MANONMANIAM SUNDARANAR UNIVERSITY TIRUNELVELI – 12

Vision

"To provide quality education to reach the un-reached"

Mission

- To conduct research, teaching and outreach programmes to improve conditions of human living
- To create an academic environment that honours women and men of all races, caste, creed, cultures and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development
- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled

SRI PARAMAKALYANI CENTRE OF EXCELLENCE IN ENVIRONMENTAL SCIENCES

Vision

The Sri Paramakalyani Centre of Excellence in Environmental Sciences was established in Alwarkurichi in 1992. The genesis of the centre can be traced to the historical judgment of the Hon'ble Supreme Court in the case of M.C.Mehta VS Union of India and others, where the introduction of Environmental Education at undergraduate and postgraduate levels was made mandatory.

The centre faithfully adheres to the vision enshrined in the constitution of India that is" to protect and improve the natural environment including forests, lakes, rivers, and wildlife" and to "develop the scientific temper humanism and spirit of inquiry and reform. To make these lofty ideals the centre envisages developing in-depth knowledge of and technologies suitable for the country.

MANONMANIAM SUNDARANAR UNIVERSITY TIRUNELVELI – 12

Sri Paramakalyani Centre of Excellence in Environmental Sciences

M.Sc Environmental science Integrated

Revised and Restructured Syllabi

(Effective from the academic year 2022-2023 onwards)

Objectives

- To impart theoretical and practical skills that underpins the various branches of the science of Environmental Science
- To enable the students to have a thorough understanding and knowledge of different branches of Environmental Science
- To make the students to develop the ability to think analytically and solve problems.
- To apply the skills and knowledge gained through the subject to real life situations and face competitive examinations with confidence.

2. Eligibility for Admission

The minimum eligibility conditions for admission to the **M.Sc., in Environmental Science integrated** program are given below.

The candidates for admission into the first semester of this course will be required to have qualified the Higher Secondary Examination with 60 % marks (5 % relaxation for SC, ST and physically challenged candidates) conducted by the Board of Higher Secondary Education, Government of Tamil Nadu/ CBSE/ ICS within the following Science subject groups:

1. Mathematics, Physics, Chemistry, Biology/Computer Science or Relevant subjects
2. Physics, Chemistry, Botany,Zoology or Relevant subjects
3. Physics, Chemistry, Biology or Relevant subjects

or any other Examination as equivalent there to in Science subject.

Admission will be based on (i) the total marks obtained in the qualifying Higher Secondary examination (Physics, Chemistry, Botany, Computer science or Relevant subjects only Pass and (ii) by following the govt. norms of reservation.

DISTRIBUTION OF CREDIT:

LANGUAGE – TAMIL	4 X4	**16**
LANGUAGE – ENGLISH	4 X4	**16**
PROFESSIONAL ENGLISH FOR LIFE SCIENCES	2 X 4	**8**
CORE	23 X 4	**92**
MAJOR - PRACTICALS	11 X 2	**22**
MAJOR ELECTIVE	4X 4	**16**
NON-MAJOR ELECTIVE	2 X 2	**4**
SKILL BASED CORE	3 X 4	**12**
SKILL BASED COMMON	1 X 2	**2**
ALLIED	4 X 3	**12**
ALLIED PRACTICAL	4 X 2	**8**
COMMON	2 X 2	**4**
COMMON YOGA	1 X 2	**2**
COMMON-COMPUTERS FOR DIGITAL ERA	1 X 2	**2**
EXTENSION ACTIVITY	1 X 1	**1**
INTERNSHIP/APPRENTICESHIP	1 X 6	**6**
MINI - PROJECT	1 X 8	**8**
SUPPORTIVE COURSE	1 X 3	**3**
FIELD WORK	1 X 2	**2**
MOOCs	1 X 3	**3**
MINI-PROJECT	1 X 3	**3**
INDUSTRIAL INTERNSHIP	1 X 4	**4**
PROJECT & VIVA-VOCE	1 X 6	**6**
TOTAL NO OF CREDITS		**249**
TOTAL MARKS		**7300**

3. Duration of the Course

The duration of the course is 3 years under choice-based credit system. This minimum number of credits to be earned during the three years of the course is 145. Students who have passed all the papers for three years of the course will be given a B. Sc degree at the end of third year.

1. Scheme of Evaluation:

For evaluation of theory papers (core, allied, elective) the Continuous Internal Assessment (CIA) will be of 25 marks and External Examination for 75 marks. Core Practicals and Allied Practicals carry a maximum of 100 marks with 50% internal and 50% external. Mini project carries a maximum of 100 marks with 25% internal and 75% external.

1.1Core, Allied and Elective Papers:

a) Continuous Internal Assessment:

- There will be three internal tests, each for a maximum of 25 marks and for a limited portion of the syllabus for all theory papers. Each test will be held for duration of 1 hour. The question paper pattern for the internal test is given below:

Section	Type of questions	Max. Marks
Part A	Objective Type - 5 Questions	5 x 1 = 05
Part B	2 out of 3 Problems Questions	2 x 5 = 10
Part C	1 out of 2 Descriptive or Analytical Questions	1x 10 = 10
	Total Marks	25

- For the first six semesters, the Continuous Internal Assessment **25 marks** are divided as **20 marks** for the internal written test (average of the marks from the best two tests out of three tests) and **5 marks** for the assignment activities.
- There is no passing minimum in the internal test marks for each paper.

b) External Examinations:

- The duration of the University examination for each theory course is 3 hours. The question paper pattern for the end-semester examination of each theory paper is given below:

Section	Type of Questions	Max. Marks
Part A	Objective Type - 10 Questions (2 from each units)	10 x 1 = 10
Part B	Unit-wise choice - Either (a) or (b) type - 5 Questions Problems	5 x 5 = 25
Part C	Unit-wise choice - Either (a) or (b) type - 5 Descriptive or analytical Questions	5 x 8 = 40
	Total Marks	75

- There is a passing minimum of 50% in the University examination in each theory course and there is a passing minimum of 50% in the overall component, ie., out of the total marks in the CIA component and University examination for each theory course.
- There will be a special supplementary examination for those candidates who have failed in only one subject in the entire programme.

1.2. Practicals:

The CIA and the University Examination marks will be awarded as per the table given below:

Phase of Examinations	**Marks**	**Methodology**
Phase I - Continuous Assessment	Continuous Assessment : 25 Marks	"N" number of practical's be conducted based on the practical's prescribed in the syllabus and the marks should be distributed equally for each practical's. There is no passing minimum in the Internal Continuous Assessment.

	Test : 25 Marks	Two tests should be conducted and average of tests will be taken
	Total : **50 Marks**	**<u>Calculation of Marks:</u>** Sum of marks awarded to number of practical's (25 marks) + the average Marks of two tests (25 marks)
Phase II - End Semester Assessment Practical Examinations	**Course Teacher :** 25 marks **External Examiner**: 25 marks **Total** : 50 Marks { For Practical's: 20 marks Records : 5 marks }	Only one practical examination be conducted at the end of semester for the students on lot basis by appointing TWO examiners from the same Department / one from the other institution. 1. Course Teacher 2. External Examiner (From other Institution / from the same Department) Passing minimum: 50% (25 marks) in the External.

1.3. Apprenticeship/Internship

Apprenticeship/Internship course will provide the students to gain knowledge. Internships are off-campus experiential learning activities designed to provide students with opportunities to make connections between the theory and practice of academic study and the practical application of that study in a professional work environment. Internships are completed under the guidance of an on-site supervisor and a faculty guide, who in combination with the student will create a framework for learning. The student will append, to their internship contract, from the site supervisor which lists responsibilities and how your performance will be evaluated.

CIA (Max: 25 Marks)				End - Semester Examination (Max. : 75 Marks)				
Marks for Reviews (Average of the Best two of three compulsory Reviews) (Max.: 25 marks)				Marks for Report Evaluation (Max: 25 marks)		Marks for Viva Voce Exam (with the Dept. Faculty Member/Course Students) (Max: 50 Marks)		Total (Max.)
Review I	Review II	Review III	Average of the best two (Max.)	Supervisor (Max.)	External (from outside the institution) (Max.)	Supervisor (Max.)	External (from outside the institution) (Max.)	
25	25	25	25	12.5	12.5	25	25	100

1.4. Mini Project Work (I-VI)

A mini project is to be carried out by a group of a maximum of three students. The mini project work shall be based on any research-oriented topics (Field of Environmental Science) under the guidance of a faculty member of the Department as a Project Supervisor. After completion of the project work at the end of semester VI, each student should submit two copies of the project

report/ thesis to the Department on or before a date as notified for the same. The project viva-voce examination for the students will be conducted individually.

CIA (Max: 25 Marks)				End - Semester Examination (Max. : 75 Marks)				
Marks for Reviews (Average of the Best two of three compulsory Reviews) (Max.: 25 marks)				Marks for Thesis Evaluation (Max: 25 marks)		Marks for Viva Voce Exam (with the Dept. Faculty Member/Course Students) (Max: 50 Marks)		Total (Max.)
Review I	Review II	Review III	Average of the best two (Max.)	Project Supervisor (Max.)	External (from outside the institution) (Max.)	Project Supervisor (Max.)	External (from outside the institution) (Max.)	
25	25	25	25	12.5	12.5	25	25	100

There is no passing minimum for the CIA components and for the CIA in total. There is passing minimum of 50% in the University examinations in Project course and there is a passing minimum of 50% in the overall component, i.e. out of the total marks in the CIA component and the University examination for each Project course.

4. **Scheme of the Course (For I – X Semesters)**

Course structure

SEM	Pt. I/II/III /IV/V	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks Maximum		
I	I	1	Language	Tamil	4	4	25	75	100
	II	2	Language	English	4	4	25	75	100
	III	3	Core 1	Concept of Environment	4	4	25	75	100
	III	4	Core 2	Natural Resources	4	4	25	75	100
	III	5	Major Practical –I	Major Practical -I (Core 1 & 2) (Concept of Environment and Natural Resources)	4	2	50	50	100
	III	6	Allied – I	Plant and Animal Diversity	3	3	25	75	100
	III	7	Allied Practical – I	Plant and Animal Diversity – Practical	4	2	50	50	100
	III	8		Professional English for Life sciences-I	4	4	25	75	100
	IV	9	Common: 1	Earth and Earth Surface Process	2	2	25	75	100
	Subtotal				**33**	**29**	**275**	**625**	**900**

SEM	Pt. I/II/III /IV/V	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
II	I	10	Language	Tamil	4	4	25	75	100
	II	11	Language	English	4	4	25	75	100
	III	12	Core 3	Water and Water Resources	4	4	25	75	100
	III	13	Core 4	Atmosphere and Global Climate Change	4	4	25	75	100
	III	14	Major Practical –II	Major Practical – (Core 3 & 4) (Water and Water Resources & Atmosphere and Global Climate Change)	4	2	50	50	100
	III	15	Allied – II	Chemistry	3	3	25	75	100
	III	16	Allied Practical – II	Allied Practical – II Chemistry	4	2	50	50	100
	III	17		Professional English for Life sciences-II	4	4	25	75	100
	IV	18	Common:2	Social Harmony	2	2	25	75	100
	Subtotal				**33**	**29**	**275**	**625**	**900**

SEM	Pt. I/II/III/IV/V	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
III	I	19	Language	Tamil	4	4	25	75	100
	II	20	Language	English	4	4	25	75	100
	III	21	Core 5	Ecology and Ecosystems	4	4	25	75	100
	III	22	Major Practical – III	Major Practical – III (Ecology and Ecosystems)	4	2	50	50	100
	III	23	Allied – III	Physics and Chemistry of Environment	3	3	25	75	100
	III	24	Allied Practical – III	Allied Practical – III (Physics and Chemistry of Environment)	4	2	50	50	100
	IV	25	Non-Major Elective – 1	Environment and Society	3	2	25	75	100
		26	Mandatory –I	Yoga	2	2	25	75	100
	Subtotal				**28**	**23**	**250**	**550**	**800**

SEM	Pt. I/II/III/IV/V	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
IV	I	27	Language	Tamil	4	4	25	75	100
	II	28	Language	English	4	4	25	75	100
	III	29	Core:6	Organismal and Evolutionary Biology	4	4	25	75	100
	III	30	Major Practical – IV	Organismal and Evolutionary Biology –Practical	4	2	50	50	100
	III	31	Allied – IV	Systematics and Biogeography	3	3	25	75	100
	III	32	Allied Practical – IV	Systematics and Biogeography – Practical	4	2	50	50	100
	IV	33	Non-Major Elective -2	Biodiversity and Conservation	3	2	25	75	100
		34	Mandatory –II	Computer for Digital Era	2	2	25	75	100
	V	35	Extension Activity	NSS, NCC, YRC, YWF	-	1	-	-	100
	Subtotal				**28**	**24**	**250**	**550**	**900**

SEM	Pt. I/II/III/IV/V	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
V	III	36	Core: 7	Industrial Pollution and Human Health	4	4	25	75	100
		37	Core: 8	Environmental Legislation and Policy	4	4	25	75	100
		38	Core: 9	Green Technologies	4	4	25	75	100
		39	Core: 10	Environmental Economics	4	4	25	75	100
		40	Major Practical V	Industrial Pollution and Human Health – Practical	4	2	50	50	100
		41	Skill Based Core:1	Human-Wildlife Conflict & Management	3	4	25	75	100
		42	Skill Based Common	Personality Development	2	2	25	75	100
		Subtotal			**25**	**24**	**200**	**500**	**700**

SEM	Pt. I/II/III/IV/V	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
VI	III	43	Skill based Core – 2	Eco-friendly Products	2	4	25	75	100
		44	Elective-1	Agroforestry And Siliviculture	2	4	25	75	100
		45		Apprenticeship / Internship		6	50	50	100
	IV	46		Mini Project		6	50	50	100
	Subtotal				**4**	**20**	**150**	**250**	**400**
	Grant Total				**143**	**149**	**1350**	**3950**	**4400**

SEM	Subject Code	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
VII		47	Core:11	Environmental Biology	4	4	25	75	100
		48	Core:12	Environmental Biotechnology and microbiology	4	4	25	75	100
		49	Core:13 (e-PATHSHALA)	Energy and Environment	4	4	25	75	100
		50	Major Practical –VI	Major Practical – VI (Environmental Biology)	4	2	50	50	100
		51	Major Practical – VII	Major Practical – VII (Environmental Biotechnology and microbiology)	4	2	50	50	100
		52	Skill based Core (Mandatory)	Environmental analysis and techniques	2	2	25	75	100
		53	Elective	Any one	3	3	25	75	100
				1.Contemporary Environmental issues					
				2.Bio Monitoring And Ecological Assessment					
				3. Eco-Tourism					
			Subtotal		**25**	**21**	**225**	**475**	**700**

SEM	Pt. I/II/III /IV/V	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
							Int	Ext	Total
VIII	III	54	Core:14	Environmental Pollution and Control	4	4	25	75	100
		55	Core:15	Environmental Disaster Management	4	4	25	75	100
		56	Core:16	Statistics for Environmental Sciences	4	4	25	75	100
	IV	57	Major Practical – VIII	Major Practical – VIII Environmental Pollution and control	4	2	50	50	100
		58	Major Practical – IX	Major Practical – IX Environmental Disaster Management	4	2	50	50	100
		59	Elective	Any one	3	3	25	75	100
				1. Restoration Ecology 2. Environment and Human Health 3. Environmental Education and communication					
		60	Supportive course (Mandatory)	Environmental Toxicology	3	3	25	75	100
		61	Field Work			2	50	50	100
	Subtotal				**26**	**24**	**275**	**525**	**800**

SEM	Subject Code	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
IX		62	Core:17	Instrumentation and Research methodology	4	4	25	75	100
		63	Core:18	Remote Sensing, GIS and Environmental Modelling	4	4	25	75	100
		64	Core:19	Environmental Geosciences	4	4	25	75	100
		65	Core:20	Hazardous Waste And Solid Waste Recycling Techniques	4	4	25	75	100
		66	Major Practical – X	Major Practical – X Instrumentation and Research methodology	4	2	50	50	100
		67	Major Practical – XI	Major Practical – XI Remote Sensing, GIS and Environmental Modelling	4	2	50	50	100
		68	Elective	Any one 1. Vermi and Mushroom culture 2.Environmental chemistry 3.Non-Conventional Energy	3	3	25	75	100
		69	MOOCs	Online Course from Swayam, MOOC NPTEL etc.https://nptel.ac.in/	3	3	25	75	100
		70	Mini Project			3	50	50	100
			Subtotal		**30**	**29**	**300**	**600**	**900**

SEM	Subject Code	Sub No.	Subject Status	Subject Title	Contact Hrs/Week	Credits	Marks		
							Maximum		
X		71	Core:21	Pollution Control Engineering And Bioremediation	4	4	25	75	100
		72	Core:22 (e-PATHSHALA)	Analytical Chemistry	4	4	25	75	100
		73	Core:23	Environmental Assessment, Management and Legislation	4	4	25	75	100
		74		Industrial Internship		4	50	50	100
		75	Major Project	Project and Viva-Voce	4	6	50	50	100
			Subtotal		**16**	**22**	**175**	**325**	**500**
			Grant Total		**248**	**245**	**2325**	**5075**	**7500**

Program Outcomes (POs)

After completion of the program, the students will be able to:

1. Obtain fundamental aspects of components of environment, importance of environment, climate change, and develop the knowledge in environmental analysis and techniques. They can opt for higher studies in plant and animal sciences as the environmental science is multidisciplinary in nature.
2. Learn about natural resources includes land, and water, biodiversity and its conservation strategies and effects of exploitations.
3. Gain knowledge about environmental pollution and health related hazards and know the various control technologies of pollution.
4. Develop skills for environmental design and management through laws and policies. Acquire knowledge in the preparation, planning and implementation of environmental science related projects.
5. Develop skills on effluent treatments, wastewater treatment and purification plants and to have job opportunities in national research laboratories, environmental consultancies, and forest department like MoEFCC, UPSC, TNFOREST etc. and face job opportunities and services in different paths like teaching, research, projects, and acquire scientific posts includes state and central pollution control board.

Program Specific Outcomes (PSOs)

1. Understanding various environmental concepts, natural resources, biodiversity and scientific methodologies for conservation and to address contemporary global environmental concerns in interdisciplinary approaches
2. Analyzing how human and ecological systems interact to influence processes in air, land, and water, including the transport and fate of nutrients and contaminants through the environment.
3. Assessing and evaluating main environmental concerns and mitigation options using analytical and computational methodologies.
4. Collaborating with scientific communities to adapt diverse technologies to build solutions for real-world challenges in order to achieve sustainable development.
5. Assisting students to develop employability skills by providing them with a multi-dimensional approach

SEMESTER I

Core 1 - CONCEPTS OF ENVIRONMENT

L	T	P	C
4	-	4	4

Course code:

Course objectives:

1. To know the physical environment encompassing atmosphere, hydrosphere, lithosphere and biosphere
2. To realize the importance of interactions among various spheres and appreciate the inter- relationships among them.

Course Outcomes* (COs):

At the end of the course, the student will be able to-

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember the structure and function of Environment- Atmosphere, Hydrosphere, Lithosphere, and Biosphere.	K1
CO2	Understand the concepts of biospheres and their distribution.	K2
CO3	Apply the knowledge on ecosystems principals and their environments	K3
CO4	Analyse the importance of the different environment	K4
CO5	Evaluate the interconnections human and their environment and impact of environment and its conservation	K5

K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create

Course Outline:

Unit I **12 hr (8L+6P)**

Environment: Definition and importance; Principles and Scope; Continents; landmasses. Earth and Sun relationship: earth in the solar system, earth's planetary motions – rotation and revolution, seasonality, solstices and equinoxes.

Unit II **12 hr (8L+6P)**

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

Unit III **12 hr (8L+6P)**

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

Unit IV **12 hr (8L+6P)**

Lithosphere: Earth's crust and its composition-Internal structure of the earth-Soil texture, types of rocks- Types of soil, process of soil formation and soil nutrients.

Unit V **12 hr (8L+6P)**

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

References

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MAJOR PRACTICAL -I

CONCEPT OF ENVIRONMENT

L	T	P	C
-	-	4	2

1. Determination of requisite size of the quadrant for vegetation analysis.
2. Determination of the frequency distribution of plants in a piece of vegetation by quadrat method.
3. Estimation of chlorophyll content in the given plant material.
4. Study of flora and fauna through charts and maps
5. Comments on life cycle of some economically important insects.
6. Identification of museum specimens of some economically important fishes
7. Preparation of field report based on the survey of local flora
8. Temporary wet amount technique for the observation of living organism.
9. Identification of Soil texture – clay, sand, loamy.
10. Identification of Soil types – red soil, black soil.
11. Diagrammatic representation of solar, lunar eclipses, day and night.
12. Submission of 10 herbarium sheets with proper field note book
13. Estimation of species diversity by Shannon - Weiner diversity index method.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	H	M	L	L	H	M	L	L	L
CO2	H	H	M	L	L	H	H	L	L	L
CO3	H	H	H	M	L	H	H	L	L	L
CO4	M	M	M	L	L	H	H	L	L	L
CO5	H	H	H	H	H	H	H	H	H	L

L/M/H : L – Low; M – Medium; H – High

Core 2 – NATURAL RESOURCES

Course code:

L	T	P	C
4	-	3	4

Course objectives:

1. This course explains about the natural resources which influence quality of life, and the functioning of natural environment.
2. The course is designed to understand the importance of resources in the nature.

Course Outcomes* (COs):

At the end of the course, the student will be able to-

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember and define various types of natural resources	K1
CO2	Understand and identify how the resources are exploited by human interference	K2
CO3	Illustrate and interpret the effect of different types of revolutions in agricultural resources	K3
CO4	Discriminate the renewable and non renewable resources	K4
CO5	Appraise various energy sources	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Course Outline:

UNIT I: Water Resources **7Hrs (4L+3P)**

Characteristics of Water Bodies, Utility of Surface and Ground Water, Fresh Water and Marine Water Resources. Water Storage Systems and their Importance. Watershed Management - Aquifers, Rain Water Harvesting System

UNIT II: Land Resources **14Hrs (8L+6P)**

Introduction to Land Resources and their Types. Land Degradation and Soil Erosion - Causes and Impacts - Desertification, Deforestation, Mineral Resources: Minerals on the Geosphere, Types of Minerals, Mining - Metal and Non - Metal Resources, Exploitation of Mineral Resources, Use of Mineral Resources.

UNIT III: Biological Resources **14Hrs (8L+6P)**

Forest Types and their Resources, Carbon Sequestration, Use and Over-Exploitation – Timber and their Resources, Effects on Forest and Tribal People – Social and Cultural Forest. Agricultural resources and practices, Green revolution, White revolution and Blue revolution. Livestock Resource

Unit IV: Non – Renewable Energy Resources 10Hrs (7L+3P)

Fundamentals of energy and measurements: Types – fossil fuels: coal, oil, natural gas – Non-fossil fuels: nuclear energy, Indian Energy Scenario

Unit V: Renewable Energy sources 10Hrs (7L+3P)

Sources and applications of Solar, Wind, Biomass, Hydropower, Tidal, waves and Ocean thermal energy conversion system, Geothermal energy and gas hydrates. Bio hydrogen as a source of energy.

References

1. Ecology of Natural Resources, Francois Ramade (1991), John Wiley.
2. Text book of Environmental Studies, Eranch Bharucha (2005), Universities Press.
3. Environmental Studies, Kumarasamy K, Alagappa Moses A and Vasanthy M (2004), Bharathidasan University Publishers.
4. Environmental Science and Technology, Stanley E. Manahan (2007), Taylor & Francis, CRC Press.
5. Instant notes Ecology, Aulay Mackenzie, Andy S.Ball and Sonia R.Virdee (2002), Bios Scientific Pub. Ltd.,
6. Environmental Science, Physical Principals and Application, Egbert Boeker and rienk van Gondelle (2001), John Wiley & Sons.
7. Environmental Science, Santra, S.C (2005), New Central Book Agency (P) Ltd.,
8. Forest Economics and Management, Sharma, L.C (1998), M/S Bishen Singh Mahendrapal Singh, Dehradun.
9. G.D. Rai, Non Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.
10. R.K. Rajput, Non Conventional Energy Sources and Utilisation, S.Chand & Company Ltd., 2012.
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12. B.H.Khan, Non-Conventional Energy Resources, Tata McGraw Hill, 2nd Edn, 2009.
13. Bent Sørensen, Renewable Energy Conversion, Transmission and Storage, Elsevier Inc, 2007.
14. Demirel and Yasar, Energy-Production, Conversion, Storage, Conservation, and Coupling, Springer Link, 2012.

MAJOR PRACTICAL – II

NATURAL RESOURCES

L	T	P	C
-	-	4	2

1. Identification of rocks and minerals on the basis of physical characters.
2. Preparation of field report based on the survey of local flora.
3. Study of diversity of plants from maps.
4. Preparation of field report based on the visit to a Wild Life Sanctuary/National Park/Zoo/Biosphere Reserve
5. Demonstration of use of solar devices, photo-cells, wind-mills.
6. Demonstration of Biogas plant
7. Study of local sources and types of industrial waste.
8. Preparation of report on the effect of local industrial activities on human health.
9. Visit to Local Polluted Site –Observations and Remedial Measures

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	H	H	M	M	H	H	M	M	L
CO2	M	H	H	M	M	L	H	M	M	L
CO3	M	M	H	H	L	M	M	H	H	M
CO4	M	H	M	L	L	H	H	L	L	L
CO5	H	H	L	H	H	H	H	H	H	M

L/M/H: L – Low; M – Medium; H – High

Allied I – PLANT AND ANIMAL DIVERSITY

Course code:

L	**T**	**P**	**C**
3	-	4	3

Course objectives:

1. Understand the importance of the plant classification.
2. Understand the different animal taxa with example.

Course Outcomes* (COs):

At the end of the course, the student will be able to-

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember the diversity between Gymnosperms, Angiosperms, Cryptogams, Phanerogams, Bryophytes and Pteritophytes. classification and characteristics.	K1
CO2	Understand the plant evolution, morphology and anatomical features of lower to higher plants.	K2
CO3	Apply the knowledge of plant taxonomical characters and fundamental process of plants to study and analyze any plant species.	K3
CO4	Study the classification and characters of animal species	K4
CO5	Create knowledge in snakes identification	K5

K1: Remember; K2: Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Course Outline:

Plant Diversity

Unit I: Outline classification and Algae & Fungi 7Hrs (4L+3P)

Living organisms: Plant kingdom, Cryptogamia, and phanerogamia, Importance of classifications; History of plant Evolution and theories of Evolution. Merits and demerits of systems classification; Binomial Nomenclature

General characters, reproduction, Life cycle patterns, Classification and economic importance of algae and Fungi

Unit II: Pteridophytes& Bryophytes 7Hrs (4L+3P)

General characters and Classification (Reimer's 1954) of Pteridophytes; Sporangial organization – Homospory and Heterospory – Apospory and apogamy

General characters, classification Rothmaler (1951), Structure, reproduction, life cycles and Economic importance of Bryophytes

Unit III: Gymnosperm and Angiosperm Taxonomy 7Hrs (4L+3P)

General characters of sporophytes and gametophytes of Gymnosperms. Classification (Pilger and Melchior, 1954), detailed study of the following genera – Cycas and Pinus; Economic Importance of gymnosperms

General characters, distribution, Classification and economic importance of angiosperms, Angiosperm Life Cycles, Flower, Inflorescence, Fruit, Seed and Embryo

Animal Diversity

Unit IV: Kingdom- Protista and Phylum-Porifera, Cnidaria, Platyhelminthes, Nemathelminthes, Annelida, 7Hrs (4L+3P)

General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa

General characters and classification up to classes; Canal System in Sycon, Polymorphism in Hydrozoa, Life history of Taenia solium, Life history of Ascaris lumbricoides Parasitic adaptations of nematodes.

General characters and classification up to classes; Metamerism in Annelida, Regeneration and hermaphorodictism;

Unit III: Phylum - Arthropoda, Mollusca, Echinodermata, Protochordates, Agnatha, Pisces, Amphibia, Reptiles, Aves and Mammals 14Hrs (8L+6P)

General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects, Torsion in gastropods, Water-vascular system in Echinoderms

General features and classification of Protochordata, Agnatha and classification of cyclostomes up to classes, Osmoregulation in Fishes, Amphibia and Reptiles

General features and Classification up to orders; Parental care, Poisonous and non-poisonous snakes, Biting mechanism in snakes.

General features and Classification up to orders; Flight adaptations in birds, Origin of mammals.

References for Plant diversity

1. Plant taxonomy by O.P. Sharma, S. Chand & Co, New Delhi (2003)
2. College botany Vol I by S. Panddey, New Central Book house, Calcutta (2008)
3. College botany Vol II by S. Panddey, New Central Book house, Calcutta (2008)
4. Gymnosperms BY P.C. Vashista, Chand & Co, New Delhi (2005)

References for Animal Diversity

1. Barnes, R.D. (2009). Invertebrate Zoology, Vth Edition
2. Varma & Agarwal, (2007) Invertebrate Zoology VII the edition, S Chand & Co. New Delhi.
3. Kotpal R.L 2014 Modern Textbook of Zoology – Invertebrates. Rastogi Publications

– Meerut.

4. Kotpal R.L 2015 Modern Textbook of Zoology –Vertebrates. Rastogi Publications – Meerut.
5. Prasad, S 2012. Textbook of Vertebrate Zoology. New Age International (P) Limited, Publishers

References

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
4. Pough H. *Vertebrate life*, VIII Edition, Pearson International.
5. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

Allied - PRACTICAL

Plant Diversity

1. Morphology and anatomy of Gymnosperms
2. Morphology and anatomy of Pteridophytes
3. Classification and identification of plants
4. Herbarium preparation
5. Anatomy of embryo developmental stages

References

1. Plant taxonomy by O.P. Sharma, S. Chand & Co, New Delhi (2003)
2. College botany Vol I by S. Panddey, New Central Book house, Calcutta (2008)
3. College botany Vol II by S. Panddey, New Central Book house, Calcutta (2008)
4. Gymnosperms BY P.C. Vashista, Chand & Co, New Delhi (2005)

Animal Diversity

1. Study of the following specimens:
   Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female *Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Scolopendra, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria* and *Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Torpedo,Labeo, Exocoetus, Anguilla,*

Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone,Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Any six common birds from different orders, *Sorex*, Bat, *Loris*.

2. Study of the following permanent slides:
   T.S. and L.S. of *Sycon*, Study of life history stages of *Taenia,* T.S. of Male and female *Ascaris*
   Key for Identification of poisonous and non-poisonous snakes
3. An "**animal album**" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

References

Lal. S.S. 2016 Practical Zoology Invertebrate. Rastogi Publications. New Delhi.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	L	H	L	L	L	H	L	L	L	L
CO2	M	H	L	L	L	M	M	L	L	L
CO3	M	M	L	L	M	M	M	L	L	L
CO4	L	H	L	L	L	H	M	L	L	L
CO5	M	H	L	L	L	H	L	L	L	L

L/M/H: L – Low; M – Medium; H – High

Common I

EARTH AND EARTH SURFACE PROCESSES

Course code:

L	T	P	C
2	-	-	2

Course objectives:

1. The paper will introduce students to the basic structure and composition of the Earth and will explore various surface processes and their impact on and role in living systems.
2. It will also deal with the interactive processes in the inner as well as outer Earth's surface.

Course Outcomes* (COs):

At the end of the course, the student will be able to-

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember the basic processes of geology, stratigraphy	K1
CO2	Understand the processes involved in the formation of earth, mountains, lithosphere, atmosphere and stratigraphy	K2
CO3	Apply the knowledge on basic geological processes to perform satellite imaging, using GIS	K3
CO4	Analyse the character of landforms in various environments and their formative processes	K4
CO5	Evaluate the interconnections between and among the elements of physical geography that result different land surface systems.	K5
CO6	Anticipate the locational factors for identification of natural resources and construction of developmental projects.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Course Outline:

Unit I: History of Earth **7Hrs (7L+0P)**

Solar system formation and planetary differentiation; formation of the Earth: formation and composition of core, mantle, crust, atmosphere and hydrosphere; chemical composition of Earth; geological time scale and major changes on the Earth's surface; Holocene and the emergence of humans, role of humans in shaping landscapes; development of cultural landscapes.

Unit II: Earth system processes **7Hrs (7L+0P)**

Movement of lithosphere plates; mantle convection and plate tectonics, major plates and hot spots, plate boundaries; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental drift, Pangaea and present-day continents, paleontological evidences of plate tectonics; continental collision and mountain formation with specific example of the Himalaya.

Unit III: Minerals and rocks **7Hrs (7L+0P)**

Minerals and important rock forming minerals; rock cycle: lithification and metamorphism; Three rock laws; rock structure, igneous, sedimentary and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: physical processes of erosion, factors affecting erosion; agents of erosion: rivers and streams, glacial and aeolian transportation and deposition of sediments by running water, wind and glaciers.

Unit IV: Earth surface processes **7Hrs (7L+0P)**

Atmosphere: evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere–ocean interface, atmosphere–land interface, ocean–land interface; land surface processes: fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes; coastal processes.

Unit V: Importance of being a mountain **7Hrs (7L+0P)**

Formation of Peninsular Indian mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis, etc. Formation of the Himalaya; development of glaciers, perennial river systems and evolution of monsoon in Indian subcontinent; formation of Indo-Gangetic Plains, arrival of humans; evolution of Indus Valley civilization; progression of agriculture in the Indian subcontinent in Holocene; withdrawing monsoon and lessons to draw.

References

1. Bridge, J., & Demicco, R. 2008. Earth Surface Processes, Landforms and Sediment deposits. Cambridge University Press.
2. Duff, P. M. D., & Duff, D. (Eds.). 1993. Holmes' Principles of Physical Geology. Taylor & Francis.
3. Gupta, A. K., Anderson, D. M., & Overpeck, J. T. 2003. Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. Nature 421: 354-357.
4. Gupta, A. K., Anderson, D. M., Pandey, D. N., & Singhvi, A. K. 2006. Adaptation and human migration, and evidence of agriculture coincident with changes in the Indian summer monsoon during the Holocene. Current Science 90: 1082-1090.
5. Keller, E.A. 2011. Introduction to Environmental Geology (5th edition). Pearson Prentice Hall.
6. Krishnan, M. S. 1982. Geology of India and Burma. CBS Publishers & Distributors.

7. Leeder, M., Arlucea, M.P. 2005. Physical Processes in Earth and Environmental Sciences. Blackwell Publishing.
8. Pelletier, J. D. 2008. Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	H	L	L	M	H	H	L	L	L
CO2	H	H	L	L	M	H	H	L	L	L
CO3	M	M	L	H	L	M	L	H	H	L
CO4	H	H	L	L	M	M	L	L	L	L
CO5	H	H	L	L	L	M	H	L	L	L
CO6	L	L	M	H	H	L	L	H	H	H

9. L/M/H: L – Low; M – Medium; H – High

SEMESTER II

Core 3 – WATER AND WATER RESOURCES

Course code:

L	T	P*	C
4	-	4	4

Course objectives:

1. The paper introduces students to the hydrological cycle, properties of water, physicochemical and biological water quality assessment and indices, types of water resources, their use and management.
2. It will also highlight the problems associated with water shortages in India and familiarizes students with case studies on international and national conflicts on water.

Course Outcomes* (COs):

At the end of the course, the student will be able to-

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember and collect knowledge on various sources and properties of water and water resource management	K1
CO2	Observe various water resources in India, Hydrological cycle and water measurement techniques	K2
CO3	Express the use of models for better water management	K3
CO4	Focus on physical, chemical, and biological properties of water and water quality standards	K4
CO5	Design the appropriate rain water harvesting scheme and integrated water resource management	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Course Outline:

Unit I: Introduction **9H (6L +3 P)**

Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapotranspiration; classification of water resources (oceans, rivers, lakes and wetlands)

Unit II: Properties of Water **12H (6L +6 P)**

Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: major inorganic and organic constituents, dissolved gases, DO, COD,

BOD, acidity and alkalinity, electrical conductivity, sodium adsorption ratio; Biological: phytoplankton, phytobenthos, zooplankton, macro-invertebrates and microbes.

Unit III: Surface and subsurface water 12H (9L +3 P)

Introduction to surface and ground water; surface and ground water pollution; water table; vertical distribution of water; formation and properties of aquifers; techniques for ground water recharge; river structure and patterns; watershed and drainage basins; importance of watershed and watershed management; rain water harvesting in urban settings.

Unit IV: Wetlands and their management 10H (7L +3 P)

Definition of a wetland; types of wetlands (fresh water and marine); ecological significance of wetlands; threats to wetlands; wetland conservation and management; Ramsar Convention, 1971; major wetlands of India.

Unit V: Marine resource management 10H (7L +3 P)

Marine resources; commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approach, construction techniques and monitoring of coastal zones).

References

1. Bansil, P.C. 2004. Water Management in India. Concept Publishing Company, India.
2. Brebbia, C.A. 2013. Water Resources Management VII. WIT Press.
3. CEA. 2011. Water Resources and Power Maps of India. Central Board of Irrigation & Power.
4. Grumbine, R.E. & Pandit, M.K. 2013. Threats from India's Himalaya dams. Science **339**: 36-37.
5. Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. Water Resource Systems Planning and Analysis. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. Water Resources Sustainability. The McGraw-Hill Publications.
7. Schward& Zhang, 2003. Fundamentals of Groundwater. John Willey and Sons.
8. Souvorov, A.V. 1999. Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management. Elsevier Publications.
9. Vickers, A. 2001. Handbook of Water Use and Conservation. WaterPlow Press.

MAJOR PRACTICAL – III

WATER AND WATER RESOURCES

L	T	P*	C
-	-	4	2

1. Determination of physical parameters of water (Temperature, Colour, Odour, pH)
2. Determination of DO, COD and BOD
3. Determination of acidity, alkalinity and E.C. of water
4. Determination of hardness, TDS, TSS, and TS of given water sample
5. Identification of Phytoplankton- Diatoms, Dinoflagellates, Blue green algae and Coccoolithophores.
6. Identification of Zooplankton- Copepods, Hydromedusae, Pteropods, Chaetognatha, Thaliaceae and planktonic Larvae.
7. Identification of locally available Seaweeds, Sea grasses and Mangrove plants.
8. Identification of coastal invertebrate fauna.
9. Visiting a nearby surface water area, wetland and marine area

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	H	M	M	L	H	H	L	M	L
CO2	H	H	M	M	H	H	H	H	M	M
CO3	H	H	L	M	H	M	M	H	H	M
CO4	H	H	H	M	L	H	H	M	M	M
CO5	M	M	M	H	H	M	M	M	H	M

L/M/H: L – Low; M – Medium; H – High

Core 4- ATMOSPHERE AND GLOBAL CLIMATE CHANGE

Course code:

L	T	P*	C
4	-	4	4

Course objectives:

1. The paper deals with dynamics of atmospheric processes, which include its composition, meteorological phenomena and atmospheric chemistry.

2. The paper also highlights the anthropogenic intervention in 'anthropocene', which has led to global climate change.

3. The paper also explores effects of global changes on human communities and initiatives taken at global and regional levels to combat them.

Course Outcomes* (COs):

At the end of the course, the student will be able to-

	Course Outcomes	**Cognitive level (K1 to K6)**
CO1	Remembering the concepts, structure and composition of atmosphere.	K1
CO2	Apply mathematical tools to study atmospheric processes and atmospheric chemistry.	K2
CO3	Explain the principles behind, and use of meteorological instrumentation.	K3
CO4	Describe, analyse and create graphical depictions of meteorological information.	K4
CO5	Demostrate critical and analytical skills to interpret and predict weather systems using weather products.	K5
CO6	Present and communicate weather analyses and forcasts in a team or individually.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Course Outline:

Unit I: Introduction and Global energy balance 12h (6L +6 P)

Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere in making the Earth, the only biosphere; Milankovitch cycles. Earth's energy balance; energy transfers in atmosphere; Earth's radiation budget; green house gases (GHGs); greenhouse effect; global conveyor belt.

Unit II: Atmospheric circulation 12h (9L +3 P)

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; *El Nino* and *La Nina*; tropical cyclone; Indian monsoon and its development, changing monsoon in Holocene in the Indian subcontinent, its impact on agriculture and Indus valley civilization; effect of urbanization on micro climate; Asian brown clouds.

Unit III: Meteorology, atmospheric stability and atmospheric chemistry 12h (6L +6 P)

Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion; plume behavior; Gaussian plume model. Chemistry of atmospheric particles and gases; smog – types and processes; photochemical processes; ions and radicals in atmosphere; acid-base reactions in atmosphere; atmospheric water; role of hydroxyl and hydroperoxyl radicals in atmosphere.

Unit IV: Global warming and climate change 12h (6L +6 P)

Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different green house gases (GHGs) causing the climate change; atmospheric windows; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO2 fertilization and agriculture; impact on economy and spread of human diseases.

Unit V: Ozone layer depletion, climate change and policy 12h (6L +6 P)

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures and international protocols. Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

References

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.

8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopaedia of Global Warming and Climate Change (2nd edition). Sage Publications.

MAJOR PRACTICAL – IV

ATMOSPHERE AND GLOBAL CLIMATE CHANGE

L	T	P*	C
-	-	4	2

1. Calculation of horizontal divergence from wind data
2. Calculation of absolute vorticity from wind data
3. Calculation of geostrophic wind
4. Calculation of gradient wind
5. Calculation of thermal wind
6. Calculation of vertical velocity
7. Analysis of variation of surface temperature, Trend of rainfall, Trend of lightning activity

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	H	L	M	L	H	H	L	L	L
CO2	H	H	H	M	L	H	H	M	L	L
CO3	M	M	L	H	M	L	L	H	M	M
CO4	L	L	L	H	H	L	L	H	H	L
CO5	L	L	M	M	H	L	L	M	M	L
CO6	L	L	L	M	M	M	L	H	H	L

L/M/H: L – Low; M – Medium; H – High

Allied II - CHEMISTRY

Course code:

L	T	P*	C
3	-	4	3

Course objectives:

1. To develop a basic knowledge on Inorganic, organic and physical chemistry.

2. To make the students acquire an understanding the basic components of biochemistry

Course Outcomes* (COs):

At the end of the course, the student will be able to-

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Understand the basics of chemistry	K2
CO2	Classify inorganic, organic and physical chemistry	K2
CO3	Remember the underlying principles of classification of biochemicals	K1
CO4	Explain the chemical process	K2
CO5	Describe the biochemical components	K2

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Course Outline:

Unit I Basics of Chemistry **6Hrs (3L+3P)**

Concentration units: Molarity-mole-mole fraction- Normality - Equivalent weight-Molality, percentage solutions-ppm-Avagadro's number-Lewis concept of acids and bases-Ionic product of water - pH scale, Henderson Hasselbach equation, buffers, buffer capacity, preparation of acidic and basic buffer solutions.

Unit II Inorganic chemistry **6Hrs (3L+3P)**

Atomic structure: electronic configuration - Aufbau principle - Pauli's exclusion principle- Hund's rule. Bonding: electrovalent, covalent, hydrogen bonds-orbital overlap, Hybridization and VSEPR theory. Occurrence, general characteristics of s, p, d, f block elements – metallic character – oxidation states – size – density – melting and boiling points – ionization energy – colour – magnetic properties – reducing properties – catalytic properties

Unit III Organic chemistry **7Hrs (4L+3P)**

Classification of organic compounds-IUPAC system of nomenclature of common organic compounds with and without functional groups- Electronic effects - inductive effect, resonance effect, hyper conjugation, electromeric effect, Steric effect – steric overcrowding – steric inhibition– steric relief (with examples)-Heterolytic and hemolytic cleavage – nucleophiles and electrophiles – Markownikoff's rule and peroxide effect-SN1,SN2, E1, E2 mechanism- General characteristics of aromatic compounds - aromaticity – Huckel's rule with examples- non – benzenoid aromatic compounds (definition and examples only)

Unit IV Physical chemistry **7Hrs (4L+3P)**

Definition – composition between thermal and photochemical reactions – Laws of Photochemistry-Beer Lambert's law-Grothus Draper Law-Einstein's Law-fluorescences, phosphorescence, thermoluminescence, chemiluminescence and bioluminescence – definition with examples – photosensitization-Lasers – principle, types and uses. Thermodynamics-Basic concepts - system, surroundings - types of systems - extensive and intensive properties - state functions and path functions-Laws of thermodynamics

Unit V Biochemistry **8 Hrs (5L+3P)**

Carbohydrate-Classification, structure, general properties and functions-Lipids-Classification, structure, properties and functions- Nucleic acids-classification, structure and function-Proteins-Classification, structure, properties and functions-Vitamins-Hormones

References

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2. P. L. Soni, Text Book of Inorganic Chemistry, 20th edition, 2001.
3. R. D Madan, Modern Inorganic Chemistry, S. Chand and company, 13th edition, 2005.
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ALLIED PRACTICAL – II
ALLIED CHEMISTRY

L	T	P*	C
-	-	4	2

Volumetric analysis

ACIDIMETRY AND ALKALIMETRY

1. Estimation of NaOH
2. Estimation of HCl

PERMANGANOMETRY

3. Estimation of ferrous ammonium sulphate – Std. ferrous ammonium sulphate
4. Estimation of sodium oxalate – Std. oxalic acid

COMPLEXOMETRY

5. Estimation of Zinc – Std. $ZnSO_4$
6. Estimation of Magnesium – Std. $MgSO_4$

IODOMETRY

7. Estimation of copper – Std. copper sulphate
8. Estimation of $K_2Cr_2O_7$ – Std. $K_2Cr_2O_7$

DICHROMETRY

9. Estimation of ferrous iron – Std. ferrous ammonium sulphate
10. Estimation of $K_2Cr_2O_7$ – Std. $K_2Cr_2O_7$

Inorganic preparations

Preparation of tetrammine copper(II) sulphate

Organic Analysis

Aromatic saturated Monocarboxylic acid

Aliphatic saturated carbohydrate

Aromatic saturated dicarboxylic acid

Aromatic saturated dihydric Phenol

Aliphatic saturated dicarboxylic Acid

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	L	L	L	L	L	L	L	L	L	L
CO2	L	L	L	L	L	L	L	L	L	L
CO3	L	L	L	L	L	L	L	L	L	L
CO4	L	L	L	L	L	L	L	L	L	L

CO5	L	L	L	L	L	L	L	L	L	L

L/M/H: L – Low; M – Medium; H – High

Common-SOCIAL HARMONY

Course code:

L	T	P*	C
2	-	-	2

Course objectives:

This course is offered with an objective to provide a basic understanding for the undergraduate students on the need and potential of the youth in developing the nation through volunteerism and positive approach

Course Outcomes* (COs):

At the end of the course, the student will be able to-

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Understand the basic features of constitution	K1
CO2	Classify the community mobilisation	K2
CO3	Remember the Indian Tradition of volunteerism	K3
CO4	Differentiate civil and self defense	K4
CO5	Create social harmony and national integration	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Course Outline:

Unit I: Citizenship **4Hrs (4L+0P)**

Basic Features of Constitution of India - Consumer awareness and the legal rights of the consumer – Introduction to RTI

Unit II: Community Mobilisation **4Hrs (4L+0P)**

Mapping of community stakeholders - Designing the message in the context of the problem and the culture of the community - Identifying methods of mobilization - Youth – adult partnership

Unit III: Volunteerism and Shramdan **4Hrs (4L+0P)**

Indian Tradition of volunteerism - Needs & Importance of volunteerism - Motivation and Constraints of Volunteerism - Shramdan as a part of volunteerism

Unit IV: Civil/Self Defense **4Hrs (4L+0P)**

Civil defense service, aims and objectives of civil defense - Needs for self defense – Self defense training

Unit V: Social Harmony and National Integration 4Hrs (4L+0P)

Indian History and Culture - Role of youth in peace-building and conflict resolution - Role of youth in Nation building

References

1. Constitution of India & Indian polity – Ganesa Subramanian
2. Community mobilization: methods & models – R.R. Prasad
3. https://en.wikipedia.org/wiki/volunteering
4. http://wikieducator.org/shramdaan
5. Self Defense: The Self Defense Guide for Beginners – Life-style
6. Facets of Indian culture –Vidya, Rajaram, kalpana
7. Role of youth in nation building –Mohan Rao Bhagwat and Smriti Razdan
8. Role of youth in peace –building and conflict resolution – Ozerdem.A., Podder. S.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	L	L	L	L	L	L	L	L	L	L
CO2	L	L	L	L	L	L	L	L	L	L
CO3	L	L	L	L	L	L	L	L	L	L
CO4	L	L	L	L	L	L	L	L	L	L
CO5	L	L	L	L	L	L	L	L	L	L

L/M/H: L – Low; M – Medium; H – High

THIRD SEMESTER

CORE 5: ECOLOGY AND ECOSYSTEMS

L	T	P*	C
4	-	4	4

Objectives:

1. Improve ecological literacy by learning the basic principles and concepts of the field of ecology
2. Improve scientific literacy by learning how ecologists construct knowledge

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember facts on ecology, and ecological dynamics	K1
CO2	Understand to correlate ecological dynamics and regulation of vital processes on earth as biogeochemical cycles	K2
CO3	Relate ecosystem services, ecological resilience, ecological economics, and landscape ecology	K3
CO4	Device experiments to appreciate concepts of Ecology	K4
CO5	Evaluate the forces impacting ecosystems viz., climate change, stress, population, consumerism, globalization, land use change	K5
CO6	Create habitat inventory of streams, river and freshwater wetlands	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT –I Ecology and Ecological factors 12h (9L+6P)

Meaning and scope, Biosphere, origin of life and speciation. Abiotic and Biotic factors and interactions; competition- inter and intra specific.

UNIT -II Ecosystem 12h (9L +6P)

Concept, structure, function and types of ecosystems, food chain, food web; Ecological pyramids Ecological energetics - The Energy flow in Ecosystems, biogeochemical cycles- Nitrogen, Carbon, Phosphorus, Sulphur,

UNIT- III Ecosystem stability and homeostasis 10h (7L+6P)

Development and evolution (succession) in an ecosystems, Characteristics of Terrestrial and aquatic ecosystem (lotic, lentic, estuarine, wetlands, mangrove, grassland, forest, desert, mountain). Biomes- classification, ecosystem services and Ecosystem analysis

UNIT–IV Community and Population 10 h (7L +3P)

Organization, population characteristics, population regulation– biotic potential and environmental resistances; Factors of population regulation; Ecotone, Edge effect.Ecological Niche.

UNIT –V Man and Environment 10 h (7L +3P)

Man-environment relationship, General relationship between landscape, biomes and climate. Concept of sustainable development, Environmental ethics, Human population growth and environmental constrains, Human impact on ecosystems

References

1. Allen J. D. 1995 Stream Ecology – Structure and function of running waters Chapman and Hall, UK 388 pp.
2. Begon, M., Townsend, C. R., and Harper, J. L. 2005. Ecology from Individuals to Ecosystems. Wiley-Blackwell, USA.
3. Botkin, Daniel B. and Keller, Edward A. 2007 Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA,
4. Chapman, J. L. and Reiss, M. J. 1998. Ecology: Principles and Applications. Cambridge University Press, UK.,
5. Kemp, M. J. 1997 Environmental Science. The McGraw-Hill Companies.
6. Nebel, B. J. and Wright, R. T. 1981 Environmental Science. Prentice Hall.
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9. Rieley, J. O. and Page, S. E. 1990 Ecology of plant communities. Longman scientific and technical co published with John Wiley and Sons.
10. Siever R. 1974. Energy and Environment. W.H. Freeman and Company.
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MAJOR PRACTICAL - V

ECOLOGY AND ECOSYSTEM

L	T	P*	C
-	-	4	2

1. Meteorological Recordings
2. Air temperature, Light conditions, Clouds, Wind direction, Precipitation, Evaporation, rain fall and Evapotranspiration
3. Determination of minimum size of quadrate for community study.
4. Determination of density, frequency, abundance and dominance of plant species using quadrat method.
5. Calculation of similarity index between two adjoining communities.
6. To prepare pyramid of number, biomass and energy in at least one type of ecosystem
7. Measurement of productivity by chlorophyll method.
8. Habitat Inventory of streams, river and freshwater wetlands
9. Water quality parameters Dissolved oxygen, Conductivity, hardness Alkalinity

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	H	H	H	H	H	H	H	H
CO2	H	H	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H	H	H
CO4	H	H	H	H	H	H	H	H	H	H
CO5	H	H	H	H	H	H	H	H	H	H
CO6	H	H	H	H	H	H	H	H	H	H

L/M/H L – Low; M – Medium; H - High

ALLIED III - PHYSICS AND CHEMISTRY OF ENVIRONMENT

Course Code

L	T	P*	C
4	-	4	3

Course Objectives:

- This paper aims to build conceptual understanding of students by exposing them to the basic principles behind various environmental processes.
- The paper has been divided into two sections, with the view to introduce students to the concepts of physics and chemistry associated with particle movement, chemical processes and pollutant chemistry.

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Illustrate the concepts related to environmental chemistry and physics	K1
CO2	Understand the inherent forces and flows responsible for various naturally occurring events.	K2
CO3	Solve simple transport problems in natural environment	K3
CO4	Analyse the importance of environmental changes and understand various aspects of air, soil and water chemistry	K4
CO5	Evaluate various application strategies on controlling toxic chemicals in the environment, including POPs and emerging pollutants	K5
CO6	Setting up and conducting experiments	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Fundamentals of environmental physics 15 Hrs (9L+6P)

Basic concepts of light and matter; quantum mechanics (relation between energy, wavelength and frequency), black body radiation, Kirchhoff's law, Boltzmann equation, spectroscopic concepts: Introduction to the concept of absorption and transmission of light, Beer–Lambert law, photovoltaic and solar cells; scattering of light, Rayleigh and Mia scattering. Basic concepts of pressure, force, work and energy; types of forces and their relation (pressure gradient, viscous, Coriolis, gravitational, centripetal, and centrifugal force); concept of heat transfer, conduction, convection; concept of temperature, lapse rate (dry and moist adiabatic); laws of thermodynamics; concept of heat and work, Carnot engine, transmission of electrical power, efficiency of turbines, wind mills and hydroelectric power plants.

UNIT II: Movement of pollutants in environment 6 Hrs (3L+3P)

Diffusion and dispersion, point and area source pollutants, pollutant dispersal; Gaussian plume model, mixing heights, hydraulic potential, Darcy's equation, types of flow, turbulence.

Unit III: Fundamentals of environmental chemistry 15 Hrs (9L+6P)

Atomic structure, electronic configuration, periodic properties of elements (ionization potential, electron affinity and electronegativity), types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds); mole concept, molarity and normality, quantitative volumetric analysis. Thermodynamic system; types of chemical reactions; acids, bases and salts, solubility products; solutes and solvents; redox reactions, concepts of pH and pE, electrochemistry, Nernst equation, electrochemical cells. Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, organic functional groups, polarity of the functional groups, synthesis of xenobiotic compounds like pesticides and dyes, synthetic polymers.

UNIT IV: Atmospheric chemistry 7 Hrs (4L+3P)

Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; chemistry of acid rain, case studies; reactions of NO_2 and SO_2; free radicals and ozone layer depletion, role of CFCs in ozone depletion.

UNIT V: Water and soil chemistry 10 Hrs (7L+3P)

Chemical and physical properties of water; alkalinity and acidity of water, hardness of water, calculation of total hardness; solubility of metals, complex formation and chelation; colloidal particles; heavy metals in water. Soil composition; relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium in soil; phenolic compounds in soil.

References

1. Beard, J.M. 2013. *Environmental Chemistry in Society* (2nd edition). CRC Press.
2. Boeker, E. &Grondelle, R. 2011. *Environmental Physics: Sustainable Energy and Climate Change*. Wiley.
3. Connell, D.W. 2005. *Basic Concepts of Environmental Chemistry* (2nd edition). CRC Press.
4. Forinash, K. 2010. *Foundation of Environmental Physics*. Island Press.
5. Girard, J. 2013. *Principles of Environmental Chemistry* (3rd edition). Jones & Bartlett.

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7. Hites, R.A. 2012. *Elements of Environmental Chemistry* (2nd edition). Wiley & Sons.
8. Manhan, S. E. 2000. *Fundamentals of Environmental Chemistry*. CRC Press.
9. Pani, B. 2007. *Textbook of Environmental Chemistry*. IK international Publishing House.

ALLIED PRACTICAL - III

PHYSICS AND CHEMISTRY OF ENVIRONMENT

L	T	P*	C
-	-	4	2

1. Verification of Beer-Lambert's Law
2. Determination of Viscosity
3. Preparation of Normal, Molar, Molal and percentage solutions
4. Henderson Hasselbach equation and determination of pH of a solution – Potentiometric method
5. Determination of alkalinity and acidity in water
6. Determination of hardness in water

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	H	H	H	H	M	H	H	M
CO2	M	M	H	M	M	M	M	M	M	M
CO3	L	M	H	H	M	H	M	M	M	M
CO4	H	H	H	H	H	H	H	H	H	M
CO5	M	M	H	M	M	M	M	M	M	M
CO6	M	M	M	H	H	H	M	H	H	M

L/M/H L – Low; M – Medium; H - High

NON- MAJOR ELECTIVE 1

ENVIRONMENT AND SOCIETY

L	T	P*	C
3	-	-	2

Objectives:

- The course examines the relationship between the environment and society enabling the students to understand and appreciate the role played by environment, society, and, their interface in shaping environmental decisions.
- The students will be enabled to think critically on environmental issues.

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	**Cognitive level (K1 to K6)**
CO1	Identify the role of social structures in the distribution of impacts and responses to environmental issues.	K1
CO2	Understand key concepts and theories about environmental problems, including vulnerability, resilience, adaptation and human security	K2
CO3	Relate different perspectives and approaches to environmental problems, and how these influence research, policy and action;	K3
CO4	Analyse how environmental problems are linked to development and understandings of human-environment relationships and society-technology dynamics;	K4
CO5	Judge the key issues related to individual environmental problems such as climate change, biodiversity loss, deforestation	K5
CO6	Develop comprehensive understanding of environmental problems and solutions.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Introduction and Issues in environmentalism 10Hrs (10L+0P)

Social and cultural construction of 'environment'; environmental thought from historical and contemporary perspective in light of the concepts of Gross Net Happiness and Aldo Leopold's Land Ethic. Significant global environmental issues such as acid rain, climate change, and resource depletion; historical developments in cultural, social and economic issues related to land, forest, and water management in a global context; interface between environment and society.

UNIT II: Development-environment conflict 10Hrs (10L+0P)

Developmental issues and related impacts such as ecological degradation; environmental pollution; development-induced displacement, resettlement, and rehabilitation: problems, concerns, and compensative mechanisms; discussion on Project Affected People (PAPs).

UNIT III: Urbanization and environment 6Hrs (6L+0P)

Production and consumption oriented approaches to environmental issues in Indian as well as global context; impact of industry and technology on environment; urban sprawl, traffic congestion and social-economic problems; conflict between economic and environmental interests.

UNIT IV: Environment and social inequalities 10Hrs (10L+0P)

Inequalities of race, class, gender, region, and nation-state in access to healthy and safe environments; history and politics surrounding environmental, ecological and social justice; environmental ethics, issues and possible solutions. Brief account of Forest Conservation Act 1980 1988; Forest Dwellers Act 2008; Land Acquisition Act1894, 2007, 2011, 2012; Land Acquisition Rehabilitation and Resettlement Act 2013.

UNIT V: Community participation 6 Hrs (10L+0P)

State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development; case studies of environmental movements (Appiko Movement, Chipko Movement,
Narmada BachaoAndolan); corporate responsibility movement; appropriate technology movement; environmental groups and movements, citizen groups; role played by NGOs; environmental education and awareness.

References

1. Chokkan, K.B., Pandya, H. &Raghunathan, H. (eds). 2004. *Understanding Environment*. Sagar Publication India Pvt. Ltd., New Delhi.
2. Elliot, D. 2003. *Energy, Society and Environment, Technology for a Sustainable Future*. Routledge Press.
3. Guha, R. 1989. *Ecological change and peasant resistance in the Himalaya*. Unquiet Woods, Oxford University Press, Delhi.
4. Leopold, A. 1949. *The Land Ethic*. pp. 201-214. Chicago, USA.
5. National Research Council (NRC). 1996. *Linking Science and Technology to Society's Environmental Goals*. National Academy Press.

6. Pandit, M.K. 2013. Chipko: Failure of a Successful Conservation Movement. In: Sodhi, N.S.,
7. Gibson, L. & Raven, P.H. *Conservation Biology: Voices from the Tropics*. pp. 126-127. Wiley-Blackwell, Oxford, UK.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	H	H	H	H	M	H	H	M
CO2	H	M	H	H	H	H	H	H	H	H
CO3	H	M	H	H	H	H	H	H	H	H
CO4	H	H	H	H	H	H	H	H	H	M
CO5	H	H	H	M	H	H	H	H	H	H
CO6	H	H	M	H	H	H	M	H	H	M

L/M/H L – Low; M – Medium; H - High

Mandatory – I YOGA

L	T	P*	C
2	-	-	2

Objectives

The course aims at;

1. Prevention of health problems and rehabilitation through Yoga
2. Promoting positive health
3. Promoting total personality development of students in Colleges and Universities
4. Invoke positive attitude and spirit to channelize their energies in to creative and constructive endeavours

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember the systems of human body	K1
CO2	Understand the basics of yogs	K2
CO3	Apply yoga for mental health	K3
CO4	Analyse asanas and kapalabhati	K4

CO5	Evaluate pranayama and meditation	K5
CO6	Create a sound body	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Unit – I – Introduction to Human Body **3Hrs (3L+0P)**

Body Structure - Systems of Human Body – Body Function – Physical Health – Physical Fitness – meaning of wholesome development.

Unit – II – Yoga **3Hrs (3L+0P)**

Origin and development of Yoga - Meaning and importance of Yoga - Yoga as a Science -Principles of Yogic Practices, Yogic therapies and modern concept of Yoga – Balanced Diet.

Unit – III – Mental Health **3Hrs (3L+0P)**

Mind – Mental Health -Stages of Mind – Mental frequency – Mind training process – Methods of concentration – Brain and memory power.

Unit IV –Asanas and Kapalabhati **3Hrs (3L+0P)**

Importance of preparatory exercises - Meaning of Asana, its types, benefits and principles - Meaning of Kapalabhati, its types, benefits and principles.

Unit V – Pranayama and Meditation

Meaning of Pranayama, its types, benefits and principles - Meaning of Meditation, principles and its benefits

Practical (15 hours)

1. Simplified Exercises / Warm-up
2. Yogasana

a. Standing - Tadasana, Vriksasana, pada hastasana, Ardha Cakrasana, Trikonasana

b. Sitting - Bhadrasana, ardhaustrasana, sasankasana, vakrasana

c. Prone - Bhujangasana, salabhasana, makarasana,

d. Supine – Sethubandhasana, Pavanamutasana, savasana

3. Kapalabhati
4. Pranayama
5. Meditation and Relaxation.

References

1. Anatomy and Physiology of Yogic Practices - M.M Ghore, Kaivalyadhama, Lonavala, Pune. 4.

2. Yoga for different ailments - series published by SVYASA, Bangalore and Bihar Yoga Bharati.
3. Yoga therapy : by Swami Kuvalayanand, Kaivalaya dhama, Lonavala.
4. Pranayama - B.K.S. Iyengar
5. Asana, Pranayama, Mudra, Bandha - Swami Satyananda Saraswati, Bihar School of Yoga, Munger.
6. Promotion of positive Health - published by SVYASA, Bangalore

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L	L	L	L	L	L	L	L	L	L
CO2	L	L	L	L	L	L	L	L	L	L
CO3	L	L	L	L	L	L	L	L	L	L
CO4	L	L	L	L	L	L	L	L	L	L
CO5	L	L	L	L	L	L	L	L	L	L
CO6	L	L	L	L	L	L	L	L	L	L

L/M/H L – Low; M – Medium; H - High

FOURTH SEMESTER

CORE 6: ORGANISMAL AND EVOLUTIONARY BIOLOGY

L	T	P*	C
4	-	4	4

Objectives:

- This paper introduces students to the fundamentals of ecology and evolutionary biology.
- Each unit covers vast range of topics, which will help the students to develop basic concepts of ecology and evolutionary biology**.**

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Explain the evolutionary processes and the major evolutionary innovations that have led to the diversity of extant plant and animal life.	K1
CO2	Understand and apply knowledge of the structures and processes involved in the functioning of plants and animals.	K2
CO3	Relate how biology is an evidence-based discipline involving observation, experimentation and hypothesis testing and how it relates to other scientific disciplines.	K3
CO4	Develop and implement experimental strategies to investigate different biological and experimental systems and analyse and present results of these investigations.	K4
CO5	Critically assess biological information and apply it to theoretical, experimental and professional contexts.	K5
CO6	Design their collaborative and independent educational experiences of laboratory, project and course work in other contexts.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: History of life on Earth **20Hrs (14L+6P)**

Paleontology and evolutionary History; evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multi cellular organisms; major groups of plants and animals; stages in primate evolution including Homo.Lamarck's concept of evolution; Darwin's Evolutionary Theory: variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; The Evolutionary Synthesis.

UNIT II: Evolution of unicellular life **10Hrs (7L+3P)**

Origin of cells and unicellular evolution and basic biological molecules; abiotic synthesis of organic monomers and polymers; Oparin-Haldane hypothesis; study of Miller; the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT III: Geography of evolution **6 Hrs (3L+3P)**

Biogeographic evidence of evolution; patterns of distribution; historical factors affecting geographic distribution; evolution of geographic patterns of diversity.

UNIT IV: Molecular evolution **10Hrs (7L+3P)**

Neutral evolution; molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence.

UNIT V: Fundamentals of population genetics **15Hrs (9L+6P)**

Concepts of populations, gene pool, gene frequency; concepts and rate of change in gene frequency through natural selection, migration and genetic drift; adaptive radiation; isolating mechanisms; speciation (allopatric, sympatric, peripatric and parapatric); convergent evolution; sexual selection; coevolution; Hardy-Weinberg Law.

References

1. Futuyma, D.J. 2009. *Evolution* (2nd edition). Sinauer Associates.
2. Gillespie, J. H. 1991. *The Causes of Molecular Evolution.* Oxford University Press.
3. Graur, D. & Li, W.H. 1999. *Fundamentals of Molecular Evolution* (2nd edition). Sinauer Associates.
1. Kimura, M. 1984. *The Neutral Theory of Molecular Evolution*. Cambridge University Press.
2. Minkoff, E.C. 1983. *Evolutionary Biology*. Addison Wesley. Publishing Company.

3. Nei, M. & Kumar, S. 2000. *Molecular Evolution and Phylogenetics*. Oxford University Press.
4. Nei, M. 1975. *Molecular Population Genetics and Evolution*. North-Holland Publishing Company.
5. Nei, M. 1987. *Molecular Evolutionary Genetics*. Columbia university press.
6. Thorne, J. L., Kishino, H., & Painter, I. S. 1998. Estimating the rate of evolution of the rate of molecular evolution. *Molecular Biology and Evolution* **15**: 1647-1657.

MAJOR PRACTICAL - IV

ORGANISMAL AND EVOLUTIONARY BIOLOGY

L	T	P*	C
-	-	4	2

1. Darwin's Finches with diagram/ cut out of beaks of different species
2. Study of fossil evidence
3. Phylogeny of horse with diagrams
4. Karyotype analysis
5. Molecular tools in phylogeny
6. Protein and nucleotide sequence analysis

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	M	M	M	M	M	M	M	M	M	M
CO2	M	M	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	M	M	M	M	M	M	M	M
CO6	M	M	M	M	M	M	M	M	M	M

L/M/H L – Low; M – Medium; H - High

ALLIED IV

SYSTEMATICS AND BIOGEOGRAPHY

L	T	P*	C
4	-	4	4

Objectives:

- This course will discuss principles and applications of classical and modern-day systematics to classification of living organisms, develop understanding of historical and contemporary patterns of distributions of organisms,
- To learn Design effective conservation strategies using biogeographic theories in an era of global change and large scale human induced degradation.

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	**Cognitive level (K1 to K6)**
CO1	Knowledge of analytical methods used in phylogeny reconstructions and historical biogeography;	K1
CO2	Understand the connection between evolutionary history, diversity and distribution of organisms on earth.	K2
CO3	Apply terms and their use in phylogenetic analyses.	K3
CO4	Analyse results from phylogenetic, biogeographic and phylogeographic analyses.	K4
CO5	Evaluate data for phylogenetic and biogeographical analysis.	K5
CO6	Develop tools used in phylogenetic analyses and analyses of biogeographic patterns.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Concept and systematics approaches **6 Hrs (3L+3P)**

Definition of systematics; taxonomic identification; keys; field inventory; herbarium; museum; botanical gardens; taxonomic literature; nomenclature; evidence from anatomy, palynology, ultrastructure, cytology, phyto-chemistry, numerical and molecular methods; taxonomy databases.

UNIT II: Taxonomic hierarchy, Nomenclature and systems of classification

14 Hrs (8L+6P)

Concept of taxa (species, genus, family, order, class, phylum, kingdom); concept of species (taxonomic, typological, biological, evolutionary, phylogenetic); categories and taxonomic hierarchy. Principles and rules (International Code of Botanical and Zoological Nomenclature); ranks and names; types and typification; author citation; valid publication; rejection of names; principle of priority and its limitations; names

of hybrids; classification systems of Bentham and Hooker; Angiosperm Phylogeny Group (APG III) classification.

UNIT III: Numerical and molecular systematics 6 Hrs (3L+3P)

Characters; variations; Operational Taxonomic Units; character weighting and coding; phenograms; cladograms; DNA barcoding; phylogenetic tree (rooted, unrooted, ultrametric trees); clades: monophyly, paraphyly, polyphyly; homology and analogy; parallelism and convergence.

UNIT IV: Introduction to Biogeography 16 Hrs (10L+6P)

Genes as unit of evolutionary change; mutation; genetic drift; gene flow; natural selection; geographic and ecological variation; biogeographical rules – Gloger's rule, Bergmann's rule, Allen's rule, Geist rule; biogeographical realms and their fauna; endemic, rare, exotic, and cosmopolitan species. Types and processes of speciation – allopatric, parapatric, sympatric; ecological diversification; adaptive radiation, convergent and parallel evolution; dispersal and immigration; means of dispersal and barriers to dispersal; extinction.

UNIT V: Historical, Ecological and conservation of Biogeography 18 Hrs (12L+6P)

Earth's history; paleo-records of diversity and diversification; continental drift and plate tectonics and their role in biogeographic patterns – past and present; biogeographical dynamics of climate change and Ice Age. Species' habitats; environment and niche concepts; biotic and abiotic determinants of communities; species-area relationships; concept of rarity and commonness; Island Biogeography theory; Equilibrium Theory of Insular Biogeography; geography of diversification and invasion; phylogeography.

Application of biogeographical rules in design of protected area and biosphere reserves; use of remote sensing in conservational planning.

References

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3. Singh, G. 2012. *Plant Systematics: Theory and Practice* (3rd edition). Oxford & IBH Pvt. Ltd.,New Delhi.
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5. Williams, D. M., Ebach, M.C. 2008. *Foundations of Systematics and Biogeography*. Springer.

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ALLIED PRACTICAL - IV

SYSTEMATICS AND BIOGEOGRAPHY

L	T	P*	C
	-	4	2

1. Identification of the plant specimens with reference to their families following the Bentham& Hooker's classification
2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label
3. Permanent slide preparation
4. Field work under supervision and submission of herbarium sheets
5. Submission of field visit report
6. Phylogenetic tree

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	M	M	H	H	M	M	M
CO2	M	M	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	M	M	M	M	M	M	M	M
CO6	M	M	M	M	M	M	M	M	M	M

7. L/M/H L – Low; M – Medium; H - High

NON-MAJOR ELECTIVE 2

BIODIVERSITY AND CONSERVATION

L	T	P*	C
3	-	-	2

Objective:

- Understand the concept of the biodiversity.
- To create the awareness to importance and conserve the biodiversity.

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Observe how different global impacts can interact to affect ecosystems.	K1
CO2	Describe ecological networks and what they can tell us along with their conservation.	K2
CO3	Discover the main reasons for decline and threats to biodiversity worldwide.	K3
CO4	Analyse how different global impacts can interact to affect ecosystems.	K4
CO5	Editorializeon a topical aspect of biodiversity and/or conservation.	K5
CO6	Hypothesize ways in which we could mitigate global impacts on ecosystems.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT-I BIODIVERSITY: CONCEPT AND DEFINITION 7 Hrs (4L+0P)

Composition and Scales of biodiversity-genetic, species and ecosystem diversity. Biodiversity/species inventory –documentation and monitoring. Species diversity, richness over geological time scale and distribution.Ecosystem diversity – major types. Global Hot spots, Mega diversity Centers, Hotspots of India.

UNIT-II LOSS OF BIODIVERSITY 10 Hrs (4L+0P)

Loss of species diversity, threat factors – habitat loss, overexploitations and invasions, species extinction- reasons. Endemism and Richness of biodiversity, IUCN threatened categories and red list. Loss of ecosystem diversity –factors, projected loss of biodiversity and Economics.

UNIT-III VALUES AND USES OF BIODIVERSITY 8Hrs (4L+0P)

Biodiversity values and economic importance, instrumental and intrinsic values.Ethical and aesthetic values, Anthropocentrism, Biocentrism, Ecocentrism. Valuation of Biodiversity- methods and uses of plants, animals and microbes

UNIT-IV CONSERVATION OF BIODIVERSITY 12 Hrs (7L+0P)

In situ – protected areas, biosphere reserves, national parks, Ramsar convention and, World heritage sites. Ex situ – Germpalsm collections, botanic gardens, seed banks, gene- pollen- field gene banks. Social and cultural approaches: sacred groves, sthalavrikshas. Societal Movements – Chipko movement, Bishnoi memorial khejri, Chico River, Role of educational institutions and media in conservation program

UNIT-V BIODIVERSITY MANAGEMENT 9 Hrs (5L+0P)

Organizations involved – IUCN, UNEP, UNESCO, WWF, FAO, CAB International, Biodiversity legislations and conventions – CBD, TRIPS, CITES, ITTA, ITTO. Biodiversity prospecting – Bioprospecting, IIKS, IPR and ownership of traditional knowledge.

References

1. Chaudhuri, A.B. and D.D Sarkar. 2003. Megadiversity conservation, flora, Fauna and Medicinal Plants of India's hot spots, Daya publishing House, Delhi.
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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5

CO1	H	H	H	H	H	H	H	M	H	H
CO2	H	H	M	H	H	M	M	H	H	H
CO3	H	M	H	H	H	H	H	M	H	H
CO4	H	H	H	H	H	H	H	H	H	H
CO5	H	H	H	H	H	H	H	M	H	H
CO6	H	H	H	H	H	H	H	H	H	H

L/M/H L – Low; M – Medium; H - High

Mandatory – II:

COMPUTER FOR DIGITAL ERA

L	T	P*	C
2	-	-	2

Objectives:

1. To create the awareness about the digital India among the student community
2. To make the student to understand the role of computer in the day to day living
3. To create the awareness about the e-learning and security issues.

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Identify the areas where he can extend the digital computing for their benefits.	K1
CO2	Cite ideas in an impressive and professional manner	K2
CO3	Apply the computing technology in their day to day life	K3
CO4	Correlate multidisciplinary and multicultural environment	K4
CO5	Plan to become entrepreneur based upon societal needs, understanding of professional, social and ethical responsibilities	K5
CO6	Create awareness regarding digital India initiatives to their surroundings	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I FUNDAMENTALS OF COMPUTERS 5Hrs (3L+0P)

The role of computers in the modern society- Types of Computers and their Specifications-Server-Desk Top Computers-Lap Top-Tablet-Smart Phones-Block

diagram of digital Computer-Working principle of Computer, I/O Devices-Central Processing Unit-Types of Memory-Display –Port-UPS-Setting up and Maintenance of Computer.

UNIT II TYPES OF SOFTWARE AND OFFICE AUTOMATION 6Hrs (3L+0P)

Types of Software with Examples-System Software-Application Software-Utility Software-Operating System-Basics on Windows-Introduction to Android-Application Software-Free Open Source Software-Database and its applications –Office Automation software-applications of Microsoft Word-Microsoft power Point-Microsoft Excel.

UNIT III INTERNET AND MOBILE APPLICATIONS 7Hrs (4L+0P)

Introduction to computer networks-LAN-WAN-MAN-Wired and Wireless network –WiFi Networks –Network Devices-Modem –Switch –Router-Broad Band-Leased Lines-Internet-WWW-URL-Browser-e-mail- SMS-MMS-Client Server Computing-Cloud-public and Private cloud –Mobile Applications.

UNIT IV E-GOVERNANCE IN INDIA 7Hrs (4L+0P)

E-Governance Initiative by the Government-Digital India Platform-Agencies enabling Digital India-Electronic payment and Receipt –Digital locker-e-district service-electronic signature Service-Digital AllMS-India BPO Scheme-Integrated Nutrient Management- GIS-Mobile Seva App Store-GARV- GrameenVidyutikaran.

UNIT V E-LEARNING AND MOOC 5Hrs (4L+0P)

E-Learning-Digital Library-E-Journals-Introduction to MOOC –Edex-Course era etc-SWAYAM-NPTEL-Cyber Security-Virus-Malware-Network Security –Hacking-Big Data-Data Analytics-Social Networks-social Media Analytics-Introduction to IT Act.

10 Hours practical Sessions are to be allotted for computer & Mobile Applications

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5. Charles P Pfleeger, Shari Lawrence Pfleeger, Security in Computing, I Edition, Pearson Education, 2003.
6. https://swayam.gov.in
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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L	L	L	M	M	L	L	M	M	M
CO2	L	L	L	M	M	L	L	M	M	M
CO3	L	L	L	M	M	L	L	M	M	M
CO4	L	L	L	M	M	L	L	M	M	M
CO5	L	L	L	M	M	L	L	M	M	M
CO6	L	L	L	M	M	L	L	M	M	M

L/M/H L – Low; M – Medium; H - High

Extension Activity: NCC/NSS/YRC/YWF

FIFTH SEMESTER

CORE 7

INDUSTRIAL POLLUTION AND HUMAN HEALTH

L	T	P*	C
4	-	4	4

Objectives:

- To understand the various forms of industrial pollution their causes, effects and control.
- To understand the various importance of human health problems**.**

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember the types of pollution	K1
CO2	Understand the reasons for pollution in environment	K2
CO3	Relate the causes of pollution and methods to mitigate pollution	K3
CO4	Device experiments to curb pollution	K4
CO5	Evaluate the existing techniques of analysing pollution	K5
CO6	Create newer technology for mitigation	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Air Pollution 12h (9L+3P)

Air pollution – Introduction – classification of air pollutants – primary and secondary, particulate and gaseous; Sources of air pollution – vehicles, industries – Cement plant, Limestone mining, volcanoes, dust storm; Effects of air pollution on – Man – Plants and Materials; green house effect – global warming – ozone depletion; Bhopal Gas disaster; Acid rain.

UNIT II: Water Pollution 12h (6L +6P)

Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; COD, BOD, DO; effect of water contaminants on human health(nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs).

UNIT III: Soil Pollution **14h (8L+6P)**

Soil pollution: Sources of soil pollution - Effects of soil pollution; Pesticides in soil environment and their effects; Sediments; Biological magnification, pollution through mining; Control of soil pollution.

UNIT IV: Thermal & Radioactive Pollution **12h (6L +6P)**

Thermal pollution – Introduction; sources of thermal pollution – Nuclear power plants, Hydro electrical power plants, coal power plants; Effects of thermal pollution. Oil pollution – sources and effects – oil pollution and marine biota; flora and fauna, bioindicators. Radioactive material and sources of radioactive pollution; effect of radiation on human health (somatic and genetic effects)

UNIT V: Noise Pollution **10h (7L+3P)**

Noise pollution – sources; frequency, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans - working efficiency, physical and mental health; control measures.

References

1. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. Air Pollution: Health and Environmental Impacts. CRC Press, Taylor & Francis.
2. Hester, R.E. & Harrison, R.M. 1998. Air Pollution and Health. The Royal Society of Chemistry, UK.
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6. Rao, M. N and Rao, H.V.N., Air Pollution, Tata McGraw Hill Publishing Co. Ltd.,

PRACTICAL: VIII

INDUSTRIAL POLLUTION AND HUMAN HEALTH

L	T	P*	C
-	-	4	2

1. Field visit to a polluted site/ visit to an industry and collection of samples
2. Quantification of chromium from tannery effluents.
3. Physical properties of polluted soils.
4. chemical properties of polluted water

5. Physico-chemical properties of polluted ware.
6. Bacteriological sampling and analysis of soil quality.
7. Surveillance and quality of analysis of potable water.
8. Aquatic bioassay – acute toxicity with fish
9. Case studies on environmental effects of pesticides.
10. Impact of any toxicant on selected enzymes in fish
11. Case studies on environmental issues and human health: Ex. Bhopal gas tragedy

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	H	H	H	H	H	H	H	H
CO2	H	H	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H	H	H
CO4	H	H	H	H	H	H	H	H	H	H
CO5	H	H	H	H	H	H	H	H	H	H
CO6	H	H	H	H	H	H	H	H	H	H

12. L/M/H L – Low; M – Medium; H - High

CORE8: ENVIRONMENTAL LEGISLATION AND POLICY

L	T	P*	C
4	-	-	4

Objectives:

- To understand the fundamentals and structure of environmental legislation and policy making.
- To understand the making of environmental legislation and policy in India and the world.

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember the national and international laws of environment	K1
CO2	Understand the concepts of environmental laws and sections under the laws	K2

CO3	Relate the laws with the current environmental problems	K3
CO4	Device organizations for environmental problems	K4
CO5	Evaluate the existing laws of environment	K5
CO6	Create movements for environmental threats	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Introduction and History of environmental legislation and policy 12 H(12L+0P)

Constitution of India; fundamental rights; fundamental duties; Union of India; union list, state list, concurrent list; legislature; state assemblies; judiciary; panchayats and municipal bodies; National Green Tribunal. History of environmental legislation and policy. Ancient period: worship of water, air, trees; Mauryan period: Kautilya's Arthashastra, Yajnavalkyasmriti and Charaksamhita; Medieval period: forests as woodland and hunting resources during Mughal reign; British India: Indian Penal Code 1860, Forest Act 1865, Fisheries Act 1897; Independent India: Van Mahotsava 1950, National Forest Policy 1952, Orissa River pollution and prevention Act 1953.

UNIT II: Environmental legislation 5 H (15L+0P)

Legal definitions (environmental pollution/*n, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).

UNIT III: Environmental laws in India 20 Hrs (20L+0P)

The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988; The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002; The Schedule Tribes and other Traditional Dwellers (Recognition of Forests Rights) Act 2006; The National Green Tribunal Act 2010; scheme and labeling of environment friendly products, Ecomarks.

UNIT IV: Government institutions and case studies 10 Hrs (10L+0P)

Role of Ministry of Environment, Forests & Climate Change in environmental law and policy making; role of central and state pollution control boards in environmental

law and policy making. Case studies: National Green Tribunal: Aditya N Prasad vs. Union of India & Others; Ganga Tanneries Case: M.C. Mehta vs. Union of India 1988; environmental education case: M.C. Mehta vs. Union of India, WP 860/1991.

UNIT V: International laws and policy **10 Hrs (10L+0P)**

Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Earth summit at Rio de Janeiro, 1992 (Rio Declaration, Agenda 21); Montreal Protocol 1987; Kyoto Protocol 1997; Copenhagen and Paris summits 2009; Ramsar convention, Convention on Biodiversity (1992), Basal convention (1989, 1992)

References

1. Abraham, C.M. 1999. Environmental Jurisprudence in India. Kluwer Law International.
2. Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. Bulletin of the National Institute of Ecology 15: 227-238.
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8. Venkat, A. 2011. Environmental Law and Policy. PHI Learning Private Ltd.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	M	M	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	M	M	M	M	M9	M	M	M	M
CO5	M	M	M	M	M	M	M	M	M	M
CO6	M	M	M	M	M	M	M	M	M	M

L/M/H L – Low; M – Medium; H - High

Core 9: GREEN TECHNOLOGIES

L	T	P*	C
4	-	4	4

Objectives:

- To understand the concept of green technology, its goals and advantages
- To understand the role of green technologies in sustainable development

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember the concepts of green energy technology	K1
CO2	Understand the planning of infrastructure	K2
CO3	Relate the green economy towards green technology development	K3
CO4	Device experiments towards green energy technology	K4
CO5	Evaluate the energy efficient methods	K5
CO6	Create newer technologies for the green economy	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Introduction ‘ 5 Hrs (5L+0P)

Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; sustainable consumption of resources; individual and community level participation such as small-scale composting pits for biodegradable waste, energy conservation; encouraged use of public transport instead of private transport.

UNIT II: Green technologies 5 Hrs (5L+0P)

Green technologies in historical and contemporary perspectives; successful green technologies: wind turbines, solar panels; 3 R’s of green technology: recycle, renew and reduce; paradigm shift from ‘cradle to cradle’ to ‘cradle to grave’

UNIT III: Green infrastructure, planning and economy 15 Hrs (15L+0P)

Green buildings; history of green buildings, need and relevance of green buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building; Eco-mark certification, establishment of Eco-mark in India, its importance and implementation; Green planning: role of governmental bodies, land use planning, concept of green

cities, waste reduction and recycling in cities, role of informal sector in waste management, public transportation for sustainable development, green belts. ; Introduction to UNEP's green economy initiative, inclusive economic growth of the society, REDD+ initiative, and cap and trade concept; green banking.

UNIT IV: Applications of green technologies **15 Hrs (15L+0P)**

Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermal melting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats). Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets, promotion and/or subsidy of alternative forms of transportation for employees, such as carpools, fuel efficient vehicles, and mass transit, methane emissions reduction and/or reuse). Pollution reduction and removal (Flue Gas Desulfurization (FGD) methods, catalytic or thermal destruction of NO_X, Fluidized Bed Combustion, Dioxins reduction and removal methods, Thermal Oxidizers or Wet Scrubbers to neutralize chemicals or heavy metals, solvent recovery systems, Low Volatile Organic Compound (VOC) paints and sealers).

UNIT V: Green chemistry and green future **20 Hrs (20L+0P)**

Introduction to green chemistry; principles and recognition of green criteria in chemistry; biodegradable and bio-accumulative products in environment; green nanotechnology; reagents, reactions and technologies that should be and realistically could be replaced by green alternatives; photodegradable plastic bags. Green future: Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; major challenges and their resolution for implementation of green technologies; green practices to conserve natural resources (organic agriculture, agroforestry, reducing paper usage and consumption, etc.); emphasis on waste reduction instead of recycling, emphasis on innovation for green future; role of advancement in science in developing environmental friendly technologies.

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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	M	M	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	M	M	M	M	M	M	M	M
CO6	M	M	M	M	M	M	M	M	M	M

L/M/H L – Low; M – Medium; H - High

Core 10: ENVIRONMENTAL ECONOMICS

L	T	P*	C
4	-	-	4

Objectives:

- To understand the fundamentals of environmental economics.
- To understand the concepts of environmental economics and its importance in conservation of biodiversity and ecosystem

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember the fundamentals and scope of environmental economics	K1
CO2	Understand the concepts of environmental economics and its importance in conservation of biodiversity and ecosystem	K2
CO3	Relate Social costs and benefits of environmental programmes	K3
CO4	Device experiments and modes for zero emissions	K4
CO5	Evaluate economic solutions to environmental problems	K5
CO6	Create tools for environmental economic policy	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Introduction to microeconomics **15 Hrs (15L+0P)**

Definition and scope of environmental economics; environmental economics versus traditional economics; brief introduction to major components of economy: consumer, firm and their interaction in the market, producer and consumer surplus, market failure, law of demand and supply, tangible and non tangible goods; utilitariasm; Pareto optimality; compensation principle.

UNIT II: Environmental economics **15 Hrs (15L+0P)**

Main characteristics of environmental goods; marginal analysis; markets and market failure; social benefit, costs and welfare functions; meaning and types of environmental values; measures of economic values; tangible and intangible benefits; Pareto principle or criterion; Hardin's Thesis of 'The Tragedy of Commons'; prisoner's dilemma game; methods of abatement of externalities; social cost benefit analysis; cost-effectiveness analysis.

UNIT III: Economic solutions to environmental problems **15 Hrs (15L+0P)**

Social costs and benefits of environmental programmes: marginal social benefit of abatement, marginal social cost of abatement; pollution control: policies for controlling air and water pollution, disposal of toxic and hazardous waste- standards

vs. emissions charges, environmental subsidies, modelling and emission charges; polluter pay principles; pollution permit trading system.

UNIT IV: Natural resource economics **5 Hrs (5L+0P)**

Economics of non-renewable resources; economics of fuels and minerals; Hotelling's rule and extensions; taxation; economics of renewable resources; economics of water use, management of fisheries and forests; introduction to natural resource accounting.

UNIT V: Tools for environmental economic policy **10 Hrs (10L+0P)**

Growth and environment; environmental audit and accounting, Kuznets curve, environmental risk analysis, assessing benefits and cost for environmental decision making; cost benefit analysis and valuation: discounting, principles of Cost-Benefit Analysis, estimation of costs and benefits, techniques of valuation, adjusting and comparing environmental benefits and costs.

References

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Mapping of COs to POs and PSOs

	Correlation level with POs	Correlation level with PSOs

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	M	M	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	M	M	M	M	M	M	M	M
CO6	M	M	M	M	M	M	M	M	M	M

L/M/H L – Low; M – Medium; H - High

Skill based core 1

HUMAN-WILDLIFE CONFLICT AND MANAGEMENT

L	T	P*	C
4	-	4	4

Objectives:

- To understand the activities and conflicts of human in wildlife management.
- To understand the scientific and social perspective of conservation of forest

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	**Cognitive level (K1 to K6)**
CO1	Remember the activities and conflicts of human in wildlife management	K1
CO2	Understand scientific and social perspective of conservation of forest	K2
CO3	Relate socio-economic and legal basis of conflicts	K3
CO4	Device techniques to reduce human animal conflict	K4
CO5	Evaluate the existing laws and techniques for human animal conflict	K5
CO6	Create symbiotic relationship between tribals and forest, forest and development	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Introduction and Evolution of the concept of wildlife management

20 hrs (20L+0P)

Introduction: Need of environmental management; wildlife conservation: moral obligation? philosophy of wildlife management; why is it necessary to worry about human wildlife conflicts? Role of government, wildlife biologists and social

scientists, concept of deep and shallow ecology. Evolution of the concept of wildlife management: Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetka wall paintings; conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts; Bishnoi community; understanding wildlife management, conservation and policies regarding protected areas in 21st century; positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits).

UNIT II: Wildlife conservation laws in India **10 Hrs (10L+0P)**

Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, brief introduction to Wildlife Protection Act of 1972, Forest act 1927, Environmental Protection Act 1986, and Forest conservation Act 1920; introduction of Tiger task force, Status of current protected areas in India.

UNIT III: Socio-economic and legal basis of conflicts **10 Hrs (10L+0P)**

Concepts of development and encroachment, who is the intruders: human or animal? Impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation: luxury hotels within protected areas vs. displacement of native tribes, forest produce as a need vs. forest exploitation, introduction to tribal rights in India, demographic profile of tribes in India, importance of forest produce to tribal populations, Scheduled tribes and other traditional Forest dwellers (Recognition of forest right) Act, 2006.

UNIT IV: Wildlife conflicts **6 Hrs (6L+0P)**

Insight into the important conflicts: Keoladeo National park conflict of Bharatpur, Human and elephant conflicts of Kerala, Fisherman and tiger conflict of Sundarbans forest, shifting cultivation in North east India.

UNIT V: Human wildlife coexistence **14 hrs (14L+0P)**

Symbiotic relationship between tribals and forest, forest and development, focus on the inclusive growth of tribes: community participation in forest management, case study of Chipko movement, sacred groves forests, India's Bishnoi community and their conservation practices; ecological economic welfare and development: conservation of indigenous culture and traditions, role of international organizations: Man and biosphere programmes; concept of conservation reserves and community reserves, importance of wildlife corridors in minimizing the conflicts and conservation.

References

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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	M	M	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	M	M	M	M	M	M	M	M
CO6	M	M	M	M	M	M	M	M	M	M

L/M/H L – Low; M – Medium; H - High

SKILL BASED COMMON – PERSONALITY DEVELOPMENT

L	T	P*	C
2	-	-	4

Course code:

Course Objectives:

1. To make students understand the concept and components of personality, thereby to apply the acquired knowledge towards their academic career
2. To make the student thorough with the basic soft skills.

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	**Cognitive level (K1 to K6)**
CO1	Remember the concept of personality	K1
CO2	Understand self awareness	K2
CO3	Apply interpersonal skills	K3
CO4	Analyse the aspects of personality development	K4
CO5	Evaluate the personality and career options	K5
CO6	Create career choice as per personality	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Unit – I Introduction 4Hrs (4L+0P)

Personality- Concept, determinants of personality, Need for Personality Development, Basic personality traits including values – beliefs and nature versus nurture – your own personality and how you use that in career

Unit – II Self Awareness 5Hrs (5L+0P)

Meaning of Self-awareness, Benefits of understanding self, SWOT Analysis, Importance of Self Confidence and Self Esteem. Positive and Negative Self Esteem. **5 L**

Unit – III Interpersonal Skills 7Hrs (7L+0P)

Introduction to Interpersonal Relationships – Defining the difference between aggressive, submissive and assertive behaviors, Analysis Relations of different ego states, Analysis of Transactions, Benefit of effective interpersonal skills.

Unit – IV Other Aspects of Personality Development 6Hrs (6L+0P)

Body language - Problem-solving - Decision-making skills - Conflict and Stress Management - Leadership and qualities of a successful leader – Character building -Team-work – Time management - Work ethics –Good manners and etiquette.

Unit – V Personality and Career Choice 6Hrs (6L+0P)

Career and personality, Self-efficacy, Changing Your Personality- Positive attitude, Individuality, Controlling emotions, Emotional Intelligence.

References:

1. Personality Development for Students by Dr. Vijay Agarwal- Publisher Benten Books
2. Hurlock, E.B (2006). Personality Development, 28th Reprint. New Delhi: Tata Mc Graw Hill

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5

CO1	L	L	L	L	L	L	L	L	L	L
CO2	L	L	L	L	L	L	L	L	L	L
CO3	L	L	L	L	L	L	L	L	L	L
CO4	L	L	L	L	L	L	L	L	L	L
CO5	L	L	L	L	L	L	L	L	L	L
CO6	L	L	L	L	L	L	L	L	L	L

L/M/H L – Low; M – Medium; H - High

SIXTH SEMESTER

Skill Based Core-2: ECO FRIENDLY PRODUCTS

L	T	P*	C
20	-	-	4

Objective:

- To provide knowledge on biofertilizer
- To develop student's technical skills on bio fertilizer production

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember the knowledge on biofertilizer	K1
CO2	Understand the concepts of biofertilizer	K2
CO3	Relate the hazards of chemical fertilizers and biofertilizers	K3
CO4	Device student's technical skills on bio fertilizer production	K4
CO5	Evaluate the sources of biofertilizers	K5
CO6	Create new biofertilizers	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Unit I General Biofertilizers 12hr (4L+0P)

Bacterial, fungal and algal biofertilizers; mycorrhiza -types-endo, ectomycorrhiza and orchidaceous mycorrhiza, Problems and prospects of biofertilizers. Rhizobium-Physiology, Rhizobium interactions, mass cultivation

Unit II Production of Biofertilizers 12h (4L+0P)

Largescale production of bio fertilizers, *Blue* green algae, VAM fungi- Field application of biofertilizers - method of application; Chlorella biofertilizer-growth Parameters-Mushroom cultivation.

Unit III Bacterial Biofertilizers 12hr (4L+0P)

Cyanobacteria as biofertilizers – Azolla- Bacterial biofertilizers - Mass production of Azospirillum, Azotobacter and Phosphobacteria; N_2 fixation - Phosphate solubilization and mobilization.

Unit IV: Biopesticides **12hr (4L+0P)**

Definition, kinds and commerce of biopesticide, Bacillus thuringiensis, insect viruses and entomopathogenic fungi – its characters, physiology, mechanism of action and application of bioinsectides - neem and related natural products.

Unit V Vermicompost Technology **12 hr (4L+0P)**

Introduction to vermiculture, biology, economic important, their value in maintenance of soil structure, production of organic fertilizers by vermiculture- Earthworm farming, Extraction (harvest), vermicomposting- vermiwash collection, composition and use harvest and processing.

References

1. Altman, A., 1997. Agricultural biotechnology, CRC Press.
2. Ariëns, E.J., Van Rensen J., Welling, W., 1988. Stereo selectivity of pesticides. Biological and chemical problems. Chemicals in agriculture. Volume 1, Elsevier Science Publishers, The Netherland.
3. Blackburn, R.S., 2009. Sustainable textiles: Life cycle and environmental impact. Elsevier Science Publishers, The Netherland.
4. Board, N., 2004. The complete technology book on vermiculture and vermicompost CRC Press.
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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	M	M	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	M	M	M	M	M	M	M	M
CO6	M	M	M	M	M	M	M	M	M	M

L/M/H L – Low; M – Medium; H – High

ELECTIVE-1: AGROFORESTRY AND SILIVICULTURE

L	T	P*	C
25	-	-	3

Objective:

To introduce the concepts and methods in agroforestry practices.

To expose students to the techniques in the field of Silviculture.

Course Outcomes (COs)

At the end of the course, the student will be able to –

	Course Outcomes	Cognitive level (K1 to K6)
CO1	Remember concepts and methods in agroforestry practices	K1
CO2	Understand the agroforestry and silviculture techniques in current use	K2
CO3	Relate plant management practices in agroforestry	K3
CO4	Device students to the techniques in the field of Silviculture	K4

CO5	Evaluate the extent and causes of land denudation	K5
CO6	Create forest through important trees of silviculture	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I Concept and definition 5H (4L+0P)

Agroforestry, social forestry, community forestry and farm forestry; Benefits and constraints of agroforestry; Historical development of agroforestry and overview of global agroforestry systems. Classification of agroforestry systems: structural, functional, socioeconomic and ecological; Diagnosis and design of agroforestry system; Criteria of an ideal agroforestry design, productivity, sustainability and adoptability; overview of global agroforestry

UNIT II Plant management practices in agroforestry 5 H (4L+0P)

Tree-crop interactions: ecological and economic; Concept of complementarity, supplementary and competition; Productivity, nutrient cycling and Concept of complementarity, supplementary and competition; Productivity, nutrient cycling and light, water and nutrient competition in agroforestry; Concept of allelopathy and its impact on agroforestry; Energy plantations - choice of species and management; Financial analysis and economic evaluation of agroforestry systems: Agroforestry and carbon sequestration

UNIT III Extent and causes of land denudation 5H (4L+0P)

Effects of deforestation on soil erosion, land degradation, environment and rural economy; Wastelands: their extent, characteristics and reclamation;Watershed management and its role in social, economic and ecological development; Biomass production for fuel wood, small timber, raw material for plant-based cottage industries, non-wood forest products such as gums, resins & tannins, medicinal plants, essential oils, edible fruits, Agroforestry and environmental conservation; Role of green revolution in forest conservation in India.

UNIT IV Definition, object and scope 5 H (4L+0P)

Silvicultue, Seed collection, processing, storage, viability and pre-treatment; Seed dormancy and methods for breaking dormancy; Seed testing and germination tests; Seed certification and ISTA Rules; Forest nursery - need, selection and preparation of site, layout and design of nursery beds. Management of nursery-, weed control, insect pest and diseases control; Planting techniques: site selection, evaluation and

protectionre; Site factors - climatic, edaphic, physiographic, biotic and their infuence on forest vegetation.

UNIT V Silviculture of important tree 5H (4L+0P)

opulus, Eucalyptus, Dalbergia, Acacia, Tectona, Shorea, Prosopis, Casurina, Pinus, Gmelina, Azadirachta, Diospyros, Pt erocarpus, Anogeissus, Santalum, Quercus Albizia and Tamarindus indica

References

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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	M	M	M	M	M	M	M	M
CO2	M	M	M	M	M	M	M	M	M	M
CO3	M	M	M	M	M	M	M	M	M	M
CO4	M	M	M	M	M	M	M	M	M	M
CO5	M	M	M	M	M	M	M	M	M	M

CO6	M	M	M	M	M	M	M	M	M	M

L/M/H L – Low; M – Medium; H – High

Apprenticeship/Internship Programme

MINIPROJECT – Report and Viva-Voce

SEVENTH SEMESTER

CORE 11: ENVIRONMENTAL BIOLOGY

Course code:

L	T	P	C
4	-	3	4

Course Objectives

- To study the structure, functions and classification of ecosystem
- To study about Population ecology and Community Ecology
- To understand the biodiversity and its importance and conservation
- To know the concept of industrial ecology and hotspots

Course outcomes

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	State basic elements of ecology and environmental factors.	K1
CO2	Explain about ecosystem dynamics, functions, classifications and interactions of the organisms in ecosystem.	K2
CO3	Apply biodiversity and its conservation strategies, and gain knowledge in hotspots	K3
CO4	Apply their knowledge in ecosystem restoration	K3
CO5	Explain the importance and impact of biogeochemical cycles	K4
CO6	Make connections and interrelations between various disciplines in the environment.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Ecosystem Structure and functions 8Hrs (5L+3P)

Ecology as an inter-disciplinary science - Origin of life and speciation - Human Ecology and Settlement - Ecosystem Structure and functions: Structures - Biotic and Abiotic components. Functions - Energy flow in ecosystems, energy flow models, food chains and food webs. Biogeochemical cycles, Ecological succession. Species diversity, Concept of ecotone, edge effects, ecological habitats and niche - Ecosystem stability and factors affecting stability - Ecosystem services

UNIT II: Ecosystem classification: 8Hrs (5L+3P)

Basis of Ecosystem classification, Types of Ecosystem: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic. Biomes: Concept, classification and distribution. Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chapparal, Savanna, Tropical Rain forest.

UNIT III: Population ecology and Community Ecology 10Hrs (7L+3P)

Population ecology: Characteristics of population, concept of carrying capacity, population growth and regulations. Population fluctuations, dispersion and metapopulation

Concept of 'r' and 'k' species. Keystone species. Community ecology: Definition, community concept, types and interaction - predation, herbivory, parasitism and allelopathy. Biological invasions.

UNIT IV: Biodiversity and its conservation 10Hrs (7L+3P)

Definition, types, importance of biodiversity and threats to biodiversity. Concept and basis of identification of 'Hotspots'; hotspots in India. Measures of biodiversity. Strategies for biodiversity conservation: in situ, ex situ and in vitro conservation. National parks, Sanctuaries, Protected areas and Sacred groves in India. Concepts of gene pool, biopiracy and bio-prospecting. Concept of restoration ecology. Extinct, Rare, Endangered and Threatened flora and fauna of India.

UNIT V Industrial Ecology 10Hrs (7L+3P)

Concept of Industrial Ecology, Toxicology and Microbiology: Absorption, distribution and excretion of toxic agents, acute and chronic toxicity, concept of bioassay, threshold limit value, margin of safety, therapeutic index, biotransformation. Major water borne diseases and air borne microbes.

Major Practical – VI

Environmental Biology Practical

L	T	P*	C
4	-	4	4

1. Estimation of Species Abundance of Plants
2. Study of Transpiration and Water Balance in Plants
3. Assessment of Chlorophyll Content in Plants
4. Identification of fauna and flora (4 each) of terrestrial, freshwater and marine ecosystems;

5. Identification of phytoplankton and zooplankton (either freshwater or marine).
6. Qualitative estimation of phytoplankton by Lacky's Drop Method and Zooplankton by Sedgwick-Rafter Cell method
7. Estimation of primary productivity – Light and dark bottle method – effects of depth and light
8. Community study: quadrant method; flora and fauna study by frequency, density and abundance – line transect method.
9. Visit to In situ or Ex situ Conservation Centre/ Social Service Organization/ Environmental Education Centre
10. Calculation of Biodiversity Index.
11. Construction of Ecological pyramids of different ecosystems.
12. Productivity of aquatic ecosystem by plankton study.
13. Study of wetland flora and fauna.

References

1. Ecology and Environment: P.D. Sharma., Rastogi Publication.
2. Fundamental of Ecology: E. P. Odum,W. B. Sauders Company, USA
3. Ecology, 2nd Edition by Paul Colinvaux, Wiley.
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5. Ecology: Theories and Applications (4th Edition) by Peter Stiling; Prentice Hall.
6. Text Book of Environmental Studies, Erach Bharucha, Orient longman Pvt. Ltd., Ernakulam.

Mapping of COs to POs and PSOs

	ENVIRONMENTAL BIOLOGY									
	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	L	L	M	H	H	M	L	L
CO2	H	H	L	L	L	H	H	M	L	L
CO3	H	H	L	L	M	H	H	M	L	L
CO4	H	M	L	L	M	H	H	M	L	L
CO5	H	L	L	L	L	M	M	M	L	L
CO6	H	M	M	M	L	M	M	M	M	L

L/M/H L – Low; M – Medium; H - High

Core 12: ENVIRONMENTAL BIOTECHNOLOGY AND MICROBIOLOGY

Course code:

L	T	P	C
4	-	4	4

Course Objectives

1. To teach the students about the environmental microbiology, biotechnology and bioremediation.
2. To teach about the genetically engineered microorganisms in bioremediation process and intellectual property rights.

Course outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Focus knowledge of environmental microbiology, biotechnology and uses of microorganisms in wastewater treatment	K4
CO2	Apply the microorganisms to production of various enzymes, proteins and biogas	K3
CO3	Understand the process of conversion waste into useful products like fertilizers, biogas and remediation of petroleum and heavy metals	K2
CO4	Apply their knowledge in remediation of pollutants using genetically engineered microorganisms	K3
CO5	Know the scope and importance of intellectual property rights	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **10Hrs (7L+3P)**

Scope and Role of environmental Microbiology – Concept of Microbial Ecology– Succession and Colonization of Microbes in Environment – biogeochemical cycles – root nodule formation – detection of faecal contamination – microbes-microbes interactions; plant-microbes interactions; wastewater treatment; Soil Humus;

UNIT II **10Hrs (7L+3P)**

Microbiology of water, air and soil - Microorganisms in extreme environments– microbial treatment of wastewater – use of microorganisms in methane production

from agro industrial waste (Biogas, ethanol, hydrogen and biopolymer) – production of single cell protein; production of enzymes like cellulase, proteases, amylases, alcohol and acetic acid production.

UNIT III **10Hrs (7L+3P)**

Bioremediation: in-situ and Ex-situ bioremediation, bioremediation of hydrocarbons, bioremediation of dyes, bioremediation of paper and pulp industry; bioremediation of heavy metals, xenobiotics and coal waste; bioaugmentation; Phytoremediation - Abatement of different types of pollution using plants, types of phytoremediation, mechanism involved with case studies - Petroleum pollutant biodegradation.

UNIT IV **8hrs (5L+3P)**

Role of BT in Environment Protection: Biotechnological methods for pollution detection – biomineralization - GEMs in biotreatment of waste and environment safety – Bt pesticide – biofertilizer – Vermicomposting – mushrrom production – gene banks for conservation of biodiversity – biomining – microbial leaching, biosensors – microbial enhanced oil recovery –

UNIT V **8hrs (5L+3P)**

Biosafety and IPR: Introduction, Implications of IPRs on commercialization of biotechnology products, copy rights, trade secrets, patents and geographical indications; WIPO; GATT and Trade related IPRs; Patent status; significance of patents in India. Biosafety; guidelines and different levels of biosafety levels.

References

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2. Environmental Biotechnology (Oxford Higher Education)- B.C. Bhattacharyya and RintuBanerje
3. Environmental Biotechnology - Dr Alan H. Scragg
4. Environmental Biotechnology: Theory and Application - Gareth M. Evans and Judith C. Furlong
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Major Practical - VII

ENVIRONMENTAL BIOTECHNOLOGY AND MICROBIOLOGY

L	T	P*	C
-	-	4	2

1. Different types of culture media preparation
2. Enumeration of microbes from water or soil sample.
3. Pure culture – Different streaking techniques.
4. Staining techniques: grams staining and lactophenol cotton blue staining
5. Screening and isolation of enzyme producers like cellulase, proteases, amylase
6. Bioproduction of industrially important enzyme, and alcohol from wastes
7. Immobilization of Microbial cells
8. Recovery of toxic metal ions of an industrial effluent by immobilized cells.
9. Bioremediation – Treatment of dye by immobilization
10. Isolation of genomic DNA from plant and bacteria
11. Isolation and purification of degradative plasmid of microbes growing in polluted environments. (DEMO)
12. Visit to a nearby vermicomposting laboratory

Mapping of COs to POs and PSOs

ENVIRONMENTAL BIOTECHNOLOGY										
	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	L	H	H	H	H	H	M	M	H
CO2	H	L	H	H	H	H	H	L	L	M
CO3	H	L	M	M	H	L	H	M	L	M
CO4	H	L	M	L	H	H	H	L	M	M
CO5	M	M	L	M	M	H	H	M	L	M

L/M/H L – Low; M – Medium; H – High

Core 13: ENERGY AND ENVIRONMENT (e-pathashala)

L	T	P*	C
4	-	3	4

Objective:

1. To educate the students on energy resources in environment.
2. To impart understanding on energy efficiency and energy audit.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Learn basics of energy sources and its types and properties	K1
CO2	Understand the principle of generation of tidal, ocean thermal, geothermal, and wind energy	K2
CO3	Apply the principles of nuclear energy	K3
CO4	Create knowledge in conversion of biomass into fuels	K6
CO5	Understand about emission of carbon dioxide, effects and reduction methods	K2
CO6	Describe about energy audit and energy conservation	K1

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **6Hrs (6L+0P)**

Sun as an energy source, solar radiation, fossil fuel classification and composition, physicochemical properties of fuel, calorific value of fuel, renewable energy resources

UNIT II **6Hrs (6L+0P)**

Hydropower as an energy source, principles of generation of tidal energy, principles of generation of ocean thermal energy conversion, geothermal energy, principles and applications of wind power, components and types of wind turbines,

UNIT III **6Hrs (6L+0P)**

Principles of solar energy generation, applications of solar energy, solar collectors, solar photovoltaic system, solar pond, Nuclear energy from fission, nuclear fusion of energy, prospects of nuclear energy in India, principles of energy conversion using magnetic fields,

UNIT IV **6Hrs (6L+0P)**

Biomass as an energy source, types of biofuels, energy conversion routes from biomass. Thermochemical conversion – technologies-gasification, pyrolysis technology for bioenergy production, biodiesel production from lipids, anaerobic digestion and biogas production, ethanol as a source of energy, urban waste to resource recovery and recycling for energy, hydrogen as a fuel for future and fuel cell.

UNIT V **6Hrs (6L+0P)**

Emission of carbon-dioxide from energy consumption in developed and developing countries, environmental implications of energy use, energy use pattern in world and India, radioactive forcing and global warming, impact of large scale exploitation of solar energy and wind energy, impact of large scale exploitation of hydropower and other renewable energy sources.

Energy efficiency and energy audit, energy conservation-principles and approaches – green buildings – energy policies – international and national norms.

References

1. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
2. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
3. Murphy, W. R., Energy Management, Elsevier, 2007.
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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	M	L	M	M	H	M	L	M
CO2	M	M	M	L	L	L	H	M	M	L
CO3	M	M	M	L	M	M	H	L	H	L
CO4	M	M	L	L	M	L	H	L	M	M
CO5	M	H	L	H	H	M	H	L	L	M
CO6	M	M	L	L	M	L	H	L	L	M

L/M/H L – Low; M – Medium; H - High

Skill based core (Mandatory)

ENVIRONMENTAL ANALYSES AND TECHNIQUES

L	T	P*	C
2	-	0	2

Objectives

1. To provide detailed methodologies for the analytical techniques commonly used for different kinds of environmental samples.
2. To know the principle involved in the quality control of the analysis

Pre-requisite for the study of the course:

The pre-requisite for studying the course on Environmental analyses and techniques is basic knowledge about technological analysis in Environmental Science and fundamental knowledge of environmental parameters.

Outcome of the study:

The student completed this course can expect to have a well-versed knowledge on air pollution analysis, estimation of heavy metals, modelling techniques, Radioactivity Measurement.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Learn the techniques of analysis of water quality	K1
CO2	Understand the principle and estimation of heavy metals and sample	K2

	collection methods	
CO3	Apply the principles and techniques for soil quality analysis	K3
CO4	Create knowledge in conversion of biomass into fuels	K6
CO5	Understand about air pollutant analysis	K2
CO6	Learn about radioactivity measurement	K1

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Unit – I **6Hrs (6L+0P)**

Detection of color, turbidity, pH, EC and temperature, oil and grease in water and waste water. Analysis of Dissolved oxygen, BOD, COD, Alkalinity, Hardness, TS, TDS, TSS and other solids, Ammonical Nitrogen, Organic Nitrogen, Sulphite, Fluoride, Potassium, Sodium, Chloride, Phosphorous, silica and phenolic in waste water – Theory and Practical.

Unit-II **6Hrs (6L+0P)**

Theory and practical of estimation of Zinc, Mercury, Lead, Copper, Chromium, Cadmium, Magnesium, Iron and Manganese in waste water samples. Sample preparation and estimation of Organo Chloride, Organo Phosphates, carbonates and pyrethroids in water and soil samples.

Unit–III **6Hrs (6L+0P)**

Preparation and Estimation of bulk density, specific gravity, moisture, water holding capacity, alkalinity, Sulphate, Calcium, Nitrogen, Phosphorous, Organic Carbon and heavy metals in soil samples.

Unit – IV **6Hrs (6L+0P)**

Experiments related to air pollution analysis – Analysis of ambient air quality, ambient and stack sampling, Particulate and gaseous pollutants, meteorological parameters, atmospheric stability, wind profile and stack plume patterns, modelling techniques.

Unit – V **6 Hrs (6L+0P)**

Radioactivity Measurement – Radioactive Decay, Isotopes, Instruments used for measurement of radiation intensities, Radiochemical separation for the determination of Radium in environmental matrix. Detection of Alpha, Beta and Gamma radio activity in selected matrices.

References

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Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	M	M	L	H	M	H	H	H	H
CO2	H	M	M	L	H	M	H	H	H	H
CO3	H	M	M	L	H	M	H	H	H	H
CO4	H	M	M	L	H	M	H	H	H	H
CO5	H	M	M	L	H	M	H	H	H	H

Elective papers

Elective Paper 1: Contemporary Environmental issues

Course code:

L	**T**	**P**	**C**
3	**-**	**-**	**3**

Course Objectives

- To provide an overview of the most pressing environmental problems at global level
- To understand the causes and the consequences of the environmental issues.
- To develop ideas and solutions to tackle the environmental problems.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Analysis the global and national level environmental related issues.	K4

CO2	Developing knowledge in need of Conservation of water, soil and forest resources	K3
CO3	Remember the various wild life conservation projects	K1
CO4	Evaluate about epidemiological issues in worldwide	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Global Environmental Issues: 10 hrs (10L+0P)

Biodiversity loss, Climate change, Ozone layer depletion. Sea level rise. International efforts for environmental protection.

National Action Plan on Climate Change (Eight National missions – National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a 'Green India', National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change).

UNIT II 6 hrs (5L+0P)

Current Environmental Issues in India: Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States.

UNIT III 8 hrs (8L+0P)

Conservation of water, soil and forest: Water conservation-development of watersheds, Rain water harvesting and ground water recharge.

National river conservation plan – Namami Gange and Yamuna Action Plan.

Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India. Soil erosion, reclamation of degraded land, desertification and its control.

Climate change - adaptability, energy security, food security and sustainability.

Forest Conservation – Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement. People Biodiversity register.

UNIT IV 8 hrs (8L+0P)

Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision.

Carbon sequestration and carbon credits. Waste Management – Swachha Bharat Abhiyan. Sustainable Habitat: Green Building, GRIHA Rating Norms. Vehicular emission norms in India.

UNIT V **8 hrs (8L+0P)**

Epidemiological Issues: Fluorosis, Arsenocosis, Goitre, Dengue. Environmental Disasters: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011.

References

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Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	H	M	H	H	M	M	H	M	L
CO2	M	H	M	H	M	M	M	H	M	L
CO3	L	H	M	H	L	M	M	H	M	L
CO4	L	L	M	M	H	M	M	H	M	L

L/M/H L – Low; M – Medium; H - High

Elective paper 2: BIO MONITORING AND ECOLOGICAL ASSESSMENT

Course code:

L	**T**	**P**	**C**
3	**-**	**-**	**3**

Course Objectives

- Acquire knowledge in physicochemical and biological changes in ecosystems

- Enable the students to assess the habitat conditions based on biological indicators
- Learn the general methods of biological indication of ecosystem health.
- Apply knowledge in the construction and application of biomonitoring systems.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Recognize the importance of a multidisciplinary team approach to exposure assessment and biological monitoring of environment.	K1
CO2	Understand the presence of bioindicators are the qualitative and quantitative indication of the environment	K2
CO3	Explain the bioindicators, biomarkers, aquatic macrophytes are bioindicators	K3
CO4	Evaluate the practical advantages and limitations of biological monitoring as practiced in industrial hygiene and public health	K5
CO5	Discuss the principles and concept of ecological monitoring	K

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **7Hrs (7L+0P)**

Definitions, strategies and principles for bioindication/biomonitoring of the environment. Causes of biological changes. Advantages of bioindicators over other types of indicators of the environment.

UNIT II **10Hrs (10L+0P)**

Types of bioindicators. Specific bioindicators. Biomarkers. Qualitative and quantitative indication of the environment. Saprobic system. Microbial indicators. Algae as ecological bioindicators. Lichens as indicators of air pollution. Bryophytes as bioindicators. Plants as bioindicators.

UNIT III **6Hrs (6L+0P)**

Ecological indices. Changes in plants indicating environment - invasive Plant communities - Agri-environmental indicators. Forests type and quality as indicators.

UNIT IV **6 Hrs (7L+0P)**

Aquatic macrophytes as bioindicators. Plankton communities as indicators of water quality. Macroinvertebrates as indicators of water quality. Fish as bioindicators. Insects as indicators of terrestrial ecosystems. Terrestrial vertebrates as bioindicators.

UNIT V **7Hrs (7L+0P)**

Overview of Ecological Monitoring: Principle - concepts – need and significance. Techniques applied Visual – instrumental; Global environmental monitoring system of UNEP – functions. World conservation monitoring Centre.

References

1. Nalini, K.S. 1993 Environmental Resources and Management, Anmol Publishers.
2. Nautiyal, S and A. K. Kaul 1999 Forest Biodiversity and its Conservation Practices in India. Oriental Enterprises, Dehradun, India.
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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	L	M	M	H	M	M	M
CO2	H	H	M	M	L	M	H	M	M	M
CO3	H	H	L	L	M	M	H	M	M	M
CO4	H	H	M	M	L	M	H	M	M	M
CO5	H	M	L	M	H	M	H	M	M	M

L/M/H L – Low; M – Medium; H - High

Elective paper

3. ECOTOURISM

Course code:

L	T	P	C
3	-	-	3

General Objectives

- This course introduces the students to the economic, cultural and environmental impacts of ecotourism.
- To aware of the different ecotourist spots and its activities.
- To understand ecotourism as a significant aspect of tourism in future.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	describe the key terminology, principles, concepts and types ecotourism	K1
CO2	identify the ecotourism spots and maintenance for sustainable tourism and recreation and critically discuss the ecological centres	K2
CO3	Learn about types, development and conservation of ecotourism	K3
CO4	Appraise economic impacts of ecotourism and review of scope and management of ecotourism.	K4
CO5	Remember the significance of ecotourism and national parks.	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Introduction to Ecotourism **6hrs (6L+0P)**

Concepts of Tourism – Types of Tourism – Religious – Cultural – Heritage – Monumental – Adventure – Mass – Sustainable – Consumptive and Non-Consumptive Tourism. Ecotourism - Concepts, History and Origin, Objectives and Benefits. Factors affecting Ecotourism.

UNIT II: Ecotourism Spots **6hrs (6L+0P)**

Places of interests of Ecotourism – Eco-circuit of the Eastern and Western Ghats, Himalayas, Coastal regions (India) – Infrastructural Facilities. Maintenance of Ecological Centers – Important Biosphere Reserves. Target group of Ecotourism.

UNIT III: Ecotourism, Types and Conservation **10hrs (10L+0P)**

Types of Ecotourism - Rain forest – Mountain, Polar, Islands and Coasts – Wilderness –Total Quality Management (TQM) of Ecotourism Resorts, Knowledge, skills, attitude and commitment of ecotourism service providers. Biodiversity Conservation and Sustainable Ecotourism, Community Based Tourism for Conservation and Development. Conservation – Insitu and Exsitu (Sanctuaries, National Parks, Gene Banks, Seed Banks, Ova Bank)

UNIT IV: Impact of Ecotourism 12hrs (12L+0P)

Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research-Disasters and Ecotourism-Role of ethics in ecotourism - Advantages and Disadvantages of Ecotourism- Ecobranding and Eco-labeling of Ecotourism Products - Marketing of Ecotourism, Ecotourism and Sustainable Development - Management Issues in Ecotourism, Ecotourism-based/related employment, Scope and areas of employment.

UNIT V: Significance of Ecotourism 8hrs (8L+0P)

Parambikulam Tiger Reserve, Kaziranga National Park, Ecotourism spots in Tamil Nadu (Ooty, Kodaikanal, Yelagiri, Yerkaud, Pachamalai). Gulf of Mannar, Point Calimere, Vedanthangal Bird Sanctuary. A World Heritage Site in Assam, The Kabini River, Jog falls, Snow fall mountains in Kulumanali, Ganktok.

References

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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	L	M	H	L	M	M	M
CO2	H	H	M	M	L	H	L	M	M	M
CO3	H	H	L	L	M	H	L	M	M	M
CO4	H	H	M	H	H	H	L	M	M	M
CO5	H	H	L	H	H	H	L	M	M	M

L/M/H L – Low; M – Medium; H – High

EIGTH SEMESTER

CORE 14: ENVIRONMENTAL POLLUTION AND CONTROL

Course code:

L	T	P	C
4	-	4	4

Objectives of the study

- To understand about the sources, and types of pollution
- To understand the measurement of water quality parameters
- To understand the control methods of pollution

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Describe the sources and effects of water and soil pollution and study the environmental impact of fertilizers, pesticides, use and throw plastics and hospital wastes.	K1
CO2	Explain the sources and effects of air pollution, thermal, radioactive and noise pollution	K2
CO3	Experiment the various air, water, and soil pollutants using instrumental, chemical and microbiological methods	K3
CO4	Practical knowledge for the determination of different water parameters, and air pollutants.	K4
CO5	Learn measurement of noise level of different areas and Survey of air pollution control equipments.	K5

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Air Pollution **15 hrs (9L+6P)**

Sources and types of Pollutants - Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates); Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards. Impact of air pollutants Acid rain. Dispersion of air pollutants - Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model. Control devices for particulate matter: Principle and working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and

electrostatic precipitator. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality.

UNIT II: Noise Pollution **8 hrs (5L+3P)**

Sources, weighting networks, measurement of noise indices (L_{eq}, L_{10}, L_{90}, L_{50}, LDN, TNI). Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements. Impact of noise and vibrations on human health.

UNIT III: Water Pollution **12 hrs (9L+3P)**

Types and sources of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN. Indian standards for drinking water (IS:10500, 2012). Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant.

UNIT IV: Soil Pollution **12 hrs (6L+6P)**

Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Analysis of soil quality. Soil Pollution control. Industrial effluents and their interactions with soil components. Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers.

UNIT V: Thermal, Marine Pollution and Radioactive pollution **8 hrs (5L+3P)**

Sources of Thermal Pollution, Heat Islands, causes and consequences. Sources and impact of Marine Pollution. Methods of Abatement of Marine Pollution. Coastal management. Radioactive pollution – sources, biological effects of ionizing

References

1. Krishnan Kannan, K., 1997. Fundamentals of Environmental Pollution, S. Chand Company, New Delhi.
2. Sharma, B. K., Kaur, H., 2000. Environmental Chemistry, Goel Publishing House, Meerut, India.
3. Dara, S.S., 2000. A text book of environmental chemistry and pollution control. S. Chand Company, New Delhi.

4. Sharma, P. D., 1993. Environmental Biology and Toxicology, Rastogi Publications, New Delhi.
5. A.G.Murugesan and C.Rajakumari, Environmental Science and Biotechnology – Theory and Techniques, MJP Publishers.
6. APHA. 1975. Standard methods for the examination of waste water. AWWA, New York.

MAJOR PRACTICAL - VIII

ENVIRONMENTAL POLLUTION AND CONTROL – PRACTICALS

L	T	P*	C
-	-	4	2

1. Determination of TS, TDS & TSS in industrial effluents / sewage
2. Estimation of COD
3. Estimation of Sulphate in industrial effluents
4. Estimation of Phosphate in water
5. Estimation of chloride in water
6. Determination of total hardness and Ca & Mg hardness,
7. Microbiology of Air: by exposure plate method;
8. Air quality analysis using high volume air sampler
9. Determination of organic carbon, from soil samples
10. Soil sampling, description of the soil horizon, determination of soil pH, conductivity and salinity from soil samples
11. Demonstration of noise pollution monitoring equipment

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	L	H	H	M	H	H	H	L
CO2	H	H	H	H	H	M	H	H	H	M
CO3	H	H	M	M	H	M	H	H	H	L
CO4	H	H	M	H	H	M	H	H	M	M
CO5	H	H	M	H	H	M	H	H	H	H

L/M/H L – Low; M – Medium; H - High

Core 15: ENVIRONMENTAL DISASTER MANAGEMENT

Course code:

L	T	P	C
4	-	4	4

Course Objectives

1. To improve the scientific knowledge among students about various natural and man-made disasters
2. To train the student to involve them to cope with different disaster management activities like preparedness, prevention and thereby to reduce disasters effect.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Learn types of environmental hazards and disasters and its profile in India	K1
CO2	Analyses the causes and impacts of disasters on environment	K4
CO3	Focus the various national agencies that play a major role in disaster management	K4
CO4	Evaluate risk reduction approaches of disasters with safety issues in mitigating industrial disasters.	K5
CO5	The knowledge gained will enable the students to volunteer themselves in disaster management programs thus helping affected community.	K6
CO6	Develop understanding about different environmental disasters management practices and preparedness.	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I Introduction Principles and Practices 9Hrs (7L+5P)

Introduction, Meaning and Fundamentals of Disasters, disaster impacts, Humanity and Development, Disruption of Development by Disasters, Loss of Resources, Environmental Disasters and Environmental stress.

UNIT II Types of Environmental hazards & Disasters 9Hrs (7L+5P)

Natural Hazards- Planetary Hazards - disasters Volcanoes - Eruption, Volcanic Hazards, Earthquakes, Causes of Earthquakes, Hazardous effects, Earthquake Hazards

in India, Landslides, Landslide hazard, Lightning, Hailstorms, Tropical cyclones & Local storms, - Floods, Droughts, Cold waves, Heat waves, Tsunami - hazards Chemical hazards/ disasters, Release of toxic chemicals, nuclear explosion, Sedimentation processes Biological hazards/ disasters - Population Explosion

UNIT III Disaster Prediction and Regional Forecasting 9Hrs (7L+5P)

Prediction, Forecasting and Managing - Principles - Nationwide HPC Grid Integrating / Interfacing HPC and Satellite Resources - Sharing of spatial and non-spatial data -. Decision Support Centre (DSC) National Emergency Operation Centre (NEOC) - Virtual Private Network (VPN) National Emergency Communication Network - (NECN) Early Warning Systems (EWS) for Hazards.

UNIT -IV Disaster Management- preparedness 9Hrs (9L+5P)

Emerging approaches in Disaster Management- Pre- disaster stage (preparedness) - Preparing hazard zonation maps, Predictability/ forcasting& warning, Preparing disaster preparedness plan, Land use zoning, Disaster resistant house construction, Population reduction in vulnerable areas, Awareness. Emergency Stage - Rescue training for search & operation at national & regional level, Assessment surveys. Post Disaster stage-Rehabilitation.

UNIT V Disaster Management mitigation & awareness 9Hrs (9L+5P)

Education on disasters, Community involvement, Monitoring Management-. Stakeholders' Roles and Responsibilities, Categories of stakeholders - Governmental agencies - Non Governmental agencies -Disaster education. disaster recovery, mitigation and preparedness, Disaster Associated Health Issues - programme planning and management.

References

1. R.B.Singh (Ed) Environmental Geography, Heritage Publishers New Delhi,1990
2. Savinder Singh, Environmental Geography, PrayagPustakBhawan, 1997\
3. H.K. Gupta (Ed) Disaster Management, Universities Press, India, 2003
4. R.K. Bhandani An overview on Natural &Man-made Disaster & their Reduction, CSIR, New Delhi
5. M.C. Gupta Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi, 2001.
6. Kates, B.I & White, G.F The Environment as Hazards, oxford, New York, 1978
7. Geoff L. Wells, 1997, Major Hazards and Their Management, Gulf Publishing Company, 305 p.

8. Mohammed I., El-Sabh, SrinivasanVenkatesh, CinnaLomnits, Tad S. Murty, (Editor), 2001, Earthquakes and Atmospheric Hazards: Preparedness Studies, Springer, 208 p.
9. Bill MacGuire, Ian Mason, Christopher Kilburn, 2002, Natural Hazards and Environmental Change, A Hodder Arnold Publication; Reissue edition, 202 p.
10. Simon Ross, 1998, Natural Hazards, Nelson Thornes Ltd, USA, 96 p.
11. David R. Godschalk, 1998, Natural Hazard Mitigation: Recasting Disaster Policy and Planning, Island Press, 591 p.,
12. Chowdhury Emdadul. Haque, 2005, Mitigation of Natural Hazards And Disasters: International Perspectives, Springer, 239

MAJOR PRACTICAL – IX

ENVIRONMENTAL DISASTER MANAGEMENT

L	T	P	C
-	-	4	2

1. Study of Recent Disasters (at local, state and national level)
2. Preparation of Disaster Risk Management Plan of an Area or Sector
3. Disaster assessment and monitoring using multi-temporal RS data
4. Field study/ visit
5. Case studies.

Mapping of COs to POs and PSOs

	ENVIRONMENTAL DISASTER MANAGEMENT									
	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	M	H	M	L	H	M	H	M
CO2	H	L	M	H	H	L	M	M	H	H
CO3	H	L	L	M	L	L	M	M	H	H
CO4	H	M	M	H	M	L	M	H	H	M
CO5	H	M	L	L	L	L	M	H	M	M
CO6	H	M	M	M	H	L	H	L	L	M

L/M/H L – Low; M – Medium; H – High

Core 16: Statistics for Environmental Sciences

Course code

L	T	P	C

4	**-**	**-**	**4**

Course Objectives:

- To help them understand the statistical techniques within biological and ecological context
- To train them how to create well-written reports, containing relevant information

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Understand the basic concepts of statistics	K2
CO2	Write and collect the information and draw scientific inference from ecology and environment related data	K6
CO3	Analyze, model and quantify in environmental regression models	K4
CO4	Understand the basic concepts of Big data analytics like ANOVA, t-test, f-test etc	K2
CO5	Evaluate and execute a well-planned field research	K5
CO6	Apply Probability and probability distribution using different statistical calculations.	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Introduction to Statistics **12 hrs (12L+0P)**

Definition and Application of Statistics, Qualitative Data, Quantitative Data, Frequency Distribution, Cumulative Frequency, Diagrammatical Representation of Statistical Data (Bar,

Pie), Graphical Representation of Frequency Distribution (Histogram, Frequency Polygon, Cumulative Frequency Curves).

Attributes and Variables: types of variables, scales of measurement, measurement of Central tendency and Dispersion, Standard error, Moments – measure of Skewness and Kurtosis, Distributions - Normal, log-normal, Binomial, Poisson, t, 2 and F-distribution.

UNIT II Descriptive Statistics **8hrs (8L+0P)**

Measure of Central Tendency: Mean, Median, Mode, Geometric Mean (Merits and Demerits), Measure of Dispersion: Range, Standard Deviation, Variance, (Merits and Demerits), Co-Efficient of Variation.

UNIT III Probability **8hrs (8L+0P)**

Basic concept of probability theory, Sampling theory, Trial, event, sure event, random event, Sample space, Definition of probability, mutually exclusive events, Independent event, Laws of Probability - simple problems, Normal probability curve.

UNIT IV: Hypothesis Testing, correlation and Regression **12 hrs (12L+0P)**

Hypothesis: Types of Hypothesis, Level of Significance, Type I and Type II Error, Standard Error, Degrees of Freedom, Chi Square Test, Student's t Test: One Sample t Test, Paired t Test. tests of hypothesis (t-test, 2-test ANOVA: one-way and two-way); significance and confidence limits. Correlation- Definition, Types of Correlation, Karl Pearson's Coefficient Of Correlation, Simple Linear Regression, One Way ANOVA and Two way ANOVA.

UNIT V: Environmental Modelling **12 hrs (12L+0P)**

Approaches to development of environmental models; linear, simple and multiple regression models, validation and forecasting. Models of population growth and interactions: Lotka-Voltera model, Leslie's matrix model.Scientific Report Writing - Theory behind scientific communication – Importance, target audience - Insight on parts of a Scientific Report – with regard to creating abstracts, documenting theories, models, and accurately interpreting results.

References

1. Fundamentals of Mathematical Statistics: S.C. Gupta And V. K. Kapoor
2. Fundamentals of Statistics: S.C. Gupta
3. Fundamentals of Biostatistics: Veer BalaRastogi

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	L	H	L	M	L	M	M	H	H
CO2	H	M	H	H	H	L	H	M	H	H
CO3	H	L	H	M	H	M	H	L	H	H
CO4	H	M	H	M	H	L	H	L	H	H
CO5	H	M	H	H	H	M	H	L	H	H
CO6	H	M	H	H	H	L	H	H	H	H

L/M/H L – Low; M – Medium; H - High

ELECTIVE PAPER

1. RESTORATION ECOLOGY

Course code

L	T	P	C
3	-	-	3

Course Objective:

1. To understand the ecological concepts relevant for restoring ecosystems and critically think about the scientific/logistic challenges of applying these concepts into a restoration plan.
2. Students will describe the role of key ecological concepts in restoration

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Provide you with an understanding of the process of assisting in the recovery of damaged, degraded or destroyed ecosystems.	K2
CO2	Describe the major ecological principles underlying the successful restoration of natural resources including concepts of disturbance and succession	K1
CO3	Use ecological and management principles and select appropriate methods and tools for designing and conducting restoration projects for sustainable development	K6
CO4	Know the National restoration goals, Policy and Program	K1
CO5	Explain the importance of integrated aquatic ecosystem restoration like wild life and water resources	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **9Hrs (9L+0P)**

Restoration Ecology - Definition, principles, concepts and strategies. (long term vs. short term) role of ecological principles in restoration, role of pioneer species in restoration and holistic approach in restoration.

UNIT II **9Hrs (9L+0P)**

Restoration of natural resources; restoration of river corridor, water resources and mine spoils. Approaches to Flood Plain Management, Concepts and Programs related to Restoration and Management of Lakes, Rivers and streams, Riverine - Riparian ecosystem and Wetlands, Fluvial restoration

UNIT III **9Hrs (9L+0P)**

Planning and evaluating aquatic ecosystem restoration — Project planning, selecting assessment criteria and synthesizing data. Introduction to watershed, concept and significance. Physical and hydrological characteristics of watershed. Drain - line treatment; Area treatment - Goals, features and watershed as unit of sustainable development

UNIT IV **9Hrs (9L+0P)**

Integrated Aquatic Ecosystem Restoration- Introduction, Institutional barriers to Integrated Aquatic Restoration, Importance of Integrated restoration to wildlife, Appropriate scale for restoration, Impact of human activities on water resources, climate change threats to water quality, Shifts in freshwater ecosystems

UNIT V **9Hrs (9L+0P)**

National restoration goals, Policy and Program. redesigning for restoration Integrated Water Resource Management (IWRM). Government agencies and NGOs in conservation and restoration; environmental education and its role in conservation and restoration. Finish Biotic Restoration Landscape ecology and restoration Finish monitoring and adaptive management

References

1. John CairnS Jr., 1992. Restoration of Aquatic Ecosystems - Science, Technology and Public Policy. National Academy Press. Washington D.C.
2. Adamus, P.R., Clairain, E. J., Smith R.D., Young R. E., 1987. Wetland Evaluation Technique (WET). Vol II. Methodology Operational Draft. U.S. Army corps of Engineers waterways Experiment Station, Vicksburg, Miss.
3. Barker, LA and E. B. Swain, 1989. Review of lake management in Minne-sota. Lake Reservoir Manage. 5:1-10.
4. Young, T. P. 2000. Restoration ecology and conservation biology. Biological Conservation 92: 73.83.
5. Hobbs, R. J. and Harris, J. A 2001. Restoration ecology: repairing the Earth's ecosystems in the new millennium. Restoration Ecology 9: 239-246.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	M	H	M	H	M	M	H	M	H
CO2	H	M	M	L	H	M	M	H	M	H
CO3	H	H	H	M	H	M	M	H	M	H
CO4	H	M	H	M	H	M	M	H	M	H
CO5	H	M	M	M	H	M	M	H	M	H

L/M/H L – Low; M – Medium; H - High

Elective paper

2. ENVIRONMENT AND HUMAN HEALTH

Course code:

L	T	P	C
3	-	-	3

Course Objectives

- To understand the water contamination and water quality standards
- To develop the knowledge about communicable diseases
- To know the toxic effects of heavy metals and pesticides on human health

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Create awareness of drinking water quality standards	K6
CO2	Know about the occupational health issues and their importance	K2
CO3	Recognize harmful substances which can pollute the immediate environment (air, water and soil) and cause health problems for people	K1
CO4	Evaluate the cultural factors in health and disease	K5
CO5	Recognize, assess and evaluate occupational health hazards	K1
CO6	Develop skills in ventilation and safe disposal of solid and biomedical wastes	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **8 hrs (8L+0P)**

Introduction – Need for protected water – Contamination of water – Sewage, Industrial effluents– Small scale purification of drinking water at home level – Water quality standards

UNIT II **8 hrs (8L+0P)**

Epidemiology of communicable diseases- Hepatitis, Cholera, Diarrhoeal diseases, Typhoid, Amoebiasis , Malaria , Plague , Causative agents – Mode of Transmission – Clinical features – Prevention and control

UNIT III **10 hrs (10L+0P)**

Heavy metals and health hazards – Aluminium, Arsenic, Cadmium, Chromium, Lead, Mercury – Pesticides and health hazards – Sources for human beings – Prevention – Occupational Diseases – Beedi rolling and health

UNIT IV **8 hrs (8L+0P)**

Air pollutants and human health – Prevention of Air Pollution associated diseases – Noise pollution and human health - Global warming and human health – Health hazards due to use and throw plastics

UNIT V **8 hrs (8L+0P)**

Ideal Housing – Ventilation – Safe disposal of solid wastes and biomedical wastes – Cultural factors in health and disease – Use of Mobile phone and human health - Health education and communication.

References

1. K. Park, (1987) Preventive and Social medicine – M/s. BanarsBhanot publication publishers, Jabalpur, India
2. Krishnan Kannan (1997), Fundamentals of environmental pollution, S.Chand Company, India
3. Rangwala (1987) Fundamentals of water supply and sanitary engineering, Charotar Publishing House, Anand, India
4. Manol Tiwari et al., (2007). Environmental Studies, I.K. International Publishing House Pvt. Ltd
5. Daniel S. Blumenthal., (1985). Introduction to Environmental Health. Springer Publishing Company, New York
6. V.P. Desai. (1997). Way to Environment and our health. SonaliPingley Publishers, Mumbai.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**

CO1	H	H	M	L	H	L	M	L	L	M
CO2	L	H	M	M	H	L	M	L	L	M
CO3	L	H	M	M	H	L	M	L	L	M
CO4	L	H	M	M	H	L	M	L	L	M
CO5	L	H	M	M	H	L	M	L	L	M
CO6	M	H	M	M	H	L	M	L	L	M

L/M/H L – Low; M – Medium; H - High

Elective paper

3. ENVIRONMENTAL EDUCATION AND COMMUNICATION

Course code

L	T	P	C
3	**-**	**-**	**3**

Course Objectives

1. To understand the concept and significance of Environmental Education.
2. To understand the nature and scope of environmental education with regard to Indian policies.
3. To acquire knowledge of environmental issues and policies in India
4. To understand the curriculum and methods in environmental education
5. Demonstrate an understanding of critical and cultural approaches to environmental communication.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1:	Understand the concept and significance of Environmental Education	K1
CO2:	Associate the nature and scope of environmental education with regard to Indian policies.	K2
CO3:	Simulate critical thinking skills in relation to environmental affairs	K3
CO4:	Connect many disciplines and fields that intersect with environmental concerns.	K4
CO5:	Defend intrinsic values of ecological processes and communities.	K5
CO6:	Create and communicate science effectively, with appropriate use of scientific terminology.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **9Hrs (9L+0P)**

Introduction to Environmental Education: Meaning, definition, characteristics and scope of Environmental Education – Importance of and guiding principles of Environmental Education - incorporating E.E at various levels- Primary, Secondary and Higher Secondary levels. Education about environment: Factors of degradation of environment – adverse socio – economic impacts of degradation of environment.

UNIT-II **9Hrs (9L+0P)**

Environmental pollution and its consequences – Air pollution, water pollution, land pollution, nuclear pollution, Ozone depletions - Urbanization and its impacts on environment - Deforestation and its impacts on environment - Factors responsible for flora and fauna extinction – Measures to conserve flora and fauna – Ways of protecting, Management of Environment, Preserving and Restoring of environment.

UNIT III **9Hrs (9L+0P)**

Environmental movements in India: Silent Valley movement, Chipko movement, Narmada Bachao, Andolon, National Test Range at Baliupal, Orissa –conditions for achieving the goals of sustainable development – Strategies for sustainable development in India. International Efforts for Environmental Protection: The Stockholm conference 1972 – The Rio Summit 1992 – the Rio Declaration at the earth charter – Major achievement of the Rio Summit – Main features of the Rio Declaration – Kyoto conference and part on Global Warming 1997 – present developments.

UNIT IV **9Hrs (9L+0P)**

Environment research programme: Environmental Management – Data base Management for Environmental appraisal, Monitoring and warning system. Society, culture and environment: Meaning – Changes of Values, cultural values, aesthetic values, man and environment, the nature of scientific conclusions, the state of public knowledge of ecology, rights and responsibilities in ecology understanding.

UNIT V **9Hrs (9L+0P)**

Definition, Nature and Scope, Need of Environmental Communication - Public Participation in Environmental Decisions - Ecology and Society need of public Education through media. Relevance of eco-education and mass media - Rethinking of eco-education through media impact of Environment on Human development -

Human behaviour and Environmental Education through media - Sustainable development and New Communication media Environmental issues and local media.

References

1. Sharma, R. A. (2008). Environmental Education. Meerut: R.Lall Books Depot.
2. Sharma, B. L., &Maheswari, B. K. (2008). Education for Environmental and Human value. Meerut: R.Lall Books
3. Singh,YK (2009) Teaching of environmental science. New Delhi: APH Publishing Corporation.
4. Sharma, V. S. (2005). Environmental education. New Delhi: Anmol publication.
5. Reddy, P. K., & Reddy, N. D. (2001). Environmental Education. Hyderabad: Neelkamal publications.
6. Agarwal, S.P. and Aggarwal, J.C. (1996) Environmental Protection, Education and Development. New Delhi: New Concepts.
7. Mahesh Rangarajan, Editor, 2009. Environmental Issues in India: A reader. Pearson Education India
8. Kelu.P (2000) Environmental Education – A conceptual Analysis Calicut: Calicut University
9. Robert Cox and Phaedra C. Pezzullo (2016) Environmental Communication and the Public Sphere (4th ed.). Los Angeles: Sage Publications.
10. Anders Hansen and Robert Cox, (2015) The Routledge Handbook of Environment and Communication. London: Routledge.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	H	H	H	M	M	M	M	H
CO2	M	M	H	H	H	M	H	M	M	H
CO3	M	M	H	H	H	M	M	H	M	M
CO4	M	M	H	H	H	M	M	H	M	H
CO5	M	M	H	H	H	M	M	M	M	H
CO6	M	M	H	H	H	M	M	H	M	M

L/M/H L – Low; M – Medium; H - High

Supportive course (Mandatory)

ENVIRONMENTAL TOXICOLOGY

Course code:

L	T	P	C
3	-	-	3

Course objectives

- To impart the knowledge of principles and scope of toxicology.
- To gain the knowledge about the factors influence the toxicity

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Gain knowledge on various environmental toxicants, concepts of LC50, LD50 and ED50	K1
CO2	Understand the entry of toxicants, and behaviour of toxicants in the environment	K2
CO3	Apply the relationship of dose-response in toxicity	K3
CO4	Gain knowledge on the exposure routes of toxicants, toxicological test methods, and determination of toxic levels of contaminants	K4
CO5	Discuss the level of toxicity in various organs	K5
CO6	Practise the toxicity of substances in animal model in research aspects	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I: Basic concepts of Toxicology **10 hrs (10L+0P)**

Principles of Toxicology - Scope of Toxicology - Dose response relationship, concept of LC50, LD50 and ED50 - Types of toxic substances: Degradable and non-degradable - Acute and chronic toxicity – Synergism and Antagonism - Sigmoid relationships - Chemical and biological factors influencing toxicity

UNIT II: Toxicants in the Environment **8 hrs (8L+0P)**

Toxic substances in the environment, their sources and entry routes – exposure of toxicants by air, water, soil and diet. Bioaccumulation, biomagnifications and biotransformation of toxic materials in food chain.

UNIT III: Dose-Response Relationships **8 hrs (8L+0P)**

Graded response - Quantal response, Time action curves - Threshold limit value (TLV) - Margin of safety - Toxicity curves. Physiological and metabolic effects on flora and fauna.

UNIT IV: Toxicity Testing **6 hrs (6L+0P)**

Methods used to assess toxicity, Bioassay – types, characteristics, significance and Limitations. Bioassay methods using plant, animal and microbial models - Teratogenicity, carcinogenicity and mutagenicity

UNIT V: Organ toxicity **12 hrs (12L+0P)**

Hepatotoxicity: Common examples of hepatotoxicants, Nepherotoxicity: Common examples of nepherotoxicants, Pulmonary toxicity: Common examples of pulmonary toxicants, Neurotoxicity: Common examples of neurotoxicants.

References

1. Casseret LJ and Doull J (1982) Toxicology. The Basic Science of Poisons. Macmillan Publishers, New York.
2. Curtis D. Klaassen, John B. Watkins (2015) Casarett&Doull's Essentials of Toxicology, Third Edition, McGraw Hill Professional.
3. David Woolley, Adam Woolley (2008) A Guide to Practical Toxicology: Evaluation, Prediction, and Risk, Second Edition, CRC Press, USA.
4. Donald W. Sparling (2017) Basics of Ecotoxicology, CRC Press/Taylor & Francis Group, USA.
5. Kaiden Higgins (2017) Environmental Toxicology, Larsen and Keller Education, USA.
6. Shaw I and Chadwick J (1998) Principles of Environmental Toxicology, CRC Press, USA.
7. Stephen M. Roberts, Robert C. James, Phillip L. Williams (2015) Principles of Toxicology: Environmental and Industrial Applications, John Wiley & Sons, New Jersey, USA.
8. William Hughes (1996) Essentials of Environmental Toxicology, Taylor & Francis, USA.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	M	H	M	M	H	M	H	H	M	H

CO2	H	H	M	M	H	M	H	H	M	H
CO3	M	H	M	M	H	M	H	H	M	H
CO4	H	H	L	M	H	M	H	H	M	H
CO5	M	H	M	M	H	M	H	H	M	H
CO6	M	H	L	M	H	M	H	H	M	H

L/M/H L – Low; M – Medium; H - High

FIELD WORK

NINTH SEMESTER

Core 17: INSTRUMENTATION AND RESEARCH METHODOLOGY

Course Code:

L	T	P	C
4	-	4	4

Course Objective:

- Understand and Study about various Instrumentation methods and their working.
- To develop the knowledge about scientific research, formulating thesis and report writing

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Evaluate, Construct and execute a scientific project, write scientific reports, develop research and communication skills	K4 & K6
CO2	Learn principles and working of spectroscopic instruments	K1
CO3	Understand principles, working and applications microscopic and centrifuge techniques used in scientific research	K2
CO4	Create knowledge in extraction of various plant and other products using chromatographic and electrophoresis techniques	K6
CO5	Skill developed in the field of environmental instrumentation and analyses	K4
CO6	Application of knowledge in setting up and conducting experiments	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **12 hrs (9L+3P)**

Spectroscopy: Absorption Spectroscopy: Quantitative aspects, photometer and spectrophotometer designs. Molecular UV and UV absorption Spectroscopy, Photo acoustic spectroscopy. Molecular fluorescence, phosphorescence and chemiluminescence spectroscopy. Atomic spectroscopy, Raman spectroscopy and their applications, NMR - application to Proton and other isotopes, environmental

effects, ESR. X-ray spectroscopy, fluorescence, absorption, diffraction. Mass spectroscopy

UNIT II **12 hrs (9L+3P)**

Microscope: Microscopy- Bright field, Dark field, Phase contrast microscope, Confocal microscopy. Electron microscope: Scanning Electron microscope and Transmission Electron microscope, STM, AFM, HR-TEM.

Centrifuge techniques: Basic principles of sedimentation, the sedimentation coefficient. Types of centrifuges. Preparative and analytical ultra-centrifuge. Types of rotors. Clearing Factor.

UNIT III **12 hrs (6L+6P)**

Chromatography: Plate theory, qualitative and quantitative analysis, adsorption chromatography, partition chromatography, thin layer chromatography, Paper chromatography, column chromatography, Computerized system; Gas-liquid chromatography, Gas solid type, HPLC, Partition Chromatography, Ion-exchange chromatography, Size exclusion chromatography

Electrophoresis: General principles, supporting materials. AGE, SDS-PAGE, Isoelectrofocusing, Western, Southern and Northern blotting and PCR.

UNIT IV **10 hrs (7L+3P)**

Introduction to Research: Meaning of research; Types of research- Exploratory research, Conclusive research; The process of research, Scientific Research: Methods of scientific research-Preparation of review article-editing research paper-collection of literature-references-bibliography and thesis writing.

Unit V **12 hrs (9L+3P)**

Formulating the research hypothesis- Types of Research hypothesis; Writing a research proposal- Contents of a research proposal and types of research proposals.

Research Design: Meaning of Research Designs; Nature and Classification of Research Designs; Exploratory Research Designs: Secondary Resource analysis, Case study Method, Expert opinion survey, Focus group discussions; Descriptive Research Designs: Cross-sectional studies and Longitudinal studies; Experimental Designs, Errors affecting Research Design.

References

1. Chatwal, G. and Anand,S. 1989. Instrumentation Methods of Chemical Analysis. Himalays Publishing House, Delhi.
2. Robinson, J.W. (ed).1991, Practical Handbook of Spectroscopy CRC Press, Boston.

3. Webster, J.C. (ed). 2005. Bioinstrumentation. John Wiley & Sons Inc., Singapore.
4. Gurumani, N. 2006. Research methodology for Biological Sciences, MJP Publishers, Chennai.
5. Palanichamy, S. Shunmugavelu, M. 2006. Research methods in Biological Sciences. Sarojini for palani paramount Publication. Anna Nagar Palani.
6. Cannel. J.P. 1998. Natural Products Isolation, Humana Press New Jersey.
7. Harbone J. B. 2003. Phytochemical methods, (5th Edition) Chapman &Hall, London.
8. Keith Wilson, 2000. A practical guide to clinical biochemistry.
9. Willard Merrit Instrumental methods of analysis 7th Edition

MAJOR PRACTICAL – X

INSTRUMENTATION AND RESEARCH METHODOLOGY

L	T	P*	C
-	-	4	2

1. Preparation of research article
2. UV-Spectrophotometer
3. Thin Layer chromatography
4. Paper chromatography
5. Column chromatography
6. Principles and operation of microscope types with illustration
7. PAGE of protein extracted from plant leaf
8. Agarose gel electrophoresis of DNA sample isolated from plant
9. Research Communication and scientific documentation: structure of a scientific paper, thesis, dissertation, research article.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	M	L	H	H	L	H	M	M	H
CO2	H	H	H	H	H	L	H	M	M	H
CO3	M	M	M	M	H	M	H	M	M	H
CO4	H	H	H	H	H	M	H	M	M	H
CO5	H	H	H	H	H	H	H	M	M	H
CO6	H	H	H	H	H	H	H	M	M	H

L/M/H L – Low; M – Medium; H - High

CORE 18: REMOTE SENSING, GIS AND ENVIRONMENTAL MODELLING

Course code

L	T	P	C
4	-	4	4

Course Objectives

- The understand the working and application of remote sensing and GIS
- This course introduces the students to various computer-based and statistical methods used for study and management of natural resources and the environment.
- The students are expected to learn about remote-sensing techniques, physical principles, sampling, statistics and image-analysis methods.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	To learn how sensors collect spatial geographic data	K1
CO2	To generate geographical information by processing digital data by remote sensing and assess its environmental applications.	K2
CO3	To apply RS, GIS and GPS tools in various dimensions of the environment.	K3
CO4	Analysis mathematical and statistical concepts required for model development.	K4
CO5	Building a foundation for understanding Remote Sensing and Geographic Information System (RS-GIS) as a powerful tool for geospatial analysis.	K6

K1- Remember; K2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **8 hrs (5L+3P)**

Remote Sensing: definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation.

UNIT II **12 hrs (6L+6P)**

Geographical Information Systems: definitions and components; spatial and non-spatial data raster and vector data; database generation; database management system;

land use/ land cover mapping; overview of GIS software packages; GPS survey, data import, processing, and mapping.

UNIT III **8 hrs (5L+3P)**

Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies.

UNIT IV **8 hrs (5L+3P)**

Environmental modelling: Scope and definition - Basics of Model Formulation - Basic Mathematical Formulation - Modelling approaches– deterministic, stochastic and the physical approach- Applications of environmental models- the model building process.

UNIT V **12 Hrs (6L+6P)**

Mathematical Modelling: General theory of mathematical modelling. Integration of basic processes (evaporation, snow-melt, runoff, soil water dynamics, groundwater flow) in mathematical models. Model calibration, parameter optimisation, validation. Water quality modelling- surface water quality modelling and Ground water quality modelling, air quality modelling (the box model, the Gaussian plume model point sources, line sources, area sources- Gaussian puff model).

References

1. Lillesand, TM, Kiefer RW and J.W.Chipman. "Remote Sensing and Image Interpretation" 5th Edition, John Willey and Sons Asia Pvt. Ltd., New Delhi, 2004.
2. Anji Reddy, M. "Textbook of Remote Sensing and Geographical Information System" 2nd edition. BS Publications, Hyderabad, 2001.
3. Lo. C.P.andA.K.W.Yeung, "Concepts and Techniques of Geographic Information Systems",Prentice Hall of India Pvt. Ltd., New Delhi, 2002
4. Peter A.Burrough, Rachael A. McDonnell, "Principles of GIS", Oxford University Press, 2000.
5. Ian Heywood "An Introduction to GIS", Pearson Education Asia, 2000

Major Practical – XI

Remote sensing, GIS and Environmental Modelling

L	T	P*	C
-	-	4	2

1. Remote sensing imageries – processing

2. Geometric rectification

3. Classification of remote sensing data

4. Remote sensing application – wetland identification

5. Mapping stream s and river habitats

6. River basin inventory using ground data and remote sensing data

7. Vegetation analysis - past and present

8. Forest type analysis using remote sensing.

9. False image analysis

10. Disaster images and analysis.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	M	H	M	H	L	M	H	M	H
CO2	H	M	H	M	H	L	M	H	M	H
CO3	H	M	H	M	H	L	M	H	M	H
CO4	H	M	H	M	H	L	M	H	M	H
CO5	H	M	H	M	H	L	M	H	M	H

L/M/H L – Low; M – Medium; H - High

CORE 19: ENVIRONMENTAL GEOSCIENCES

Course code:

L	**T**	**P**	**C**
4	**-**	**-**	**4**

Course Objective:

- Understand the origin of earth, rock and soil characters
- Understand the climates of India, weathering
- Study about geological process, and natural hazards

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Have a basic understanding on the Earth formation and its structural components.	K1
CO2	Identify and classify common rocks and minerals	K3

CO3	Understanding the Earth system of interacting rock, water, air and life and how these elements have shaped Earth's surface	K2
CO4	Have the skill to identify the geologic features of the earth and use them to understand the geologic history of a region.	K2
CO5	Understand the climatic patterns and weathering reactions in India	K1
CO6	Make Prediction of natural hazards like earth quakes, tsunami and volcanic eruptions and mitigation of their impacts.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **10 hrs (10L+0P)**

Origin of earth - Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere. Concept of minerals and rocks. Formation of igneous and metamorphic rocks. Controls on formation of landforms - tectonic including plate tectonic and climatic. Concept of steady state and equilibrium, Energy budget of the earth. Earth's thermal environment and seasons. Coriolis force, pressure gradient force, frictional force, geo-strophic wind field, gradient wind.

UNIT II **10 hrs (10L+0P)**

Climates of India, western disturbances, Indian monsoon, droughts, El Nino, La Nina. Concept of residence time and rates of natural cycles. Geophysical fields.

Weathering including weathering reactions, erosion, transportation and deposition of sediments. Soil forming minerals and process of soil formation, Identification and characterization of clay minerals, Soil physical and chemical properties, soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls.

UNIT III **8 hrs (8L+0P)**

Geochemical classification of elements, abundance of elements in bulk earth, crust, hydrosphere and biosphere. Partitioning of elements during surficial geologic processes, Geochemical recycling of elements. Paleoclimate.

UNIT IV **10 hrs (10L+0P)**

Distribution of water in earth, hydrology and hydrogeology, major basins and groundwater provinces of India, Darcy's law and its validity, groundwater fluctuations, hydraulic conductivity, groundwater tracers, land subsidence, effects of excessive use of groundwater, groundwater quality. Pollution of groundwater resources, Ghyben-Herzberg relation between fresh-saline water.

Natural resource exploration and exploitation and related environmental concerns. Historical perspective and conservation of non-renewable resources.

UNIT V **6 hrs (6L+0P)**

Natural Hazards: Catastrophic geological hazards - floods, landslides, earthquakes, volcanism, avalanche, tsunami and cloud bursts. Prediction of hazards and mitigation of their impacts.

References

1. Engineering and General Geology by Parbin Singh, Eight Edition, S K Kataria& Sons
2. A. Text book of Geology by Mahapatra, CBS Publishers
3. Fundamentals of Historical Geology and Stratigraphy of India by Ravindra Kumar, New Age International
4. Engineering Geology by Duggal, S.K, Pandey, H.K and Rawal, N, McGraw Hill Education, 2014
5. Oliver. H. Heintzelman, Richard, M. Highsmith, J.R. 1965,1971 'World Regional Geography' Printice Hall of India (P)ltd., NewDelhi
6. Cole, J. 1996 'A geography of the world's major regions', Rout ledge, London
7. De Blij H.J. 1994, Geography regions & concept-John Wiley-Newyork
8. Gourou P. 1980 ' TheTrophical World' Longman, London.

Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	M	M	H	H	M	M	L	L	L
CO2	H	M	L	H	H	M	M	L	L	L
CO3	H	L	L	H	H	H	M	L	L	L
CO4	H	M	M	H	H	H	M	M	M	H
CO5	H	L	L	H	H	M	M	M	M	H
CO6	H	L	L	M	M	M	M	M	M	H

L/M/H L – Low; M – Medium; H - High

CORE 20: HAZARDOUS WASTE AND SOLID WASTE RECYCLING TECHNIQUES

Course code:

L	**T**	**P**	**C**
4	**-**	**-**	**4**

Course Objective:

- Study about solid waste, Industrial waste, marine waste and biological Processing waste recovery studies.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Analysis the characters, impacts, treatment and disposal methods of hazardous waste	K3
CO2	Evaluate the management of solid and liquid wastes from municipal and industrial sources. .	K5
CO3	Apply the principles of remedial measures of recycling, reuse and recovery from the wastes.	K3
CO4	Understand and describe the principle and mechanistic role of microbes in the degradation of various pollutants.	K2
CO5	Formulate the integrated waste management	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **8 hrs (8L+0P)**

Hazardous waste – Types, characteristics and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal.

UNIT II **8 hrs (8L+0P)**

Solid Waste - types and sources. Solid waste characteristics, generation rates, solid waste components, proximate and ultimate analyses of solid wastes. Solid waste collection and transportation: container systems - hauled and stationary, layout of collection routes, transfer stations and transportation.

UNIT III **12 hrs (12L+0P)**

Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste.

UNIT IV **12 hrs (12L+0P)**

Integrated waste management: Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management:

Life cycle assessment: Cradle to grave approach; lifecycle inventory of solid waste; role of LCA in waste management; advantage and limitation of LCA; case study on LCA of a product.

UNIT V **9 hrs (9L+0P)**

E-waste: classification, methods of handling and disposal .Fly ash: sources, composition and utilisation. Plastic waste: sources, consequences and management.

References

1. Asnani, P. U. 2006. Solid waste management. India Infrastructure Report 570.
2. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley & Sons.
3. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press.
4. McDougall, F. R., White, P. R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons.
5. EPA. 1999. Guide for Industrial Waste Management. Washington D.C.
6. White, P.R., Franke, M. &Hindle P. 1995. Integrated Solid waste Management: A Lifecycle Inventory. Blackie Academic & Professionals.
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Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	M	H	H	H	H	M	H	H	H	H
CO2	M	H	H	H	H	M	H	H	H	H
CO3	M	H	H	H	H	H	H	M	H	H
CO4	M	H	H	H	H	H	H	M	H	H
CO5	M	H	H	H	H	M	H	H	H	H

L/M/H L – Low; M – Medium; H – High

ELECTIVE PAPER

Elective paper 1

VERMI AND MUSHROOM CULTURE

L	**T**	**P***	**C**
3	**-**	**-**	**3**

Objective:

This course will give an idea about the application of biological science, particularly plant science in business generations and self employment. This focuses on the Vermicompost and Mushroom cultivation, its marketing and also in Agriculture depended economy and its impact on society.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Have a basic understanding on the vermi composting	K1
CO2	Identify and classify common earthworms	K2
CO3	Understanding the vermi techniques	K2
CO4	Have the skill to identify the mushrooms	K2
CO5	Understand the climatic patterns and weathering conditions for mushroom cultivation	K1
CO6	Create techniques regarding the mushroom cultivation	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Unit I **8 hrs (8L+0P)**

Vermi composting - Definition, introduction and scope: Ecological classification: Humus feeders, Humus formers leaf, mold, top soil and sub soil types. Physical, chemical and biological changes brought by earthworm in soil-burrows- drilosphere - earthworm casts.

Unit II **8 hrs (8L+0P)**

Optimal conditions for vermiculture-temperature, moisture, pH, soil type, organic matter, protection from sunlight, rain, predators-food preference. Basic components for vermi culture-culture practices- Home- School-Industries-Vermi wash.

Unit III **6 hrs (6L+0P)**

Composting- vermi composting-Required conditions-Requirements-Methods-Hep-Pot-Tray-changes during Vermi compost-Advantages-Cost-Benefit analysis of vermi composting-Role of Earthworms in soil fertility–Use of Vermicompost for crop production –Use of earthworms in land improvement and land reclamation, Economics of Vermicompost and vermiwash production.

Unit IV **8 hrs (8L+0P)**

Introduction and Importance of mushrooms; History of mushrooms cultivation; resent status of mushroom industry in India cultivable edible mushrooms; Biology of mushrooms: food value of edible mushrooms; uses of mushrooms; Poisonous mushrooms and Medicinal mushrooms.

Unit V **8 hrs (8L+0P)**

Mushrooms farm structure; design and layout; Spawn principles and techniques of spawn production; Principle and techniques of compost and composting; Cultivation techniques of white button mushroom, oyster mushroom; Management of fungal bacterial and viral diseases in mushroom; Competitors, pests and nematodes in mushrooms; Post harvesting techniques and Economics of mushroom cultivation.

References

1. Sultan Ahmed Ismail, 2005, The Earthworm Book, second revised Edition, Mother India Press, Goa.
2. Edwards C.A. and Bohlen, P.J 1996, Ecology of earthworms – 3rd Edition, Chapman and Hall.
3. Jsmail, S.A., 1970, Vermicology, The Biology of earth worms, Orient Longman, London.
4. Lee, K.E., 1985. Earthworms – Their ecology and relationship with soil and land use, Academic Press, Sydney

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	L	L	L	L	L	L	L	L	L	M
CO2	L	L	L	L	L	L	L	L	L	M
CO3	L	L	L	L	L	L	L	L	L	M
CO4	L	L	M	L	M	L	L	L	M	H
CO5	L	L	L	L	M	L	L	L	M	H
CO6	L	L	L	L	M	L	L	L	M	H

L/M/H L – Low; M – Medium; H - High

Elective paper 2

ENVIRONMENTAL CHEMISTRY

L	T	P	C
3	-	-	3

Course Objectives:

The main objectives of this course are to:

1. Impart knowledge on the fundamentals of chemical process
2. Understand the environmental problems
3. Study for solving various environmental issues

Course outcomes

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

	Course outcomes	Cognitive level
1	Have a basic understanding on the fundamental concepts of chemistry - atoms, bonding a chemical molecules	K2
2	Understand the sources, classification and formation of chemical pollutants and their impact on environment	K2
3	Have detailed knowledge on various physico-chemical parameters, chemical reactions and removal/reduction of air, soil and water pollutants from the environment	K2
4	Have the skill to design a field research on environmental problems for sustainable maintenance of the functional ecosystem	K3
K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create		

UNIT – I **6 hrs (6L+0P)**

Stochiometry, Gibb's energy, Chemical potential, Chemical equilibria, acid-base reactions. Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, Radio nuclides.

UNIT – II **6 hrs (6L+0P)**

Atomic structure, electronic configuration, types of chemical bonds, mole, molarity and normality – concepts of pH and pE – Electrochemistry, Nernst equation

UNIT – III **8 hrs (8L+0P)**

Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter – principles of photochemistry – fluorescence – phosphorescence - Thermochemical and photochemical reactions in the atmosphere.

Unit IV **8 hrs (8L+0P)**

First law of thermodynamics, enthalphy, adiabatic transformations, second law of thermodynamics, Carnot's cycle, entropy, Gibb's free energy, chemical potential, phase equilibria, Gibb's Donnan equilibrium, third law of thermodynamics, enzymes catalysis, Michaelis/ Menten equation – exo and endothermic reactions – spontaneous and non spontaneous reactions

UNIT – V **8 hrs (8L+0P)**

Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical Smog, Chemistry of water, concept of D.O., B.O.D., and C.O.D, wastewater treatment - redox potential – Organic compounds -hydrocarbons, functional groups, nucleophiles and electrophiles. Surface and interface chemistry - Adsorption, absorption, catalysis, colloids, surfactants, examples, types of adsorption, desorption. Synthetic Polymers: biological decomposition, polymer decay, ecological consideration - Inorganic and organic components of soil, nitrogen pathways and NPK in soils.

References

1. Fundamental Concepts of Environmental Chemistry, Sodhi, G.S. (2009), Alpha Science International Ltd.
2. Environmental Chemistry, (5th Ed.), De, A. K. (2002), New Age International (P) Ltd.
3. Fundamentals of Environmental Chemistry, 3rd Edition, Manahan, E. S. (2011). CRC Press.
4. Photochemistry &Spectroscopy, Simons, J. P. (1971), Wiley Interscience.
5. Fundamentals of Photochemistry, Rohatgi-Mukherjee, K. K. (2006), New Age International (P) Ltd.
6. Elements of Environmental Chemistry, Jadhav, H. V. (1992), Himalya Publication House.
7. Environmental Chemistry, Sharma, B. K. and H. Kaur, H. (1994), Goel Publishing House
8. Environmental Chemistry, Moore, J. W. and Moore, E. A. (1976), Academic Press Inc.
9. Environmental Chemistry A global perspective, (4th Ed.), Van Loon, G. W. and Duffy, S. J. (2017), Oxford University Press.

10. Chemistry of Atmospheres: An Introduction to the Chemistry of the Atmospheres of Earth, the Planets, and their Satellites (3rd Ed.), Wayne, R. P., (2000), Oxford University Press.
11. Basic Concepts of Environmental Chemistry (2nd edition), Connell, D.W. (2005), CRC Press.
12. Textbook of Environmental Chemistry, Pani, B. (2007), IK International Publishing House.
13. Elements of Environmental Chemistry (2nd edition), Hites, R.A. (2012), Wiley & Sons.
14. Standard Methods for the Examination of Water and Waste Water, (23rdEd.), APHA, (2005), Washington, D.C.
15. Fundamentals of Soil Science, (8th Ed.), Futh, H. D. (2016), Wiley India.
16. Lehninger Principles of Biochemistry, (7th Ed.), Nelson, D. L. and Cox, M.M. (2017).W.H. Freeman & Co.

Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M	H	H	M	H	H	M	M	M	H
CO2	M	H	H	M	H	H	H	H	M	M
CO3	M	H	H	M	H	H	H	H	M	M
CO4	M	H	H	M	H	H	H	H	M	M

H-High; M-Medium; L-Low

Elective paper

3. NON-CONVENTIONAL ENERGY TECHNOLOGY

Course code:

L	T	P*	C
3	-	-	3

Course Objectives:

- To understand Measurement of Energy, Feed stock materials- Reactors, Solar energy conversion technologies and Distribution of geothermal resources were studied.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level

		(K1 to K6)
CO1	Understand the need of energy conversion and the various methods of energy storage	K1
CO2	Estimate the renewable energy, Utilization of it, Principles involved in green energy collection and conversion of it to electricity generation.	K2
CO3	Apply the concepts involved in wind energy conversion system by studying its components, types and performance.	K3
CO4	Illustrate ocean energy and explain the operational methods of their utilization.	K4
CO5	Estimate the Geothermal &Tidal energy, its mechanism of production and its applications.	K5
CO6	Integrate the concepts of Direct Energy Conversion systems & their applications.	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT- I **6Hrs (6L+0P)**

Introduction- Energy- Measurement of Energy- Energy resources- Types of renewable and non- renewable energy resources- Advantages of Renewable energy resources- Resources available in India- World Energy Demand.

UNIT-II **9Hrs (9L+0P)**

Biofuels- Classes of Biofuels- Biomass energy- Sources of Biomass for fuel conversion- Advantages and Disadvantages of biomass as a source of energy – Biochemical- Thermo chemical Conversion-Bioethanol production- Bioethanol Vs Petrol- Outlook of bioethanol fuel Market worldwide- Biodiesel production- Global Scenario- Conversion Technologies.

UNIT-III **6Hrs (6L+0P)**

Biogas production- Feed stock materials- Reactors- Mechanism of methane formation- Factors affecting methane formation- Biogas production from alternate feed stocks- Biohydrogen production- Methods- Hydrogenase enzyme- Invitro production of hydrogen- Hydrogen Fuel Cells- Mechanism- Application.

UNIT-IV **9Hrs (9L+0P)**

Solar energy conversion technologies- Solar photovoltaic conversion- Application and costs of solar energy technology- Solar collector modeling- Solar collector related studies- Applications of photovoltaic electricity- Solar air and water heaters- Solar drying- Wind energy conversion technology- Wind energy planning- Ocean thermal energy- wave/ current energy- Wind powered electricity generation with and without grid interconnection.

UNIT- V **6Hrs (6L+0P)**

Geothermal energy- Energy storage- Distribution of geothermal resources- Geothermal exploration- Geothermal utilization- Comparison of geothermal energy with other energy sources - Nuclear/ thermonuclear reactors- Environmental considerations- Energy economics- Energy education

References

1. Velusamy M.A, Thangaraj K, Baskar. K, Shubra Singh. 2016. Sustainable Power for Future-Renewable Energy. University Science Press
2. Sharma. M.R. Science, Technology and Society. 2009. University Science Press.
3. David M. Mousdale., Biofuels Biotechnology, Chemistry and sustainable development. CRC Press
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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	H	M	L	M	H	H	M	H	M
CO2	H	H	M	M	L	M	H	M	H	M
CO3	H	H	L	L	M	M	H	M	H	M
CO4	H	H	M	H	H	L	H	M	H	M
CO5	M	M	L	H	H	M	H	M	H	M
CO6	H	H	M	L	M	H	H	M	H	M

L/M/H L – Low; M – Medium; H – High

Supportive Course: MOOCs/SWAYAM/NPTEL

MINI PROJECT

TENTH SEMESTER

CORE 21: POLLUTION CONTROL ENGINEERING AND BIOREMEDIATION

Course code:

L	T	P	C
4	-	3	4

Course Objective

- Study about pollution control and oxidation process.
- Understand the filtration process.
- Understand the bioremediation of metal compounds and their characters.
- Study about phytoremediation.
- Study about application of GEMS in bioremediation

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Have a full-fledged knowledge on the principles and mechanism of pollution control techniques and the engineering principles behind.	K1
CO2	Understand and describe the type of microorganisms in the environment and the role of microorganisms in the cycling of nutrients in an ecosystem.	K2
CO3	Apply the concept of bioremediation, Nanotechnology for bioremediation	K3
CO4	Explain the importance of plants and microbes in environmental remediation	K4
CO5	Know the ethical guidelines in use of GMOs, and different biosafety levels	K5
CO6	Study the principle and working of various bioreactors	K6

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **8 hrs (8L+0P)**

Characteristics of major industrial effluents – primary – secondary and tertiary treatment of effluents - Ion exchange – reverse osmosis – electrodialysis – colour

removal from industrial effluents – Sludge treatment and disposal – Modelling of activated sludge process

UNIT II **12 hrs (12L+0P)**

Working principles of the following reactors - Rotating Biological Contactors, Fluidized Bed Reactor, Expanded Bed Reactor, Contact Digesters, Packed Column Reactors, UASB Reactor – Microbial removal of nitrogen and phosphorus – Nutrient removal through biomass production - Hazardous waste management – Hospital waste management – Air pollution control in industries.

UNIT III **10 hrs (8L+0P)**

Metal-microbes interactions – Microbial immobilization and transformation of metals – Genetic aspects of heavy metal resistance– Pesticide biodegradation – Biotechnological applications for pesticide waste disposal – Oil degradation by microbes – Aquatic macrophytes for waste water treatment – Biotechnology in soil pollution abatement.

UNIT IV **10 hrs (10L+0P)**

Effluent irrigation in agriculture –Microalgal species for aquaculture – Mass cultivation techniques – Closed and Semi Outdoor Culture Systems – Harvesting and Drying of Algal Biomass – Bioagumentation for commercial production of algae, phytoremediation, Bioremediation through nanotechnology – Magnetotactic bacteria.

UNIT V **10 hrs (10L+0P)**

Genetic concept in pollution management – Transgenic microbes for treating toxic chemicals – Environmental effects of biotechnology – Gene transfer in the environment – GEMS and biosafety – Ethics of microbial biotechnology

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Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	H	H	H	H	H	M	H	H	H	H
CO2	H	H	H	H	H	M	H	H	H	H
CO3	H	H	H	H	H	M	H	H	H	H
CO4	H	H	H	H	H	M	H	H	H	H
CO5	H	H	H	H	H	M	H	H	H	H
CO6	H	H	H	H	H	M	H	H	H	H

L/M/H L – Low; M – Medium; H - High

Core 22 – e-PATHASHALA

ANALYTICAL CHEMISTRY (E-Pathshala)

L	T	P	C
4	-	-	4

Objective:

- Understand the Volumetric analysis compounds and their characters. Study about Instrumentation methods.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	Cognitive level (K1 to K6
CO1	Learn the basic about solution preparation and error analysis	K1
CO2	Understand the principles of analytical techniques	K2
CO3	Apply the principles and working of chromatographic techniques	K3

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

Unit I **9Hrs (9L+0P)**

General analytical - Errors in analysis in laboratory safety- Volumetric analysis – Acid base titrations- Complexometric titrations- Redox titrations.

Unit II **9Hrs (9L+0P)**

Precipitation argentometric titration - Gravimetric analysis - Mass spectrometry - Bomb calorimetry - Potentiometry - Ph. electrode, Membrane electrode, Biochemical electrode: ISFET, MOSFET.

Unit III **9Hrs (9L+0P)**

Conductivity meter and salinity meter - DO meter – Polarography - Anode and cathode stripping voltammetry - Cyclic voltammetry - General chromatography, distribution coefficient and its implications.

Unit IV **9Hrs (9L+0P)**

Chromatographic methods – (paper, TLC and Column chromatography) - High performance thin layer chromatography (HPTLC) - Gas chromatography (GSC/ GLC) technique and sample preparations.

Unit V **9Hrs (9L+0P)**

Gas chromatography, Mass spectroscopy - High pressure liquid chromatography - Ion exchange chromatography - Ion molecular exclusion chromatography - Capillary electrophoresis.

References

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Mapping of COs to POs and PSOs

	Correlation level with POs					Correlation level with PSOs				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	H	M	M	L	H	L	M	H	M	M
CO2	H	M	M	L	H	L	M	H	M	M

CO3	H	M	M	L	H	L	M	H	M	M

CORE 23: ENVIRONMENTAL ASSESSMENT, MANAGEMENT AND LEGISLATION

Course code:

L	T	P	C
4	-	-	4

Objectives of the course

- Provide comprehensive knowledge in EIA, Environmental Audit and laws.
- Increase understanding on key issues related to National as well as International Environmental Law and Policies.
- Develop practical skills to facilitate effective engagement with the Environmental Law.
- Prepare the students to be well-informed in Environmental Law so as to create awareness.

Course Outcomes (COs)

After completing the course the student will be able to:

	Course Outcomes	**Cognitive level (K1 to K6**
CO1	Explain the concepts about Environmental Impact Assessment, develop skills in identifying and solving problems	K4
CO2	Be able to access and analyse different case studies/examples of EIA in practice for evaluation/assessment	K5
CO3	Understand the basic laws, act, public policies, treaty related to environment.	K2
CO4	Create knowledge on study about importance of environmental audit and EIA notifications for ISO standards	K6
CO5	Apply various methods to Predict the Environmental impacts of project after deciding various environmental attributes	K3
CO6	Able to know the power and functions of government agencies for pollution control.	K1

K 1- Remember; K 2- Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

UNIT I **12 hrs (12L+0P)**

Introduction to EIA and Risk Assessment: Aims and objectives of Environmental Impact Assessment (EIA). Environmental Impact Statement (EIS) and Environmental Management Plan (EMP). EIA Guidelines. Impact Assessment Methodologies. Procedure for reviewing EIA of developmental projects. Life-cycle analysis, cost-benefit analysis. Risk Assessment - Hazard identification, Hazard accounting, Scenarios of exposure, Risk characterization and Risk management.

UNIT II **8 hrs (8L+0P)**

Environmental Audit: Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit. Environmental Management System Standards (ISO14000 series). EIA Notification, 2006 and amendments from time to time. Eco-labeling schemes.

UNIT III **12 hrs (12L+0P)**

Environmental legislations: Overview of Environmental Laws in India: Constitutional provisions in India (Article 48A and 51A). Wildlife Protection Act, 1972 amendments 1991, Forest Conservation Act, 1980, Indian Forest Act, Revised 1982, Biological Diversity Act, 2002, Water (Prevention and Control of Pollution) Act, 1974 amended 1988 and Rules 1975, Air (Prevention and Control of Pollution) Act, 1981 amended 1987 and Rules 1982, Environmental (Protection) Act, 1986 and Rules 1986, Motor Vehicle Act, 1988.

UNIT IV **12 hrs (12L+0P)**

Environmental legislations: The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Batteries (Management and Handling) Rules, 2010 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991, Noise Pollution (Regulation and Control) Rules, 2000, Coastal Regulation Zones (CRZ) 1991 amended from time to time. National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

UNIT V **12 hrs (12L+0P)**

Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at

Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.

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Mapping of COs to POs and PSOs

	Correlation level with POs					**Correlation level with PSOs**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	M	M	L	H	H	L	M	L	L	H
CO2	M	M	L	H	H	M	M	M	L	H
CO3	M	M	L	H	H	L	M	M	L	H
CO4	M	M	L	H	H	M	M	H	L	H
CO5	M	M	L	H	H	L	M	M	L	H
CO6	M	M	L	H	H	L	M	H	L	H

L/M/H L – Low; M – Medium; H – High

INDUSTRIAL INTERNSHIP

PROJECT AND VIVA-VOCE