IV
CO6	Understand the key Auto analyzer for water quality	K3	V

2.A. Syllabus

Unit 1 Introduction (15 Hrs.)

Meaning & Objectives of Research; Significance of research; Research & scientific methods; Criteria of good & advanced research; Types of Research: (Survey, Observation, case study, experimental, historical and comparative methods) Stages in preparation; Research methods versus methodology; Writing of Research Proposal, Report and Research Paper Features of a good design; Different research designs; Sampling – Types of sampling design. Data collection – methods; Measurement and scaling – Quantitative and qualitative; Classification; goodness

Unit 2 Basic principles of Chemical analysis (15 Hrs.)

Precision, accuracy, errors and minimization of errors in analyses. Conductometry – Strong acid Vs Strong base titrations. Potentiometry –types of electrodes, redox titration, Polarography–Principle and application.

Unit 3 Instrumental Analysis (15 Hrs.)

Colorimetry and Spectrophotometry – UV and VIS, Flame photometry, Nephelometry and Turbidimetry, Piezometery. XRF, Atomic Absorption Spectrophotometer (AAS), Fourier Transform Infra-Red Spectroscopy (FTIR) – Applications. Chromatography: TLC, GC, HPLC and Ion exchange chromatography. GCMS, ICP.

Unit 4 Biological Applications (15 Hrs.)

Microscopy – Light microscope, Scanning Electron Microscopy (SEM) Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Centrifugation – Differential, Density gradient, Reverse Osmosis – Applications. Electrophoresis - PAGE, PFGE, SDS-PAGE, Agarose gel, Immuno-electrophoresis, 2D electrophoresis- Gel documentation. Applications

Unit 5 Environmental Applications (15 Hrs.)

NDIR for CO, Chemiluminescent Analyzer for NO_X, Fluorescent analyzer for SO_2, Auto analyzer for water quality using flow injection analysis.

B. Topics for Self-study

- **Significance of research** (https://www.slideshare.net/manumelwin/significance-of-research-research-methodology-manu-melwin-joy)
  Types of Research (https://www.questionpro.com/blog/what-is-research)
- **Basic principles of Chemical analysis** (https://faculty.ksu.edu.sa/sites/default/files/instrumental_chemical_analysis.pdf)
- **Light Microscope** (https://microbenotes.com/light-microscope/

C. Text Books

1. William H, Merritt L, Dean DA and Settle FA, Instrumental Methods of Analysis, CSS publishers, New Delhi, 1986.
2. Sharma BK, Instrumental Methods of Chemical Analysis, Goel Publishing house, Meerut, 1999.
3. Willard LL, Merritt and John and Dean, Instrumental Methods of analysis, D Van Nostrand Company, New York, 1966.

D. Reference Books

1. APHA Standard Methods for the examination of water and wastewater, 20thEdition, Washington, 1998.
2. Barnes JDJ, Denney RC, Jeffery GH and Mendham J Vogel's, Text Book of Quantitative Inorganic Analysis, 6th Edition, Pearson Education Ltd., U.K, 1999.

E. Web Links

1. https://egyankosh.ac.in/bitstream/123456789/23391/1/Unit-4.pdf
2. https://www.uky.edu/~eushe2/Pajares/ElementsOfaProposal.pdf.
3. https://www.studocu.com/in/document/shivaji-university/chemical-reaction-engineering/topic-1-nnn-general-principles-of-chemical-analysis/10893045

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	**Introduction**		
1.1	Meaning & Objectives of Research; Significance of research; Research & scientific methods; Criteria of good & advanced research	Explain the concept & procedure of Research Proposal	K2
1.2	Types of Research: (Survey, Observation, case study, experimental, historical and comparative methods) Stages in preparation; Research methods versus methodology; Writing of Research Proposal, Report and Research paper Features of a good design;	Apply the concept of research design	K4
1.3	Different research designs; Sampling – Types of sampling design. Data collection – methods; Measurement and scaling – Quantitative and qualitative; Classification; goodness	Explain the concept measurement of Quantitative and qualitative	K2
Unit II	Basic principles of Chemical analysis		
2.1	Precision, accuracy, errors and minimization of errors in analyses.	Explain Chemical analysis principles	K2
2.2	Conductometry – Strong acid Vs Strong base titrations. Potentiometric	Relationships among them	K4
2.3	Types of electrodes, redox titration, Polarography–Principle and application.	Illustrate the concepts	K2

Unit III	**Instrumental Analysis**		
3.1	Colorimetry and Spectrophotometry – UV and VIS, Flame photometry. Nephelometry and Turbidimetry, Piezometery. XRF,	Compare the different photometry	K2
3.2	Atomic Absorption Spectrophotometer (AAS), Fourier Transform Infra-Red Spectroscopy (FTIR) – Applications.	Explain technology	K2
3.3	Chromatography: TLC, GC, HPLC and Ion exchange chromatography. GCMS, ICP.	Explain desirable requirement of hardware and software for a Chromatography technique process	K2
Unit IV	**Biological Applications**		
4.1	Microscopy – Light microscope, Scanning Electron Microscopy (SEM) Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM),	Fully equipped with concepts, methodologies and applications of different type of Microscopy.	K4
4.2	Centrifugation – Differential, Density gradient, Reverse Osmosis – Applications.	Compare the different applications	K2
4.3	Electrophoresis - PAGE, PFGE, SDS-PAGE, Agarose gel, Immuno-electrophoresis, 2D electrophoresis - Gel documentation. Applications	Apply the general procedure documentation.	K3
Unit V	**Environmental Applications**		
5.1	NDIR for CO, chemiluminescent analyzer for NO_X	Illustrate the concepts	K2
5.2	Fluorescent analyzer for SO_2, Auto analyzer for water quality using flow injection analysis.	Apply the general procedure for Auto analyzer for water quality	K3

4. Mapping Scheme (POs, PSOs and COs)

P16ES206	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	L	H	M	M	-	M	-	-	H	H	H	M
CO2	-	-	L	M	M	-	-	M	M	-	M	L	-
CO3	H	L	-	-	-	H	-	H	-	H	-	-	-
CO4	H	-	M	M	H	-	H	-	M	-	M	H	H
CO5	H	-	H	M	M	H	-	L	M	-	M	-	L
CO6	M	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: Mr. Swinton Darius

Core VII: MATHEMATICAL MODELS IN ENVIRONMENTAL SCIENCES

Semester: II **Code: P16ES207**
Credits: 4 **Hours/Week: 4**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	To build a simple static model from data.	K3	I
CO2	Create simple statistical models with a clear statement of the problem	K6	II
CO3	Identify the simplifying assumptions that underpin a model	K3	III
CO4	Apply the input–output principle to obtain a mathematical model, where appropriate.	K6	III
CO5	To Assess Ecological and Environmental Models.	K5	IV
CO6	To demonstrate the basics concepts in R programming in terms of constructs, control statements and string functions.	K3	V

2.A. Syllabus

Unit 1 **(12 Hrs.)**

Statistical data – Random variable – Probability – Measures of central tendency – Measures of dispersion – Correlation – Regression – Distribution – Binomial – Poisson – Normal.

Unit 2 **(12 Hrs.)**

Sampling techniques – t-test – Chi-square test – ANOVA test.

Unit 3 **(12 Hrs.)**

Derivative of a function – Initial value problems for first order Ordinary Differential Equations – Ecological and Environmental models – Methods of solving.

Unit 4 **(12 Hrs.)**

System of linear equations – Closed system – Open system – Methods of solving – Ecological and Environmental Models.

Unit 5 **(12 Hrs.)**

Introduction to R – Installation – Working with R commands.

B. Topics for Self-study

- https://statistics.laerd.com/statistical-guides/measures-central-tendency-mean-mode-median.php
- https://www.abs.gov.au/websitedbs/D3310114.nsf/Home/Statistical+Language+-+measures+of+central+tendency
- https://www.healthknowledge.org.uk/public-health-textbook/research-methods/1a-epidemiology/methods-of-sampling-population
- https://www.cuemath.com/algebra/solutions-of-a-linear-equation/
- https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf

C. Text Books

1. Gurumani, N, Research Methodology for Biological Sciences, MJP Publishers, Chennai, 2007.
2. Zar, J.H, Bio-statistical Analysis, 4th Edition, Pearson Education (Singapore) Private. Ltd., Delhi, 1999.
3. Mark Gardener, Beginning R – The statistical Programming Language, Wiley Publications, 2015.
4. Miguel F. Acevedo, Simulation of Ecological and Environmental Models, CRC Press, 2013.

5. George F. Simmons, Differential Equations with Applications and Historical Notes, Mc Graw Hill Publishers, 2ndedition, 2003.

D. Reference Books

1. Gupta S.P., Statistical Methods, Sultan Chand & Sons, Educational publishers, New Delhi, 2008 (36th revised edition)
2. Mondal (2008), Textbook of Ordinary Differential Equations, Prentice Hall India Learning Private Limited.
3. Colin Gillespie and Robin Lovelace (2017), Efficient R Programming - A Practical Guide to Smarter Programming, Shroff Publishers & Distributors Pvt. Ltd.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I			
1.1	Statistical data – Random variable – Probability	Define statistics. Relate statistics with environmental models.	K1
1.2	Measures of central tendency – Measures of dispersion – Correlation – Regression – Distribution – Binomial – Poisson – Normal.	Construct the Measures of central tendency. Solve the real-life models using with the distributions techniques.	K3
Unit II			
2.1	Sampling techniques – t-test – Chi-square test – ANOVA test.	Explain the various tests to find the expected result and test the statement of hypothesis and to solve the problem.	K2
Unit III			
3.1	Derivative of a function – Initial value problems for first order Ordinary Differential Equations	Illustrate the derivative of a function with initial value problems	K2
3.2	Ecological and Environmental models – Methods of solving.	Construct the various types of environmental models	K6
Unit IV			
4.1	System of linear equations – Closed system – Open system	Develop the hypothesis for the system of linear equation.	K3
4.2	Methods of solving – Ecological and Environmental Models.	Construct the various types of environmental models	K6
Unit V			
5.1	Introduction to R – Installation – Working with R commands.	Make use of R commands for programming	K3

4. Mapping Scheme (POs, PSOs and COs)

P16ES207	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	M	-	-	M	-	-	-	H	M	-	M
CO2	H	H	M	-	M	M	L	-	-	H	L	-	L
CO3	H	H	H	H	M	M	-	M	L	H	L	-	M
CO4	H	H	H	M	-	M	-	-	M	H	M	-	L
CO5	M	M	M	M	-	-	-	-	L	H	L	-	-
CO6	M	H	M	H	M	-	M	M	M	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. R. Gethsie Sharmila

Core Practical II:
PRACTICAL IN ENVIRONMENTAL MICROBIOLOGY, BIOTECHNOLOGY AND TOXICOLOGY

Semester: II **Code: P16ES2P2**
Credits: 4 **Hours/Week: 4**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Experiment
CO1	Categorize and perform the microbiological culture techniques using organisms collected from various environment.	**K4**	**1-7**
CO2	Explain the State various molecular tools for environmental assessment.	**K3**	**8-10**
CO3	Apply the microbiological techniques in pollution redemption.	**K5**	**11-14**
CO4	Identify various instrumentation in biotechnological assays.	**K3**	**12-14**
CO5	Examine toxicological assays in determining the lethal concentrations/ doses of a toxicant.	**K4**	**15-18**
CO6	Perform statistical analyses from the laboratory experiments on toxicology.	**K5**	**19-21**

2.A. Syllabus

List of Experiments

1. Observation of compound microscope **(0.5 Hrs.)**
2. Micrometry **(0.5 Hrs.)**
3. Photomicrography **(0.5 Hrs.)**
4. Microscopic preparation of diseased leaves **(0.5 Hrs.)**
5. Staining procedures –Gram's staining. **(6 Hrs.)**
6. MPN Techniques – TC, FC & FS **(4 Hrs.)**
7. Methylene blue test for determining the microbial quality of milk (**2 Hrs.)**
8. Isolation of Genomic DNA and Quantization of DNA. **(4 Hrs.)**
9. Isolation of bacterial Plasmid DNA(**1 Hr.)**
10. Agarose Gel Electrophoresis of DNA. **(4 Hrs.)**
11. Enumeration of bacteria from water and waste water
12. Estimation of Ammonia and Phosphorous content of waste water
13. Microbiological treatment of industrial effluent
14. Determination of BOD and COD (**2 Hrs.)**
15. Bioassay – Acute Toxicity studies; LC50, LD50 estimation; PROBIT Analysis. **(6 Hrs.)**
16. Estimation of Proteins in fish samples. **(4 Hrs.)**
17. Estimation of Sugars in fish samples. **(4 Hrs.)**
18. Estimation of Lipids in fish samples. (**(4 Hrs.)**
19. Separation of free amino acids by paper chromatography (**1 Hr.)**
20. Estimation of chlorophyll **(0.5 Hrs.)**
21. Estimation of Phenol **(0.5 Hrs.)**

C. Text Books

1. Dubey RC and Maheswari DK, Practical Microbiology (2009). S. Chand & company Ltd. New Delhi.
2. Pelczar MJ, Reid RD and Kreig N, Microbiology (1985). Tata Mc Graw Hill, McGraw Hill Inc., USA.
3. Prema M, Ecological methods for field and laboratory investigations (1984). Tata McGraw Hill, New Delhi.

D. Reference Books

1. Jayaraman J, Laboratory manual in Biochemistry (2011). New Age International Publishers.
2. Woolley A, A Guide to Practical Toxicology: Evaluation, Prediction, and Risk (2008).2nd Ed. CRC Press. ISBN: 9781420043143.

3. Specific Learning Outcomes

Experiment	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
1.	Observation of compound microscope	Enhance the skill of microscopic	K2
2.	Micrometry	Identify the nanometer of microbial cell	K1
3.	Photomicrography	Enhance the skill of photomicrography	K2
4.	Microscopic preparation of diseased leaves	Identify the plant diseases	K1
5.	Staining procedures – Gram's staining.	Determine and Demonstrates proficiency and use of following in Isolation of cultures by various methods (Serial dilution, Pour-plate, Spread plate and Streak plate methods).	K5
6.	MPN Techniques – TC, FC & FS	Classify and describe themicrobial growth, theirdiversity and role in Biogeochemicalprocesses, and microbialissues in environment.	K2
7.	Methylene blue test for determining the microbial quality of milk	Determine the quality of a milk sample	K3
8.	Isolation of Genomic DNA and Quantization of DNA.	Find the techniques and Isolate DNA from various sources – microbes	K1
9.	Isolation of bacterial Plasmid DNA	Find the techniques and Isolate DNA from various sources – microbes	K1
10.	Agarose Gel Electrophoresis of DNA.	Outline the optimal conditions essential for protein/nucleic acid separation and purification	K2

11.	Enumeration of bacteria from water nd waste water	Apply and enhance the skill on microbial analysis of environment.	K3
12.	Estimation of Ammonia and Phosphorous content of waste water	Determine the quality of a water sample	K3
13.	Microbiological treatment of industrial effluent	Enhance the waste water treatment techniques	K3
14.	Determination of BOD and COD	Determine the quality of a water sample	K3
15.	Bioassay – Acute Toxicity studies; LC50, LD50 estimation; PROBIT Analysis.	Estimate and Performmolecular level analysisand understand thegenetic mechanism.	K6
16.	Estimation of Proteins in fish samples.	Analyze the proteins inthe fish samples	K4
17.	Estimation of Sugars in fish samples.	Analyze the sugar (monosaccharide and polypolysaccharides) totalsugar in the fish samples	K4
18.	Estimation of Lipids in fish samples.	Analyze the Lipids in thefish samples	K4
19.	Separation of free amino acids by paper chromatography	Analyze the aminoacids and improve their techniques	K4
20.	Estimation of chlorophyll	Analyze the chlorophyll content of plant	K4
21.	Estimation of Phenol	Analyze the phenol of the plant	K4

4. Mapping Scheme (POs, PSOs and COs)

P16ES2P2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	L	-	-	L	-	M	-	H	M	-	M
CO2	H	H	M	M	-	L	L	-	-	H	L	-	L
CO3	H	M	M	-	L	-	-	L	L	H	M	L	L
CO4	H	H	L	L	L	L	L	-	-	H	L	-	M
CO5	H	H	L	L	-	-	-	L	L	H	L	L	-
CO6	H	H	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. 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

Core Practical III: MATHEMATICAL MODELS IN ENVIRONMENTAL SCIENCES

Semester: II **Code: P16ES2P3**
Credits: 3 **Hours/Week: 3**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Experiment
CO1	Evaluate the measures of Central tendency and dispersion for the given data in Environmental sciences using appropriate statistical tool.	**K5**	**1-2**
CO2	Discover the Lines of Regression incorporating the Correlation Coefficient	**K4**	**3-4**
CO3	Classify and compare the types of distribution	**K4**	**5-7**
CO4	Formulate the hypothesis and perform hypotheses testing using Software	**K6**	**8-12**
CO5	Examine the maximum and minimum for a given function a by applying the concept of derivatives	**K4**	**13-14**
CO6	Demonstrate mathematical models in understanding the Bioaccumulation models.	**K2**	**15-18**

2.A. Syllabus

List of Experiments

1. Calculation of measures of central tendency
2. Calculation of measures of dispersion
3. Calculation of Correlation Coefficient
4. Finding Lines of Regression
5. Binomial Distribution
6. Poisson Distribution
7. Normal Distribution
8. One sample t-test
9. Two sample t-test
10. Chi-square test of independent samples
11. One-way Between-Groups ANOVA
12. Two-way Between-Groups ANOVA
13. Finding differential coefficient of a function
14. Finding maximum and minimum for a given function
15. Population Model
16. Bioavailability
17. Bioaccumulation - Two compartment model
18. Bioaccumulation - Multi-compartment model

B. Topics for Self-study:

- **Data Handling – Importing CSV and tabular data files** (https://nptel.ac.in/courses/111/104/111104100/)
- **Data Handling – Importing data files from other software** (https://nptel.ac.in/courses/111/104/111104100/)
- **Data frames, import of external data in various file format** (https://nptel.ac.in/courses/111/104/111104100/)
- **Graphics and plots** (https://nptel.ac.in/courses/111/104/111104100/)

C. Text Books

1. Acevedo MF, Simulation of Ecological and Environmental Models (2013). CRC Press. *ISBN: 9781466575684.*
2. Gardener M, Beginning R – The statistical Programming Language (2015). Wiley Publications. *ISBN*: 9781118164303.
3. Simmons GF, Differential Equations with Applications and Historical Notes 2nd Ed. (2003). McGraw Hill Publishers. *ISBN*: 9781498702591.

D. Reference Books

1. Iannelli M and Pugliese A, An introduction to Mathematical Population Dynamics-Along the trail of Volterra and Lotka (2014). Springer International Publishing.
   a. Chapter 1, 2, 6 & 7
2. Peavy HS, Rowe D and Tchobanoglous G, Environmental Engineering (2017). McGraw Hill Education. ISBN: 9789351340263.

E. Web Links:

1. https://nptel.ac.in/courses/111/104/111104120/
2. https://onlinecourses.nptel.ac.in/noc21_ma35/preview
3. https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks
4. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/CompartmentModeling.pdf

3. Specific Learning Outcomes

Experiment	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
1.	Calculation of measures of central tendency	Evaluate the measures of Central tendency for the given data using appropriate statistical tool.	K5
2.	Calculation of measures of dispersion	Evaluate the measures of dispersion for the given data using appropriate statistical tool.	K5
3.	Calculation of Correlation Coefficient	Compare between the two data and give its relation	K4
4.	Finding Lines of Regression	Discover the Lines of Regression incorporating the Correlation Coefficient	K4
5.	Binomial Distribution	Identify and interpret on the Binomial distribution	K3
6.	Poisson Distribution	Identify and interpret on the Poisson distribution	K3
7.	Normal Distribution	Identify and interpret on the Normal distribution	K3
8.	One sample t-test	Experiment with One sample t-test for the appropriate data	K3
9.	Two sample t-test	Make use of two sample t-test for the appropriate data	K3
10.	Chi-square test of independent samples	Test for Chi-square of independent samples	K4
11.	One-way Between-Groups ANOVA	Formulate the hypothesis and perform hypotheses testing using One-way Between-Groups ANOVA	K6

12.	Two-way Between-Groups ANOVA	Formulate the hypothesis and perform hypotheses testing using Two-way Between-Groups ANOVA	K6
13.	Finding differential coefficient of a function	Find differential coefficient of a function	K1
14.	Finding maximum and minimum for a given function	Examine the maximum and minimum for a given function a by applying the concept of derivatives	K4
15.	Population Model	Demonstrate mathematical models in understanding the dynamics of Population model	K2
16.	Bioavailability	Determine the molar solubility	K2
17.	Bioaccumulation-Two compartment model	Obtain the dynamics of open two-pool model	K2
18.	Bioaccumulation-Multi-compartment model	Find Toxico-kinetics in three organs	K2

4. Mapping Scheme (POs, PSOs and COs)

P16ES2P3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	M	M	H	H	M	M	M	L	H	L	H	H
CO2	M	H	H	H	H	M	M	M	L	H	L	H	H
CO3	M	M	H	H	H	M	M	M	L	H	L	M	H
CO4	H	H	H	H	H	H	M	M	L	H	L	H	H
CO5	H	H	M	H	H	H	L	M	L	M	L	M	H
CO6	H	H	H	H	H	H	H	M	L	H	L	H	H

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

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

Indirect

1. Overall performance assessment,

Course Coordinator: Dr. A. Tilak Moses

Elective II: ENVIRONMENTAL MANAGEMENT, SUSTAINABLE DEVELOPMENT AND BIODIVERSITY CONSERVATION

Semester: II **Code: P19ES2:2**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Recognize the statement of environmental issues and constitutional initiatives for environmental protection	K1	I
CO2	Recognize the national and international initiatives for environmental protection	K1	II
CO3	Implement environmental management strategies	K3	III
CO4	Apply the relevant laws in various environmental issues	K3	III - V
CO5	Relate the threats to conservation issues	K4	IV
CO6	Integrate the knowledge and apply the strategies for conservation and management.	K6	V

2.A. Syllabus

Unit I: Introduction (12 Hrs.)

Statement of environment: Consumption patterns of natural resources – renewable and non – renewable; Environmental issues due to population growth in India and the world; Environmental priorities and Sustainable Development in India, Environmental ethics, Provision of Constitution of India regarding Environment (Article 48A and 51A (g)), National Environmental Policy, Environmental awareness and education – importance and approaches.

Unit II: International and National efforts for Environmental Protection (12 Hrs.)

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

Unit III: Management Strategies (12 Hrs.)

Water management: Watershed: Concept, characteristics and types, Land development, water investigation and watershed management; Rain Water Harvesting (RWH). Land Management: Land use pattern, Urban Planning and management

Forest Management: Forest Fire, Eco tourism. Afforestation – Social and agro forestry schemes, Joint Forest Management.

Disaster management: Earth quakes, Volcanoes, Tsunami – Restoration and rehabilitation technologies. Case studies – National Calamities.

Unit IV: Environmental laws (12 Hrs.)

The Indian Forest Act, 1927, The Indian Wild Life (Protection) Act, 1972, The Water (Prevention and Control of Pollution) Act, 1974, Forest (Conservation) Act, 1980, The Air (Prevention and Control of Pollution) Act, 1981.

Environment (Protection) Act, 1986 - Hazardous wastes (Management and Handling) Rules 1989, Biomedical Waste (Management and Handling) Rules 1998, Municipal Solid Waste (Management and Handling) Rules (2000), The Noise Pollution (Regulation and Control) (Amendment) Rules 2000

e-waste (Management and Handling) *Rules 2010,* Plastic wastes (Management and Handling) Rules 2011 and CPCB guidelines, National Green tribunal Act, 2010; (All with the latest amendments).

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

Threats to biodiversity – habitat alteration, invasive species, pollution, population explosion, and over- exploitation of resources; Conservation and Management – Protection of Natural Habitats; National and International Protected Areas; Current Practices in Conservation - in *situ* Conservation and *ex situ* Conservation of Threatened Species; The Biological diversity Act, 2002, Biological Diversity Rules, 2004 – Patent Act - Intellectual Property Rights (IPR).

B. Topics for Self-study

- **The Great Green Wall** (https://www.unccd.int/actions/great-green-wall-initiative)
- **Social and Ecological Benefits of Restored Wolf Populations** (https://wildlifemanagement.institute/sites/default/files/2016-09/11-Social_and_Ecological.pdf)
- **Rhino Conservation in India: A Great Cause That Needs Us** (https://www.kaziranga-national-park.com/blog/rhino-conservation-in-india/)
- **Olive Ridley Turtles in India - World Turtle Trust** (https://world-turtle-trust.org/project07.html#:~:text=In%201995%2C%20the%20Wildlife%20Institute,the%20nesting%2C%20and%20hatching%20seasons.)

C. Text Books

1. Agarwala VP, Forests in India, Oxford and IBH Publishing Co. Pvt. Ltd., NEW DELHI, 1985.
2. Gopal LJ, Rural Development, Mangal Deep publications, Jaipur, 1997.
3. Kurian Joseph and Nagendran R, Essentials of Environmental Studies, Pearson Education Limited, New Delhi, 2004.
4. Murty JVS, Watershed Management in India, Wiley Eastern Ltd., New Delhi, 1994.
5. TNPCB, Pollution control legislations – Tamil Nadu Pollution Control Board, Vol-I and II, Chennai, 1999.

D. Reference Books

1. Sharma PD, Ecology and Environment, 13th Ed. (2019). Rastogi Publications, Meerut, India. ISBN: 9789350781227.
2. Singh JS, Singh SP. and Gupta SR, Ecology, Environment and Resource Conservation (2006). Anamaya Publ., New Delhi.
3. Chapman JL and Reiss MJ, Ecology-Principles and applications (1995). Cambridge University Press.
4. Groombridge B (Ed.), Global Biodiversity–status of the Earth's living resources (1994). Chapman & Hall, London.
5. Melchias G. Biodiversity and Conservation (2001). Oxford IBH. New Delhi.

E. Web Links

1. http://fes.org.in/source-book/ecological-restoration-source-book.pdf?file=ZG93bmxvYWQvd3AxOS5wZGY=?file=ZG93bmxvYWQvd3AxOS5wZGY=
2. http://wgbis.ces.iisc.ernet.in/energy/water/proceed/proceedings_text/section9/paper3/section9paper3.htm#STR
3. http://www.iucnredlist.org/
4. https://apfisn.net/wp-content/uploads/2018/07/India.pdf
5. https://icrier.org/Urbanisation/events/23-2-15/Ecological.pdf
6. https://www.ncf-india.org/western-ghats/reviving-the-rainforest
7. https://www.sciencedirect.com/science/article/abs/pii/S187220321530024X
8. https://www.unenvironment.org/

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	**Introduction**		
1.1	Statement of environment: Consumption patterns of natural resources – renewable and non – renewable; Environmental issues due to population growth in India and the world;	Recognize the statement of environmental issues	K1
1.2	Statement of environment: Environmental priorities and Sustainable Development in India, Environmental ethics, Provision of Constitution of India regarding Environment (Article 48A and 51A (g)), National Environmental Policy, Environmental awareness and education – importance and approaches.	Recognize the constitutional initiatives for environmental protection	K1
Unit II	**International and National efforts for Environmental Protection**		
2.1	Global conventions – Stockholm Conference, Rio Summit, Rio+10, Brundtl and commission, Rio+20, Montreal Protocol, Kyoto protocol, Copenhagen summit; (Major objectives, activities and achievements only).	Recognize the international initiatives for environmental protection	K1
2.2	Global organizations – IPCC, UNEP, IUCN, WWF, Greenpeace;	Recognize the international organizations for environmental protection	K1
2.3	National organizations – ATREE, BNHS, BSI, BVIEER, CEE, CSE, NEERI, NCF, PETA, SACON, TERI, WII, ZSI (Major objectives, activities and achievements only).	Recognize the national organizations for environmental protection	K1
Unit III	**Management Strategies**		
3.1	Water management: Watershed: Concept, characteristics and types, Land development, water investigation and watershed management; Rain Water Harvesting (RWH). Land Management: Land use pattern, Urban Planning and management	Apply suitable technologies in mitigating environmental issues related to water	K3
3.2	Forest Management: Forest Fire, Eco tourism. Afforestation – Social and agro forestry schemes, Joint Forest Management.	Develop and employ forest improvement strategies	K3

	Disaster management: Earth quakes, Volcanoes, Tsunami – Restoration and rehabilitation technologies. Case studies – National Calamities	Develop and employ disaster management strategies and technologies	K3
Unit IV	**Environmental laws**		
4.1	The Indian Forest Act, 1927, The Indian Wild Life (Protection) Act, 1972, The Water (Prevention and Control of Pollution) Act, 1974, Forest (Conservation) Act, 1980, The Air (Prevention and Control of Pollution) Act, 1981.	Apply the relevant laws in various environmental issues	K3
4.2	Environment (Protection) Act, 1986 - Hazardous wastes (Management and Handling) Rules 1989, Biomedical Waste (Management and Handling) Rules 1998, Municipal Solid Waste (Management and Handling) Rules (2000), The Noise Pollution (Regulation and Control) (Amendment) Rules 2000	Apply the relevant laws in various environmental issues	K3
	e-waste (Management and Handling) *Rules 2010,* Plastic wastes (Management and Handling) Rules 2011 and CPCB guidelines, National Green tribunal Act, 2010; (All with the latest amendments).	Apply the relevant laws in various environmental issues	K3
Unit V	**Conservation**		
5.1	Threats to biodiversity – habitat alteration, invasive species, pollution, population explosion, and over- exploitation of resources	Identify the values and relate the threats to Biodiversity	K4
5.2	Conservation and Management – Protection of Natural Habitats - National and International Protected Areas – Current Practices in Conservation - in *situ* Conservation and *ex situ* Conservation of Threatened Species	Integrate the knowledge and strategies for conservation and management.	K6
5.3	The Biological diversity Act, 2002, Biological Diversity Rules, 2004– Patent Act - Intellectual Property Rights (IPR).	Integrate the knowledge and strategies for conservation and management.	K6

4. Mapping Scheme (POs, PSOs and COs)

P16ES2:2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	-	H	-	-	-	M	-	-	H	-	-	L
CO2	L	-	H	-	-	-	M	-	-	M	-	L	L
CO3	L	-	H	-	-	H	M	L	H	M	-	-	M
CO4	L	-	H	-	-	-	M	L	H	M	-	H	L
CO5	L	-	H	-	-	M	M	L	H	M	-	L	M
CO6	L	-	H	-	-	M	M	L	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: Prof. A. Alagappa Moses

Elective III: GREEN SCIENCE AND TECHNOLOGY

Semester: II **Code: P19ES2:3**
Credits: 4 **Hours/Week: 4**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Demonstrate, solve and an understanding of major concepts in Anthroposphere	**K4**	**I**
CO2	Find out the green route for chemical reaction for sustainable development	**K4**	**II**
CO3	Employ critical thinking and the scientific knowledge to design, carry Out and analyze the results of chemical reactions.	**K5**	**III**
CO4	To give an extended knowledge about minerals used for green synthesis field	**K5**	**III**
CO5	To study the waste management.	**K2**	**IV**
CO6	Student are made aware of pollution problems and waste management and the importance of green environment	**K4**	**V**

2.A. Syllabus

Unit 1 Anthroposphere (10 Hrs.)

Five spheres of the earth and their interaction and interrelationships. Anthroposphere – Definition, its effects of Anthroposphere on environment. Anthropospheric constructs, anthropospheric flows, anthropospheric conduits. Infrastructure, transportation, the communication revolution, technology and Engineering (Brief description only). Acquisition of Raw materials. Agriculture – the most basic industry. Industries and their classification.

Unit 2 Green Chemistry (10 Hrs.)

Twelve principles of green chemistry, and green science and technology. Reasons for Green Chemistry (resource minimization, waste minimization concepts) Yield and atom economy. Green oxidation and photochemical reactions. Microwave and Ultrasound assisted reactions. Important techniques and directions in practicing Green Chemistry.

Unit 3 Green Synthesis and Reactions (10 Hrs.)

Feed stocks – biological feed stocks. Green Reagents - Stoichiometric and catalytic reagents. Green solvents and reaction conditions. Green synthesis – case studies. Green catalysts – Use of zeolites, silica, alumina, clay, polymers, cyclodextrin and supported catalysts. Biocatalysts – enzymes.

Unit 4 Waste management (15 Hrs.)

Waste reduction and minimization - recycling, solvent recovery and recycling. Recovery of water from waste water. Physical methods of waste treatment. Chemical treatment. Thermal treatment, biodegradation and treatment and composting. Preparation of wastes for disposal. Ultimate disposal of wastes, In-situ-treatment.

Unit 5 Green Energy technologies and Green Buildings (15 Hrs.)

Sources of energy in the anthroposphere. Energy devices and conversions. Green technology and energy conversion efficiency. Energy conservation and renewable energy sources (list of sources only). Unrealized potential of lingo -cellulose fuels. Hydrogen. Combined power cycles. Green Composites for buildings: Concepts of Green Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

B. Topics for Self-study

- **Anthroposphere** (https://www.asdlib.org/onlineArticles/ecourseware/Manahan/EnvChBasicsCondensedLect.pdf)
- **Waste water Treatment** (https://nptel.ac.in/courses/122/106/122106030/)
- **Waste reduction and minimization** (https://nptel.ac.in/courses/120/108/120108005/)
- **Green building** (https://nptel.ac.in/courses/105/102/105102195/)

C. Text Books

1. Stanley Manahan, Fundamentals of Environmental Chemistry, 3rd edition, CRC press, Taylor and Francis Group, Boca Raton, 2009.
2. Stanley Manahan, Environmental Science and Technology – A Sustainable Approach to Green Science and Technology, 2nd Edition, CRC press, Taylor and Francis Group, Boca Raton, 2011.
3. Liu David, H.F. and Liptak, B.G, Environmental Engineers Handbook, 2nd Edition, Lewis Publishers, Boca Raton, 1997.
4. AsimK. Das, EnvironmentalChemistry with Green Chemistry, Books and Allied (P) Ltd., Kolkata, 2010.
5. Shukla, Mohit, S.P., Green Chemistry, Books International, New Delhi, 2012.
6. R. Sanghi, M.M. Srivastava, Green Chemistry – Environment Friendly Alternatives, Narosa Publishing House, New Delhi, 2009.
7. Dennis C. Brewer, Green My Home: 10 Steps to Lowering Energy Costs and Reducing Your Carbon Footprint, ISBN:9781427798411, Kaplan Publishing, 2008.
8. K.S.Jagadish, B. U. Venkatarama, Alternative Building Materials and Technologies, New Age International, 2007.
9. TERI, Sustainable Building Design Manual, Vol 1 and 2, New Delhi, 2004.
10. O. H. Koenigs Berger, T. G. Ingersoll, Alan Mayhew and S. V. Szokolay, Manual of Tropical Housing and Building, Orient Long man, 1975.

D. Reference Books

1. Abele, E., Anderl, R. and Birkhofer, H., 2005. Environmentally-friendly product Development. Springer-Verlag London Limited
2. Moss, T. and Marvin, S., 2016. Urban infrastructure in transition: networks, buildings and plans.
3. Routledge Green, L., 2002. Communication, technology and society. Sage

E. Web Links

1. https://chem.libretexts.org/Bookshelves/Environmental_Chemistry/Book%3A_Green_Chemistry_and_the_Ten_Commandments_of_Sustainability_(Manahan)/08%3A_The_Five_Environmental_Spheres_and_Biogeochemical_Cycle/8.01%3A_New_Page.
2. https://www.epa.gov/greenchemistry/basics-green-chemistry#definition
3. https://www.pnas.org/content/105/36/13197#:~:text=Reactions,-Reactions%20play%20the&text=The%20ideology%20of%20Green%20Chemistry,and%20health%20and%20environmental%20safety
4. https://www.conserve-energy-future.com/waste-management-and-waste-disposal-methods.php

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	**Anthroposphere**		
1.1	Five spheres of the earth and their interaction and interrelationships. Anthroposphere – Definition, its effects of Anthroposphere on environment	Illustrate different kinds of Spheres and effect of environment.	K2
		Illustrate the interrelationships among the Spheres	K2
1.2	Anthropospheric constructs, Anthropospheric flows, Anthropospheric conduits. Infrastructure, transportation, the communication revolution, technology and Engineering (Brief description only)	Illustrate the concepts	K2
1.3	Acquisition of Raw materials. Agriculture – the most basic industry. Industries and their classification	Relationships among them	K4
Unit II	**Green Chemistry**		
2.1	Twelve principles of green chemistry, and green science and technology	Compare the different green chemistry and technology	K2
2.2	Reasons for Green Chemistry (resource minimization, waste minimization concepts) Yield and atom economy. Green oxidation and photochemical reactions	Explain technology	K2
2.3	Microwave and Ultrasound assisted reactions. Important techniques and directions in practicing Green Chemistry	Distinguish between model and functions Analyze their relationships with technology and waste management system	K4
Unit III	**Green Synthesis and Reactions**		
3.1	Feed stocks – biological feed stocks. Green Reagents - Stoichiometric and catalytic reagents.	Explain the concept & reagents procedure of Feed stocks	K2
3.2	Green solvents and reaction conditions. Green synthesis – case studies. Green catalysts	Apply the concept of green solvents catalysts method	K4
3.3	Use of zeolites, silica, alumina, clay, polymers, cyclodextrin and supported catalysts. Biocatalysts – enzymes	Relate them to the uses and minerals physical and chemical properties	K3
Unit IV	**Waste management**		
4.1	Waste reduction and minimization - recycling, solvent recovery and recycling. Recovery of water from waste water	Illustrate water management methods	K3

4.2	Physical methods of waste treatment. Chemical treatment. Thermal treatment, biodegradation and treatment and composting. Preparation of wastes for disposal. Ultimate disposal of wastes, In-situ-treatment.	Elaborate different waste treatment Technology	K6
Unit V	**Green Energy technologies and Green Buildings**		
5.1	Sources of energy in the Anthroposphere. Energy devices and conversions	Relate them to the Anthroposphere Energy conversions	K3
5.2	Green technology and energy conversion efficiency. Energy conservation and renewable energy sources (list of sources only). Unrealized potential of lingo - cellulose fuels	Illustrate Green technology, analyzes and evaluates	K2
5.3	Green Composites for buildings: Concepts of Green Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management	Illustrate the concepts	K2
	Management of Solid Wastes Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment	Examine various processes of Solid Wastes and Sewage leading to Green Buildings	K4

4. Mapping Scheme (POs, PSOs and COs)

P19ES2:3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	L	-	-	L	-	-	-	H	L	-	M
CO2	H	H	L	-	L	L	L	-	-	H	L	-	L
CO3	H	H	H	L	L	L	-	M	L	H	L	-	M
CO4	H	H	H	M	-	L	-	-	L	H	L	-	L
CO5	M	M	L	M	-	-	-	-	L	H	L	-	-
CO6	M	H	M	H	L	-	M	M	M	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: Ms. Udhaya Banu

Core VIII: ENVIRONMENTAL POLLUTION

Semester: III **Code: P16ES308**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	understand the physical basis of the natural greenhouse effect	K4	I
CO2	Climate change- causes, effects and mitigation/ adaptation	K4	II
CO3	Critically examine the forces impacting ecosystems viz., climate change	K5	II
CO4	describe the main sources of water pollution, the main types of pollutant and how each type may be controlled	K4	III
CO5	Describe measures and impact of marine pollution	K2	IV
CO6	Understand the key chemical Radioactive Pollution.	K3	V

2.A. Syllabus

Unit 1 Air Pollution (15 Hrs.)

Types of air pollutants, primary and secondary – particulate and gaseous contaminants, their sources and impact on vegetation, animals, human beings and materials, Photochemical smog, Bhopal gas disaster, Acid rain formation its effects on environment, Greenhouse Effect-Global Warming stratospheric ozone depletion.

Unit 2 Introduction to Climate change (15 Hrs.)

Climate system and its mechanism, the greenhouse gases and global warming, Carbon cycle and climate, natural climate variability, human induced climate variability. Climate change – Scientific basis: Anthropogenic GHGs and radioactive forcing, aerosols and climate forcing, land use pattern and other climate forcing, observed changes in climate (temperature, precipitation, and sea level), impacts of climate change on ecosystem, biodiversity and man.

Unit 3 Water Pollution (15 Hrs.)

Sources of water pollution, Classification of water pollutants - Oxygen demanding wastes, pathogens, plant nutrients, synthetic organic compounds, inorganic chemicals and mineral substances, Thermal pollution - sources and effects.

Unit 4 Marine pollution (15 Hrs.)

Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system, Impact of marine pollution, Oil pollution - sources and effects, an episode of oil pollution- coastal management.

Unit 5 Radioactive Pollution (15 Hrs.)

Radiation - types and units-sources natural and man-made, Effect of radioactive pollution and nuclear explosions. Noise pollution: Sources, impacts of noise pollution.

B. Topics for Self-study

- **Bhopal gas disaster** (http://www.iitk.ac.in/news/bhopal04/matter.htm)
- **climate change** (https://nptel.ac.in/content/storage2/courses/119102007/downloads/module1.pdf)
- **Marine pollution** (https://nptel.ac.in/courses/104/103/104103020/)
- **Radioactive Pollution** (https://nptel.ac.in/courses/105/106/105106056/)

C. Text Books

1. Kumaraswamy, K., Alagappa Moses, A and Vasanthy,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., AirPollution.Tata McGraw HillPublishing 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 Vasanthy, 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
2. http://www.indiaenvironmentportal.org.in/files/file/Air%20Quality%20Index.pdf
3. https://www.tropmet.res.in/~lip/Publication/RR-pdf/RR-127.pdf

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	**Air Pollution:**		
1.1	Types of air pollutants, primary and secondary – particulate and gaseous contaminants, their sources and impact on vegetation, animals, human beings and materials	Examine the association between the Air pollution and contamination	K4
1.2	Photochemical smog, Bhopal gas disaster, Acid rain formation its effects on environment	Explain the effects of air pollution on humans and other living and non-living objects	K5
1.3	Greenhouse effect-Global Warming stratospheric ozone depletion	Discuss the concepts of greenhouse effect, global warming, ozone depletion and acid rain	K2
Unit II	**Climate change**		
2.1	Introduction to Climate change: Climate system and its mechanism, the greenhouse gases and global warming, Carbon cycle and climate, natural climate variability, human induced climate variability.	Demonstrate Climate change and their causes and classify them at local, regional & global levels	K3

2.2	Climate change – Scientific basis: Anthropogenic GHGs and radioactive forcing, aerosols and climate forcing, land use pattern and other climate forcing,	Explain climate forcing	K2
2.3	Observed changes in climate (temperature, precipitation, and sea level), impacts of climate change on ecosystem, biodiversity and man.	Recall various impact of climate change	K1
Unit III	**Water Pollution**		
3.1	Sources of water pollution, Classification of water pollutants - Oxygen demanding wastes, pathogens, plant nutrients, synthetic organic compounds, inorganic chemicals and mineral substances.	Estimate the level of pollutant in the environment	K4
3.2	Thermal pollution - sources and effects	Recall various sources of thermal pollution	K1
Unit IV	**Marine pollution**		
4.1	Sources of marine pollution and control. Criteria employed for disposal of pollutants in marine system,	Estimate the level of pollutant in the marine environment	K4
4.2	Impact of marine pollution, Oil pollution - sources and effects, an episode of oil pollution- coastal management	Evaluate the effects and suggest remedies for controlling the oil pollutants in the coastal area.	K4
Unit V	**Radioactive Pollution**		
5.1	Radiation - types and units-sources natural and man-made.	List out the different type of pollutants from various industries	K1
5.2	Effect of radioactive pollution and nuclear explosions	Evaluate the effects and suggest remedies for controlling the radioactive pollution the environment	K4
5.3	Noise pollution: Sources, impacts of noise pollution.	Examine the effects of pollutions on human ear and surrounding	K4

4. Mapping Scheme (POs, PSOs and COs)

P16ES308	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	L	H	M	M	-	M	-	-	H	H	H	M
CO2	-	-	L	M	M	-	-	M	M	-	M	L	-
CO3	H	L	-	-	-	H	-	H	-	H	-	-	-
CO4	H	-	M	M	H	-	H	-	M	-	M	H	H
CO5	H	-	H	M	M	H	-	L	M	-	M	-	L
CO6	M	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 IX: ENVIRONMENTAL ENGINEERING

Semester: III **Code: P16ES309**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Course Outcome	K-Level	Unit
CO1	Define the concepts of water distribution systems, sewer networks and working principles.	**K3**	**I**
CO2	Analyze the appropriate water/waste water treatment methods,	**K4**	**II**
CO3	Choose right methods of sampling and analysis for air pollution monitoring	**K4**	**III**
CO4	Assess the pollution concentration incorporating meteorological factors through computer modelling	**K3**	**IV**
CO5	Apply the basic engineering principles in controlling the air / noise pollution.	**K5**	**IV**
CO6	Plan and organize solid waste collection, and 3-R strategies	**K5**	**V**

2.A. Syllabus

Unit I Environmental Standards and Policies (15 Hrs.)

Water quality standards (BIS, TNPCB, International standards, WHO, ICMR, USPHS), Water Supply – Layout of water distribution systems, Process technology of water treatment, cleaner production and Clean Development Mechanism

Unit II Water Quality Engineering (15 Hrs.)

Wastewater Treatment–Primary, Secondary and advanced treatment: Physical, Chemical and Biological unit processes for purifying the waste water. Design, Layout and specifications of Industrial and Municipal wastewater treatment systems.

Unit III Air Quality Engineering (15 Hrs.)

Air quality standards. Air Pollution control - its limitations, control by process changes, control systems. Control of particulate emissions-settling chambers, centrifugal collectors, wet collectors, fabric filters and Electrostatic precipitators, their techniques. Community air pollution survey. Meteorological factors in air pollution survey. Meteorological factors in air pollution, wind, Atmospheric stability, plume behavior. Air pollution monitoring, principles of sampling and analysis of particulate and gaseous contaminants.

Unit IV Air and Noise Management Engineering (15 Hrs.)

Control of gaseous contaminants - Adsorption and Absorption techniques. Condensation and combustion techniques. Noise pollution control - control at source and at receiver.

Unit V Solid Waste Management Engineering (15 Hrs.)

Principles and methods of Municipal solid waste collection, Recovery, Reuse and Recycling of useful solid wastes. Treatment and design of disposal mechanisms - Land filling, composting and incineration techniques.

B. Topics for Self-study

- **Water Quality Criteria** (https://cpcb.nic.in/water-quality-criteria/)
- **Water and Wastewater Engineering** (https://nptel.ac.in/courses/105/104/105104102/)
- **Air Quality and Meteorology** (https://www.exponent.com/services/practices/environmental-sciences/health-sciences/capabilities/atmospheric-sciences/)
- **Solid Waste Management Engineering** (https://www.kci.com/services/environmental-engineering/solid-waste-management/)

C. Text books

1. Duggal KN, Elements of Environmental Engineering, Chand and company Ltd., New Delhi,1998.
2. Masters GM, Introduction Environmental Engineering and Science, Prentice - Hall of India Pvt. Ltd., New Delhi,1991.
3. Metcalf and Eddy, Waste water Engineering, McGraw Hill Publishing Co., New York,2001.
4. 4.Peavy HS, Rowe DR and Tchobanoglous G, Environmental Engineering, Mc Graw Hill Book Co., New York,1986.
5. Benefield, L.D. and C.W. Randall, Biological process design for wastewater treatment. Published by Englewood Cliffs: Prentice Hall,1980

D. Reference Books

1. Hammer MJ, Water and Wastewater Technology, 2ndedition, John Wiley and Sons, NY,1986.
2. Rao CS, Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi,1991.

E. Web Link

1. https://www.thebalancesmb.com/an-introduction-to-solid-waste-management-2878102
2. https://www.cmu.edu/cee/prospective/graduate-degree/masters/ms-concentrations/air-quality-engineering-and-science.html

3. Specific Learning Outcome

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit 1	**Environmental Standards and Policies**		
1.1	Water quality standards (BIS, TNPCB, International standards, WHO, ICMR, USPHS), Water Supply	Identify different water quality standards and water sources for domestic supply	**K2**
1.2	Layout of water distribution systems, Process technology of water treatment, cleaner production and Clean Development Mechanism	Design various treatment processes and operations for drinking water	**K5**
Unit 2	**Water Quality Engineering**		
2.1	Wastewater Treatment– Primary, Secondary and advanced treatment: Physical, Chemical and Biological unit processes for purifying the waste water.	Design and Plan the waste water treatment systems for sewage and industrial effluents	**K5**
2.2	Design, Layout and specifications of Industrial and Municipal wastewater treatment systems.	Illustrate the water distribution and supply layout	**K3**
Unit 3	**Air Quality Engineering**		
3.1	Air quality standards. Air Pollution control - its limitations, control by process changes, control systems. Control of particulate emissions- settling chambers,	Apply to select the most appropriate technique to purify and/or control the emission of air pollutants.	**K3**

	centrifugal collectors, wet collectors, fabric filters and Electrostatic precipitators, their techniques.		
3.2	Community air pollution survey. Meteorological factors in air pollution survey. Meteorological factors in air pollution, wind, Atmospheric stability, plume behaviour.	Estimate the pollutant concentration using models incorporating the meteorological factors	**K5**
3.3	Air pollution monitoring, principles of sampling and analysis of particulate and gaseous contaminants.	Plan air pollution monitoring by choosing right methods of sampling and analysis	**K3**
Unit 4	**Air and Noise Management Engineering**		
4.1	Control of gaseous contaminants - Adsorption and Absorption techniques. Condensation and combustion techniques. Noise pollution control - control at source and at receiver.	Design particulate air pollution control devices. Propose suitable control device for control of gaseous contaminants	**K6**
Unit 5	**Solid Waste Management Engineering**		
5.1	Principles and methods of Municipal solid waste collection	Explain the different methods of municipal solid waste collection	**K2**
5.2	Recovery, Reuse and Recycling of useful solid wastes.	Employ 3-R in managing solid wastes	**K3**
5.3	Treatment and design of disposal mechanisms - Land filling, composting and incineration techniques.	Design and devise suitable treatment / disposal of Solid Waste Methods	**K5**

4. Mapping Scheme (POs, PSOs and COs)

P16ES309	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	L	-	-	L	-	-	L	M	M	M	H
CO2	H	L	L	H	M	M	L	-	-	H	M	M	L
CO3	H	-	L	M	H	-	L	L	-	H	H	M	-
CO4	H	-	L	M	M	H	L	-	L	H	M	H	M
CO5	H	-	M	H	M	H	L	-	L	H	L	L	L
CO6	H	L	L	M	M	H	L	L	M	H	L	M	M

L: Low; M-Medium; H-High

5. Course Assessment Method

Direct

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

Indirect

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

Course Coordinator: Dr. C.Ravichandran

Core X: INDUSTRIAL POLLUTION AND SAFETY MANAGEMENT

Semester: III **Code: P16ES310**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Review manufacturing processes of various industries	**K2**	**I-IV**
CO2	Demonstrate the sources and characteristic features of wastes from various industries	**K2**	**I-IV**
CO3	Describe the effects of various industrial effluents on various discharge fields	**K2**	**I-IV**
CO4	Determine appropriate treatment technologies in various industrial effluent management facilities	**K3**	**I-IV**
CO5	Administer various occupational and industrial disputes by adapting suitable policies and legislations	**K4**	**V**
CO6	Appraise accident and disaster-prone areas and adapt suitable management strategies	**K6**	**V**

2.A. Syllabus

Unit I Tanneries and Distillery (15 Hrs.)

Production of leather, vegetable tanning and chrome tanning processes. Sources and characteristics of wastes, Effect of tannery effluent and other wastes on receiving bodies and treatment methods of the wastes. Sugar mills and Distilleries - their manufacturing processes, sources and characteristics of their wastes, on receiving bodies, Treatment of their wastes and disposal.

Unit II Paper and Pulp, and textile industries (15 Hrs.)

Manufacturing processes, sources and characteristics of wastes. Effect of wastes, Treatment processes of the wastes, Textile mills - manufacturing processes, sources and characteristics of wastes, Effects of the wastes on receiving bodies, Treatment of the wastes.

Unit III Cement and energy Industries (15 Hrs.)

Manufacturing process, sources of pollution and wastes. Effect of wastes, Control technique of pollution, Oil refineries and thermal power plants-processes involved, Sources of pollution characteristics of pollutants and their effects. Pollution control techniques.

Unit IV Fertilizer and pharmaceutical Industries (15 Hrs.)

Manufacturing processes, sources and characteristics of wastes and their effects, treatment processes. Pharmaceutical plants: manufacturing processes sources and characteristics of wastes and their effects, Treatment of wastes.

Unit V Safety Management and Industrial Acts (15 Hrs.)

Industrial safety- Causes of accident, Accident reporting system, Accident prevention, Disaster planning, Safety committee, Hazards control - Elimination, Control, Isolation, Substitution, Personal protective equipment, medical first aid- management of medical emergencies. Labour laws: factories act 1948, Mines act 1952, ESI act 1948- Health organizations: NIOH, AIIHPH, NHO, WTO, OSHA standards.

B. Topics for Self-study

- **Contextual Water Targets** (https://www.atree.org/sites/default/files/reports/CBWT_Noyyal_Bhavani_final%20report_ATREE.pdf)
- **Pollution Control Technologies** (https://www.eolss.net/sample-chapters/C09/E4-14-00-00.pdf)
- **Polluting Industries** (https://www.downtoearth.org.in/news/pollution/grossly-polluting-industries-more-than-doubled-in-8-years-soe-in-figures-64962)
- **Environmental governance in India** (https://www.downtoearth.org.in/blog/environment/environmental-governance-in-india-pushes-industries-to-face-stricter-pollution-norms-53999)

C. Text Books

1. Austin GT, Shreves, Chemical processes in industries, McGraw Hill Book Co., New York, 1977.
2. Mahajan SP, Pollution Control in process industries, Tata McGraw Hill Co. Ltd., New Delhi, 1986.
3. Rao MN and Datta, Wastewater treatment, Oxford and IBH, 1982.
4. Trivedy, B.K, Pollution control in industries, Enviro media publishing Co., Karad,1991.
5. Bill Walash and Lawrence Russel, ABC of industrial safety, Pitman Publishers, UK, 1974.

D. Reference Books

1. Trivedy, B.K, Pollution control in industries, Enviro media publishing Co., Karad,1991.
2. Bill Walash and Lawrence Russel, ABC of industrial safety, Pitman Publishers, UK, 1974.

E. Web Links

1. https://www.downtoearth.org.in/news/air/coal-burning-responsible-for-heavy-air-pollution-in-india-ieaccc-study-75536
2. http://www.bionicsro.com/effluent-treatment/pharmaceutical-water-treatment.html
3. https://ncib.in/pdf/ncib_pdf/Labour%20Act.pdf
4. https://mphdegree.usc.edu/blog/world-health-organizations-guide/

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	**Tanneries and Distillery**		
1.1	Production of leather, vegetable tanning and chrome tanning processes.	Discuss various production and manufacturing techniques involved in leather production and tanning processes	**K2**
1.2	Sources and characteristics of wastes.	Identify the types and characteristics of wastes from tanning industries	**K2**
1.3	Effect of tannery effluent and other wastes on receiving bodies and treatment methods of the wastes.	Identify and interpret the impacts of tannery wastes	**K2**
1.4	Sugar mills and Distilleries - their manufacturing processes,	Discuss various techniques involved in Distillation processes	**K2**
1.5	sources and characteristics of their wastes,	Identify the types and characteristics of wastes from Distillery industries	**K2**
1.6	on receiving bodies, Treatment of their wastes and disposal	Identify and interpret the impacts of wastes from distilleries	**K2**
Unit II	**Paper and Pulp, and textile industries**		
2.1	Paper and pulp industries - Manufacturing processes,	Demonstrate various production and manufacturing techniques involved in paper and pulp industries	**K2**
2.2	sources and characteristics of wastes.	Identify the sources and characteristics of wastes generated from paper and pulp industries	**K2**
2.3	Effect of wastes, Treatment processes of the wastes	Interpret the impact of wastes from paper and pulp industries	**K2**
2.4	Textile mills - manufacturing processes, sources and characteristics of wastes	Demonstrate various techniques involved in textile industries	**K2**
2.5	Effects of the wastes on receiving bodies, Treatment of the wastes.	Identify the sources and interpret the impact of those wastes on various environment	**K2**
Unit III	**Cement and energy Industries**		
3.1	Manufacturing process, sources of pollution and wastes.	Demonstrate various production and manufacturing techniques involved in Cement industries	**K2**

3.2	Effect of wastes, Control technique of pollution,	Identify the sources and interpret the impact of those wastes on various environment	**K2**
3.3	Oil refineries and thermal power plants-processes involved	Demonstrate various production and manufacturing techniques involved in Oil refineries and thermal power plants	**K2**
3.4	Sources of pollution characteristics of pollutants and their effects.	Identify the sources and interpret the impact of those wastes on various environment	**K2**
3.5	Pollution control techniques.	Employ suitable pollution control techniques in thermal power plants	**K3**
Unit IV	**Fertilizer and pharmaceutical Industries**		
4.1	Manufacturing processes, sources and characteristics of wastes	Demonstrate various production and manufacturing techniques involved in fertilizer industries	**K2**
4.2	and their effects, treatment processes.	Identify the sources and interpret the impact of those wastes on various environment	**K2**
4.3	Pharmaceutical plants: manufacturing processes sources and characteristics of wastes	Demonstrate various production and manufacturing techniques involved in pharmaceutical industries	**K2**
4.4	and their effects, Treatment of wastes.	Identify the sources and interpret the impact of those wastes on various environment	**K2**
Unit V	**Safety Management and Industrial Acts**		
5.1	Industrial safety- Causes of accident, Accident reporting system, Accident prevention,	Analyse accident prone zones in industries and prepare report on accident prevention	**K6**
5.2	Disaster planning, Safety committee, Hazards control - Elimination,	Evaluate the disaster hazards and develop elimination strategies	**K6**
5.3	Control, Isolation, Substitution,	Identify and adopt suitable hazard mitigation measures	**K3**
5.4	Personal protective equipment, medical first aid	Use the PPEs and suitable first-aid techniques	**K3**
5.5	management of medical emergencies	Act accordingly to medical emergencies	**K3**
5.6	Labour laws: factories act 1948, Mines act 1952, ESI act 1948	Demonstrate various labour laws existing in India	**K3**
5.7	Health organizations: NIOH, AIIHPH, NHO, WTO, OSHA standards.	Demonstrate various standards and guidelines by global health organizations	**K3**

4. Mapping Scheme (POs, PSOs and COs) P16ES310

P16ES310	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	M	H	-	L	H	L	L	L	M	M	M	M
CO2	M	M	H	-	M	H	L	L	L	M	M	M	M
CO3	M	M	H	-	M	H	L	L	L	M	M	M	M
CO4	M	M	H	M	M	H	L	L	L	M	M	M	M
CO5	M	M	M	-	M	M	M	M	M	M	M	H	M
CO6	M	M	M	M	M	L	L	L	L	M	M	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. A. Chandramohan

CORE XI – ENVIRONMENTAL IMPACT ASSESSMENT

Semester: III **Code: P16ES311**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	State the basic concepts of Environmental Impact Assessment	K5	I
CO2	Discuss the recent developments of Environmental Impact Assessment	K6	II
CO3	Interpret various methods of Environmental Impact Assessment	K6	III
CO4	Appraise the methods of preparation of Environmental Impact Assessment reports	K5	IV
CO5	Perform a health risk analysis	K5	V
CO6	Organize risk assessment, Life Cycle Analysis and Cost-Benefit analysis	K5	V

2.A. Syllabus

Unit 1 EIA **(15 Hrs.)**

Environmental Impact Assessment – History and perspectives. EIA – Definition and Terminologies. Regulatory framework in India, EIA guidelines, Govt. of India EIA Notifications and further amendments. NABET criteria for EIA consultants.

Unit 2 EIA Methodologies **(15 Hrs.)**

Environmental Impact Assessment Methodologies – Adhoc, Overlays, Matrix, Checklist and Network approach. Battle Columbus Technique and modeling. EIA Process, EIS and EMP. Public Hearing, list of industries attracting EIA, Environmental Clearance.

Unit 3 EIA Analysis **(15 Hrs.)**

Environmental Impact Analysis and Assessment - Air, Noise, Water, Land, Socio – economic and biotic environment. Environmental setting, Identification, evaluation and prediction of environmental impacts.

Unit 4 Environmental Audit **(15 Hrs.)**

Environmental Audit, ISO 14001 & OHSAS 18001, Environmental Management Systems. Case studies of EIA of developmental projects – Hydel project, Oil Pipeline project, East Coast Road, Mining project.

Unit 5 EIA Assessment **(15 Hrs.)**

Principles of Risk Assessment: Human Health Risk Assessment, Ecological Risk Assessment, Probabilistic Risk Assessment. The role of Risk assessment in Environmental Management decision. Evaluation of human health risks associated with airborne exposures. Risk management and risk communication. Life Cycle Assessment and Cost Benefit Analysis.

B. Topics for Self-study:

- **Environmental monitoring and auditing** (https://www.iaia.org/wiki-details.php?ID=15)
- **Mitigation banking** (https://environmentalbanking.org/)
- **Use of Internet in the EIA process** (https://www.iaia.org/eia-index-of-websites.php)
- **Methods and tools for EIA** (https://www.shelltercluster.org/sites/default/files/docs/GRRT%203%20-%20Environmental%20Impact%20Assessment%20Tools%20and%20Techniques.pdf)

C. Text Books

1. Canter LW, Environmental Impact Assessment (1977). McGraw Hill Book Co., New York.
2. Munn RE, Environmental Impact Assessment (1982). McGraw Hill Book Co., New York.
3. Rau JG and Wooten DC, Environmental Impact Analysis Handbook (1980). McGraw Hill Book Co., New York.

D. References

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, 1998.
3. Peter Calow, Hand Book of Environmental Risk Assessment and Management, Blackwell, Swence, London, 1998.
4. Westman WE, Ecology, Impact Assessment and Environmental Planning, John Willey and Sons, New York, 1985.

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Level of Blooms Taxonomic Transaction
Unit I	**EIA**		
1.1	Environmental Impact Assessment – History and perspectives.	Recall the Environmental Impact Assessment History and perspectives, Definition and Terminologies.	K1
1.3	EIA Notifications and further amendments. NABET criteria for EIA consultants.	Interpret the Regulatory framework employed in India. NABET criteria for EIA consultants NRBT criteria for EIA consultants, NABL.	K5
Unit II	**Methodologies**		
2.1	Environmental Impact Assessment	Explaining the Procedure followed while doing EIA	K2
2.2	Methodologies – Adhoc, Overlays, Matrix, Checklist and Network approach. Battle Columbus Technique and modeling. EIA Process, EIS and EMP. Public Hearing, list of industries attracting EIA, Environmental Clearance.	Explain the Rapid and Comprehensive EIA, Methodologies.	K2 & k6
		Adapt Adhoc, Overlays, Matrix, Checklist and Network approach. Environmental Clearance	
Unit III	**EIA Analysis**		
3.1	Environmental Impact Analysis and Assessment - Air, Noise, Water, Land, Socio – economic and biotic environment. Environmental setting, Identification, evaluation and prediction of environmental impacts.	Analyze and assess the Environmental Impact on Air, Noise, Water, Land, flora and fauna, Socio – economic and biotic environment.	K4
		Evaluate the environmental setting, Identification, evaluation and prediction of environmental impacts.	K5

Unit IV	**Environmental Audit**		
4.1	Environmental Audit, ISO 14001 & OHSAS 18001, Environmental Management Systems. Case studies of EIA of developmental projects – Hydel project, Oil Pipeline project, East Coast Road, Mining project.	Formulate the Environmental Audit Guidelines, planning for Environmental	K6
		Predict the Industrial safety and OHSA systems and ISO 14001. & OHSAS 18001.	K5
Unit V	**EIA Assessment**		
5.1	Principles of Risk Assessment: Human Health Risk Assessment, Ecological Risk Assessment, Probabilistic Risk Assessment.	Apply and assess the principles of Risk Assessment Human Health Risk Assessment, Ecological Risk Assessment, Probabilistic Risk Assessment.	K3
	The role of Risk assessment in Environmental Management decision. Evaluation of human health risks associated with airborne exposures.	Measure the role of Risk assessment in Environmental Management decision.	K5
	Risk management and risk communication. Life Cycle Assessment and Cost Benefit Analysis.	Evaluate Risk management and risk communication, Life Cycle Assessment and Cost Benefit Analysis	K5

4. Mapping Scheme (POs, PSOs and COs)

P16ES311	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	L	-	-	M	-	-	M	-	H	M	-	H
CO2	H	L	-	H	L	-	M	M	L	H	L	M	M
CO3	L	M	M	-	-	L	-	-	-	H	-	-	L
CO4	H	L	L	-	L	L	-	H	L	H	M	M	H
CO5	H	-	L	L	-	L	M	L	L	H	L	-	H
CO6	H	-	M	L	-	L	M	L	L	H	L	-	H

L-Low; M-Medium; H-High Correlation

5. Course Assessment Method

Direct

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

Indirect

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

Course Coordinator: Prof. A. Alagappa Moses

Core Practical IV: WATER POLLUTION AND ITS CONTROL ENGINEERING

Semester III **Code: P16ES3P4**
Credits: 4 **Total Hours: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Inspect the physical characteristics of water	**K4**	**1**
CO2	Assess the chemical characteristics of water	**K6**	**2**
CO3	Determine nutrient content of water and waste water	**K6**	**2**
CO4	Test the demand parameters of water	**K6**	**3**
CO5	Test the time / dosage for water / waste water treatment	**K6**	**4**
CO6	Design water treatment units	**K6**	**5**

2.a Syllabus

Water and effluent analysis:

Unit 1 Physical parameters:

Temperature, Turbidity, Odour, Colour, Total solids, Total Dissolved Solids, Total Suspended Solids.

Unit 2 Chemical parameters:

pH, Electrical Conductivity, Alkalinity, Acidity, Total Hardness, Calcium, Magnesium, Chloride, Fluoride, Iron, Manganese, Total Nitrogen, Nitrates, Nitrites, Phosphates, Sodium, Potassium, Silicates, Sulphates, Ammonia (one water sample and one available effluent sample are to be analyzed).

Unit 3 Demand parameters:

Dissolved Oxygen, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

Unit 4 Wastewater treatment studies

Aeration, fixing optimum pH and optimum coagulant dose using Jar test apparatus.

Unit 5 Design of Wastewater treatment units

1. Calculation and designing of Sedimentation Tank, Clariflocculator
2. Calculation and designing of Aeration Tank
3. Calculation and designing of Activated Sludge Processes
4. Calculation and designing of Trickling Filter
5. Calculation and designing of Disinfection Process

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. APHA Standard Methods for the Examination of Water and Wastewater, American Water Works Association, 21st Edition. ISBN 0875530478, 9780875530475 APHA Publisher, 2005.
3. Trivedy RK, Goel PK and Trisal L, Practical Methods in Ecology and Environmental Science s, Environmental Publications, Karad, 1987.
4. Saxena MM, Environmental Analysis Water, Soil and Air, Agro Botanical Publishers, India. ISBN: 81-85031-22-3, 1987

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	**Physical Parameters**		
1.1	Temperature, Turbidity, Odour, Colour, Total solids, Total Dissolved Solids, Total Suspended Solids	Discuss the principles, concept and Importance of parameters	K6
		Analyze the different water samples	K4
		Compare the results with the standards	K4
		Determine the condition of the water sample	K5
		Recommend water samples for the human consumption	K5
		Formulate the rules and regulation for the future conservation	K6
Unit II	**Chemical Parameters**		
2.1	pH, Electrical Conductivity, Alkalinity, Acidity, Total Hardness, Calcium, Magnesium, Chloride, Fluoride, Iron, Manganese, Total Nitrogen, Nitrates, Nitrites, Phosphates, Sodium, Potassium, Silicates, Sulphates, Ammonia (one water sample and one available effluent sample are to be analyzed).	Discuss the principles, concept and Importance of parameters	K6
		Analyze the different water samples	K4
		Compare the results with the standards	K4
		Determine the condition of the water sample	K5
		Recommend water samples for the human consumption	K5
		Formulate the rules and regulation for the future conservation	K6
Unit III	**Demand Parameters**		
3.1	Dissolved Oxygen, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)	Discuss the principles, concept and Importance of parameters	K6
		Analyze the different water samples	K4
		Compare the results with the standards	K4
		Determine the condition of the water sample	K5

		Recommend water samples for the human consumption	K5
		Formulate the rules and regulation for the future conservation	K6
Unit IV	**Waste Water Treatment Studies**		
4.1	Aeration, fixing optimum pH and optimum coagulant dose using Jar test apparatus	Discuss the principles, concepts and importance of aeration, and coagulation, flocculation and sedimentation	K6
		Discover the relationship between time duration and increase of DO during aeration	K3
		Determining the optimum dosage of coagulant	K6
		Determining optimum pH for coagulation	K6
Unit V	**Design of Waste Water Units**		
5.1	Calculation and designing of Sedimentation Tank, Clariflocculator Calculation and designing of Aeration Tank Calculation and designing of Activated Sludge Processes Calculation and designing of Trickling Filter Calculation and designing of Disinfection Process	Design the sedimentation tank and clariflocculator	K5
		Design aeration tank	K5
		Design activated sludge process	K5
		Design trickling filter	K5
		Determine the dose of disinfectant	K6
		Design the disinfection process	K5
		Develop the mapping of water and soil specifications.	K6

4. Mapping Scheme (POs, PSOs and COs)

P16ES3P4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	L	L	M	L	L	-	-	L	M	M	-
CO2	H	L	L	M	M	M	L	-	-	H	H	H	L
CO3	H	H	M	M	M	H	L	L	L	H	H	H	M
CO4	H	H	M	H	M	M	L	L	L	H	H	H	M
CO5	H	L	H	H	H	H	M	M	M	H	M	M	H
CO6	H	M	M	H	H	H	M	M	L	H	M	M	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 IV: Remote Sensing and GIS for Environmental Sciences

Semester: III **Code: P19ES3:4**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO	Outcomes	K-level	Unit
CO1	Explain the principles and applications of remote sensing in environmental management	**K2**	**I**
CO2	Explain the principles and applications of Geographic Information System	**K2**	**II**
CO3	(GIS) technologies in environmental management	**K4**	**III**
CO4	Recognize the application of GIS in Land use/cover management.	**K6**	**III**
CO5	Discuss the applications of GIS in mapping of ground water potential zones.	**K6**	**IV**
CO6	Develop GIS maps of environmental resources, pollution and disasters for environmental management and Disaster management	**K6**	**V**

2.A. Syllabus

Unit I Fundamentals of Remote Sensing (15 Hrs.)

Energy sources and radiation principles – Processes and elements of Electromagnetic Remote Sensing for Earth resources - Electromagnetic spectrum: components useful for Remote Sensing –- Interaction of electromagnetic energy with Earth's atmosphere and surface features – Spectral reflectance curve of vegetation, soil and water – Types of satellites - Sensor resolution: spatial, spectral, temporal and radiometric – Outline of Landsat, SPOT, IRS and high resolution satellites – Outline of hyperspectral sensors, SAR, SLAR and LIDAR. – Fundamentals of image interpretation techniques

Unit II Principles of Geographic Information System (GIS) (15 Hrs.)

Concepts and Components of GIS – Hardware, software and organizational Context- Data – (spatial and non-spatial) –Maps (types of maps) - Projection (types of projection) Data input (digitizer- scanner-editing) Raster and vector data structure- analysis using raster and vector data- retrieval, reclassification, overlaying, buffering- data output - Outline of DEM, DTM, DSM, Networking, Open GIS, Web GIS

Unit III Applications of Remote Sensing and GIS (15 Hrs.)

Land Use / Land Cover Mapping – Mapping of soil erosion prone areas and areas of soil salinity – Forest degradation and forest fire mapping -Site selection for waste disposal – Mapping of mine affected areas – Mapping of wetlands.

Unit IV Applications of Remote Sensing and GIS (15 Hrs.)

Groundwater potential zones - contamination of surface and ground water quality due to urbanization and industrialization – Lake eutrophication and its impacts – Coastal and marine pollution – Coastal dynamics - Desertification and its impacts.

Unit V Applications of Remote Sensing & GIS for Natural Disaster Assessment (15 Hrs.)

Wildfires – Severe storms – Floods – Droughts – Landslides - Earthquakes - Volcanic eruptions – Dust and Smoke. Applications of Remote Sensing and GIS for the study of atmosphere constituents - air pollution due to industrial activities.

B. Topics for Self-study

- **Thematic Map preparation Technique** (http://www.gisthai.org/resource/Sombat%20Thesis%20PDF/chapter3.pdf)
- **GIS applications in air pollution modeling** (https://www.geospatialworld.net/article/gis-applications-in-air-pollution-modeling/)
- **Application of GIS technology for Coastal Zone Management** https://www.geospatialworld.net/article/application-of-gis-technology-for-coastal-zone-management-a-hydrographer-perspective/)
- **Satellite remote sensing of water turbidity** (http://hydrologie.org/hsj/250/hysj_25_04_0407.pdf)

C. Text Books

1. Lillesand, T.M. and P.W. Kiefer, Remote Sensing and Image Interpretation 3rd Ed. (2007). John Wiley and Sons, New York.
2. Chang KT,Introduction toGeographicInformationSystem (2002).McGraw Hill,Boston.
3. Richardson BF Jr (Ed.), Introduction to Remote Sensing of the Environment (1978). Kendall/Hunt, Dubuque, Iowa.

D. Reference Books

1. Reddy MA. TextbookofRemoteSensingandGIS (2003). BS Publications Hyderabad.
2. Panda BC. Remote Sensing Principles and Application (2005). Viva Books Private Limited, New Delhi.
3. Singh S, Geomorphology and Remote Sensing in Environmental Management (1992). Scientific Publishers, Jodhpur.
4. PirazizyAA,EnvironmentalGeographyandNaturalHazards (1992).ConceptPublishingCompany, New Delhi.
5. Sabins FF, Remote Sensing Principles and Interpretation (1978). Freeman, San Francisco.

E. Web Links

1. https://www.slideshare.net/SumantDiwakar/interaction-of-emr-with-atmosphere-and-earth-surface
2. https://nptel.ac.in/courses/105/107/105107155/
3. http://www.wamis.org/agm/pubs/agm8/Paper-18.pdf.
4. https://www.intechopen.com/books/sustainable-development-authoritative-and-leading-edge-content-for-environmental-management/use-of-remote-sensing-in-wildfire-management.
5. https://www.isprs.org/proceedings/XXXVIII/7-C4/203_GSEM2009.pdf

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	**Fundamentals of Remote Sensing**		
1.1	Energy sources and radiation principles–Electromagnetic spectrum: Processes and elements of Electromagnetic Remote Sensing	Explain electromagnetic radiation principles in the application of remote sensing	K2
1.2	Interaction of electromagnetic energy with Earth's atmosphere and surface features – Spectral reflectance curve of vegetation, soil and water–	Examine the association between the electromagnetic energy with Earth's atmosphere and surface features	K4

1.3	Types of satellites– Sensor resolution: Spatial, spectral, temporal and radiometric.	Compare the different satellite imagery resolution	K2
1.4	Fundamentals of image interpretation techniques	Relate the basic elements are shape, size, pattern, tone, texture, shadows, location, association and resolution	K3
Unit II	**Principles of Geographic Information System (GIS)**		
2.1	Concepts and Components of GIS – Hardware, software and organizational Context-Data– (spatial and non-spatial)–Maps (types of maps)–Projection (Types of projection)	Explain desirable requirement of hardware and software for a GIS technique process	K2
2.2	Data input (digitizer- scanner-editing) Raster and vector data structure- analysis using raster and vector data- retrieval, reclassification, overlaying, buffering-Data output.	Apply the general procedure GIS Raster and vector data analysis in software	K3
Unit III	**Applications of Remote Sensing and GIS**		
3.1	Land use/land cover Mapping; Basic concept and classification and Land use change detection mapping.	Elaborate GIS Technique Land use Land cover plan can be determined by analyzing satellite and aerial imagery	K6
3.2	Mapping of soil erosion prone areas – Mapping of Forest degradation and Biodiversity conservation –Mapping of wetlands; Mapping of Site selection for waste disposal.	Apply the general procedure for satellite image classification technique and mapping	K3
Unit IV	**Applications of Remote Sensing and GIS**		
4.1	Mapping of Groundwater potential zones–Contamination of surface and ground water quality	Illustrate BIS standard for Groundwater and Surface water specification	K3
4.2	Watershed Management-Eutrophication and its impacts– Coastal and marine pollution– Coastal dynamics. Mapping of Air pollutants due to Industrial activities	Apply the general procedure for satellite image classification technique and mapping	K3
Unit V	**Applications of Remote Sensing and GIS for Natural Disaster Assessment**		
5.1	Floods – Droughts – Landslides – Earthquakes – Volcanic eruptions– Desertification.	Apply the general procedure for satellite image classification technique and mapping	K3

4. Mapping Scheme (POs, PSOs and COs)

P19ES3:4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	-	-	M	-	-	-
CO2	-	-	-	-	-	-	-	-	-	M	-	-	-
CO3	H	L	H	H	H	H	-	-	-	H	-	-	H
CO4	H	-	-	M	M	H	-	L		H	H	-	H
CO5	M	M	H	M	-	H	-	L	-	H	-	H	L
CO6	M	H	M	M	M	H	-	L	-	H	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: Ms. Udhaya Banu

Core Practical V: AIR AND SOIL POLLUTION AND AIR POLLUTION CONTROL ENGINEERING

Semester IV **Code: P16ES4P5**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Appraise air quality with reference to Particulates and gaseous contaminants	**K6**	**1**
CO2	Assess Pollution emission from vehicles	**K6**	**1**
CO3	Design the air pollution control devices – settling chamber, cyclone, ESP and fabric filters	**K5**	**2**
CO4	Examine the meteorological factors for air pollution	**K4**	**3**
CO5	Assess the noise pollution	**K6**	**4**
CO6	Evaluate the soil quality – physical and chemical properties	**K6**	**5**

2.A. Syllabus

Unit 1 Air analysis:

1. Particulates:
2. Estimation of PM10 in the ambient air
3. Gaseous Contaminants:
4. Estimation of SO2, H2S, NOx in the ambient air
5. Vehicular pollution - Emission check

Unit 2

1. Calculation and Designing of Settling chambers
2. Calculation and Designing of Cyclones
3. Calculation and Designing of Electrostatic Precipitator
4. Fabric filters

Unit 3

1. Temperature, Humidity
2. Preparation of wind roses
3. Determination of Atmospheric Stability – Pasquill – Turner Method

Unit 4 Noise Monitoring:

Ambient noise levels and Leq calculation using sound level meter

Unit 5 Soil analysis:

1. Soil sampling techniques, pH, Electrical Conductivity, Alkalinity, Total Organic Matter, Total Phosphorous, Total Nitrogen, Sodium, Potassium, Ca, Mg, C/N ratio.
2. Soil texture: sand, silt, clay.
3. Spot tests: Nitrate, ammonia and carbonate.

D. Reference Books

1. Trivedy R K, Goel PK and Trisal L, Practical Methods in ecology and Environmental Sciences, Environmental Publications, Karad, 1987.
2. Margesin R and Schinner, Manual of Soil Analysis – Monitoring and Assessing Bioremediation, Springer –Verlag Berlin Heidelberg, 2005.
3. James P. Lodge, Methods of Air Sampling and Analysis, Inter Society Committee Publicaion, 1988.
4. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous,Environmental Engineering, 2017

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	**Air Analysis**		
1.1	1.1.1. Particulates: Estimation of PM10 in the ambient air 1.1.2. Gaseous Contaminants: Estimation of SO2, H2S, NOx in the ambient air	Describe the concept of sampling and analysis of particulates (PM_{10}) and gaseous contaminants	K2
		Estimate the concentration of PM_{10} and gaseous contaminants in ambient air	K6
		Interpret air quality with reference to PM_{10} and gaseous contaminants	K6
1.2	Vehicular pollution - Emission check	Demonstrate the emission testing from vehicles	K3
		Conclude the quality of vehicle in terms of air pollution control	K6
Unit II	**Designing air pollution control devices**		
2.1	2.1.1. Calculation and Designing of Settling chambers 2.1.2. Calculation and Designing of Cyclones 2.1.3. Calculation and Designing of Electrostatic Precipitator 2.1.4. Fabric filters	Sketch the diagram of Settling chamber, cyclone, ESP and fabric filters	K3
		Choose appropriate device for control of particulates based on particulate size	K6
		Explain the principles of operation of settling chambers, cyclones, ESP and fabric filters	K2
		Design the air pollution control devices – settling chambers, cyclones, ESP and fabric filters	K6
Unit III	**Meteorological Parameters**		
3.1	Temperature, Humidity	Describe the importance of temperature and humidity in air quality	K2
		Apply the temperature values in calculating air pollutant concentrations	K3

3.2	Preparation of wind roses	Explain the influence of wind speed and direction in transportation of air pollutants	K2
		Construct the wind rose diagram to categorize the wind based on direction and speed	K6
		Predict the zones of high air pollutant concentration based on wind rose	K4
3.3.	Determination of Atmospheric Stability – Pasquill-Turner Method	Explain the importance of atmospheric stability in dispersion of air pollutants in the atmosphere	K2
		Assess the stability of atmosphere by Pasquill-Turner Method	K6
		Interpret the dispersion potential of atmosphere based on stability class	K6
Unit IV	**Noise Monitoring**		
4.1	Ambient noise levels and Leq calculation using sound level meter	Estimate the Sound Pressure Levels using Sound Level Meter	K6
		Compute the L_{eq} values from observed Sound Pressure Levels	K3
		Conclude the noise pollution status based on computed L_{eq} value	K6
		Interpret the results by comparing with Standards	K6
Unit V	**Soil Analysis**		
5.1	Soil sampling techniques	Apply the soil sampling techniques in the field	K3
5.2	pH, Electrical Conductivity, Alkalinity, Total Organic Matter, Total Phosphorous, Total Nitrogen, Sodium, Potassium, Ca, Mg, C/N ratio	Evaluate the soil quality based on chemical properties	K6
5.3	Soil texture – sand, silt, clay	Categorize the soil based on its texture	K4
5.4	Spot tests: nitrate, ammonia and carbonate	Test the soil qualitatively	K4

4. Mapping Scheme (POs, PSOs and Cos)

P16ES4P5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	L	L	L	H	L	L	-	-	L	H	H	-
CO2	L	L	L	L	M	M	L	L	-	L	M	H	L
CO3	H	L	M	M	L	H	L	L	L	H	L	H	H
CO4	H	H	M	H	H	M	L	L	L	H	H	H	M
CO5	M	L	M	H	H	H	L	L	M	H	H	H	M
CO6	H	L	L	L	H	H	M	L	L	H	H	M	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. Ravichandran

Elective V: INTERNSHIP AND FIELD WORK

Semester: IV **Code: P19ES4F1**
Credits: 4 **Hours/Week: 5**

1. Course Outcomes

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

CO No.	Outcomes	K-level	Unit
CO1	Recognize the methods of field study and report writing	**K3**	**I**
CO2	Explain the environmental pollution and control practices in various industries.	**K2**	**II**
CO3	Analyse and plan conservation strategies suitable for various ecosystems	**K5**	**III**
CO4	Design conservation strategies suitable for various ecosystems	**K6**	**III**
CO5	Analyse and evaluate the processes and technology in a selected industry	**K6**	**IV**
CO6	Conduct Environmental Impact Assessment	**K6**	**V**

2. Syllabus

Unit 1: Field Work/Study **(5 hours)**

Need for fieldwork, Methods of field study, importance, steps involved in field study. Field report preparation: Report writing methods.

Unit 2: Internship **(20 hours)**

(Minimum duration of 15 days in any one of the industries mentioned below).

Industries – Distillery, Tannery, Pulp and Paper industry, Sugar factory, Textile and dyeing units, Dairy, Thermal Power plants, pharmaceutical industry, Fertilizer factory, Food processing industries, Iron and Steel industry, Steel Rolling mills, Oil refineries, Cement factory, Sugar factory.

Waste management facility

Common Biomedical waste management facility, Common Effluent Treatment Plants – Tannery, Textile and Dyeing units. Solid waste management facility, Municipal sewage treatment plants.

Environmental Laboratories, Environmental Consultancy Agencies, Non-Governmental Organizations etc.

Unit 3: Eco-Tour **(20 hours)**

Visit to ecosystems - Pond ecosystem, Riverine ecosystem, Hill / Mountain ecosystem, Coastal Ecosystem, Mangroves.

Mudumalai Tiger Reserve, Anamalai Tiger Reserve, Eravikulum National Park

Mukurthi National Park, Guindy National Park, Gulf of Mannar Natioanl Park and Biosphere Reserve, Nilgiri Biosphere Reserve, Periyar Tigar Reserve, Karaivetty/Udhayamarthandam/Vaduvoor Bird Sanctuary, Point Calimere Wild life and Bird Sanctuary

Unit 4: Visit to Industry / Environmental Management Facility **(20 hours)**

Industry: Distillery, Tannery, Pulp and Paper industry, Sugar factory, Textile and dyeing units, Dairy, Food processing industries, Steel Rolling mills, Cement factory.

Waste management facility: Common Biomedical waste management facility, Common Municipal Solid waste management facility, Municipal sewage treatment plants.

Environmental Laboratories, Environmental Consultancy Agencies, Non-Governmental Organizations etc. (Minimum 5 industries)

Unit 5: Environmental Impact Assessment: (10 hours)

Case study – Impact of developmental activity/ Industrial activity (Tannery, Textile, Distillery, Mining operations, Cements units, Dam construction).

Environmental Impact Assessment studies should be conducted as per the EIA Notification 2006 of MoEFCC covering any one of the following components:

a. Air, Water, Land, Socio-economic, Ecology and biodiversity (Evaluation of reports will be done only by the Internal Examiners)

3. Specific Learning Outcomes

Unit & Section	Course Content	Learning Outcomes	Highest Blooms Taxonomic Level of Transaction
Unit I	**Field Work/Study**		
	Need for fieldwork, Methods of field study, importance, steps involved in field study. Field report preparation: Report writing methods	Recognize the methods of field study and report writing	K1
Unit II	**Internship**		
2.1	Internship for minimum duration of 15 days in any one of the industries	Analyse and evaluate the processes and technology	K5
Unit III	**Eco-Tour**		
3.1	Visit to different ecosystems - Pond ecosystem, Riverine ecosystem, Hill / Mountain ecosystem, Coastal Ecosystem, Mangroves	Analyse, plan and design conservation strategies suitable for various ecosystems	K6
Unit IV	**Visits to industries/environmental management facilities**		
4.1	Visits to industries/environmental management facilities	Explain various industrial processes and their environment-friendly practices	K2
Unit V	**Environmental Impact Assessment**		
5.1	Environmental Impact Assessment studies should on any one of the following components: Air, Water, Land, Socio-economic, Ecology and biodiversity	Conduct EIA	K5

4. Mapping Scheme (POs, PSOs and COs)

P19ES4F1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	L	-	-	-	-	L	-	-	L	-	-	M
CO2	-	H	H	-	-	-	M	M	M	M	L	L	M
CO3	-	H	H	-	-	H	H	H	H	H	H	H	M
CO4	-	H	H	-	-	H	H	H	H	H	H	H	M
CO5	-	H	H	-	-	L	M	-	L	-	-	L	M
CO6	-	H	H	-	-	M	H	H	H	H	H	H	M

5. Course Assessment Method

Direct

1. Reports, Observation Register, Record Note Books and Viva-voce

Indirect

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

Course Coordinator: Respective Guides