PERIYAR UNIVERSITY

Salem - 636 011

(Reaccredited with 'A^{++}' Grade by the NAAC)

DEPARTMENT OF ENVIRONMENTAL SCIENCE

M.Sc. ENVIRONMENTAL SCIENCE

[Choice Based Credit System (CBCS)]

OBE SYLLABUS

(Effective from the academic year 2022-2023 and thereafter)

M. Sc. ENVIRONMENTAL SCIENCE

OBE REGULATIONS AND SYLLABUS

(*with effect from the academic year 2022-2023 onwards*)

1. Preamble

Growing populations and high standards of living put increasing pressure on our environment. Since the beginning of industrialization and urbanization, we have been facing with an increasing number of environmental challenges such as air, water and soil contamination, energy crisis, land degradation, deforestation, loss of biodiversity and climate change etc., Considering the above issues, addressing environmental problems from a scientific perspective is the utmost important for today's world. Hence, there is a need to develop the next generation as skilled professionals in a multidisciplinary Environmental Science degree programme to solve the global environmental issues.

2. General Graduate Attributes

1. ***Environmental Knowledge***

   Apply the basic knowledge of environmental components and their interactions and to conceptualize the domains towards environmental protection and to visualize the environmental management perspectives.

2. ***Critical Thinking Skills***

   To critically analyze and evaluate the environment related issues and their sustainable management.

3. ***Research Skills***

   To improve the research-oriented skills by involving the basic, applied and field-based research works.

4. ***Problem Solving Skills***

   To identify, analyze and assess the complex environmental issues and apply the knowledge to resolve the issues.

5. ***Environmental Management***

   To improve, undertake and manage environment related works and develop a leadership quality and capacity to manage a team for carrying out assigned tasks.

6. ***Technical Skills***

   To acquire and equip with technical knowledge on critical environmental problems and devise technical strategies for the betterment of the environment.

7. ***Use of Modern Tools***

   To acquire the knowledge and working experience on modern tools in terms of instrumentation, softwares and research methods which can be used to assess the environmental quality.

8. Project Management

To manage and coordinate specific environmental tasks or projects and apply specific principles and methodologies to carry out research projects.

9. Societal and Environmental Concern

To have appealing concern over the environment and its well-being, need to apply the acquired knowledge and skills for the societal upliftment.

10. Individual and Team Work

To develop the skills pertaining to work individually as well as a team in a proposed project work in order to manage the task.

11. Innovation and Entrepreneurship

To apply the acquired skills and knowledge in the field of Environmental Science to initiate small scale start-ups and upscale the process towards entrepreneurship.

3. Programme Specific Qualification Attributes

- **Knowledge and understanding level (K1 and K2)**

  Students will be able to understand the basic components of ecology and environment, chemistry of pollutants and their toxic effects, biodiversity and natural resources and their process for sustainable development.

- **Application level (K3)**

  Students will be capable of applying microbes, plants and animals for potential environmental cleanup and green energy production, and to generate value-added products through waste recycling.

- **Analytical level (K4)**

  Students will be able to analyze the environmental quality parameters and to address the issues of different environmental compartments.

- **Evaluation capability level (K5)**

  Students can acquire the capability of evaluating the responsible factors for environmental related issues and be able to apply the acquired knowledge in providing solutions.

- **Scientific or synthesis level (K6)**

  Students will be able to synthesize or develop new processes, products and to formulate new scientific tools related to sustainable environmental management.

4. Vision

Create and maintain excellence in Environmental Science and contribute knowledge and effort in bringing up rich posterity in environmental sustainability.

5. Programme Objectives and Outcomes

Programme Educational Objectives (PEOs)

Post graduates of M.Sc. Environmental Science program will be

PEO1	Utilizing domain knowledge to understand the environment and to provide solutions for the development of society.
PEO2	Applying research and acquired skills with a rich set of communication and leadership skills to sustain in the environment.
PEO3	Expressing constant development in their specialized career through life-long learning, appreciating human values and ethics.

Programme Outcomes (PO)

After successful completion of the two years M.Sc. Environmental Science Programme, the students are expected to have

PO1	Deep knowledge in natural resources, ecosystem and their biogeochemical processes, biodiversity, Geographic Information Systems (GIS) and their importance, various elements of climate change and environmental clearance procedures.
PO2	Good understating in toxicological properties of environmental pollutants and their impact on environment, occupational diseases, nanomaterials and their toxicity.
PO3	Capability in applying microbes, plants and animals for potential environmental cleanup and energy production, and to generate value added products through waste recycling and other sustainable environmental management practices.
PO4	Acquire more knowledge and proficiency in Environmental Impact Assessment, auditing, pollution monitoring and management.
PO5	Skills in methods used for EIA studies, remote sensing and GIS to monitor the environmental issues and critically analyzing the global climate change.
PO6	Expertise to become as environmental consultant/manager at local, regional and national level industry/institution/organizations.
PO7	Capability to become an entrepreneur in the field of EIA, GIS, waste management and waste recycling, natural product, environmental safety trainer.
PO8	Qualification to be employed as a researcher / scientist / faculty in the Colleges / Universities / Government sectors / Industries / Research and Development organizations.

6. Candidate's eligibility for admission

Candidates who have passed the B.Sc. Degree in Environmental Science / Life Sciences / Botany / Agricultural and allied Sciences/ Zoology / Microbiology / Biotechnology / Biochemistry / Chemistry / Physics / Bioinformatics / Home Science / Food Science & Nutrition of this University or an Examination of any other University accepted by the Syndicate as equivalent thereto shall be eligible for admission to M.Sc. Degree Course in Environmental Science.

7. Duration of the programme

The duration of the M.Sc. Environmental Science shall be over a period of Two Years from the commencement of the course.

8. CBCS- Structure of the Programme

The programme structure comprises of two parts.

Course Component	No. of Courses	Hours of Learning	Marks	Credits
Part A (Credit Courses)				
Core Courses	12	864 Hours	1200	48
Elective Courses	4	288 Hours	400	16
Supportive Courses	1	72 Horus	100	4
Practical	3	324 Hours	300	9
Research Project & Industrial Visit	1	360 Hours	150	10
Internship	1	120 Horus	100	2
Human Rights	1	36 Horus	100	2
MOOC/SWAYAM Courses	1		100	2
Research Seminar	1	18 Hours	50	1
Total			**2500**	**94**
Part B (Non-Credit Courses)				
Value Added /Add-on Courses	2	60 Hours	200	-
Industry Oriented Courses	2	60 Horus	200	-

9. Curriculum structure for each semester as per courses alignment

Main syllabus (Attached as Annexure I)

10. Credit Calculation

Method of teaching	Hours	Credits
Lecture	1	1
Tutorial/Demonstration	1	1
Practical/Internship/Self-Learning	2	1

CBCS – Scheme of Examinations (Semester-wise structure)

S. No.	Paper type	Paper Code	Title of the Paper	Contact Hours/Week	Credit	Internal Marks	External Marks	Total Marks
SEMESTER - I								
1	Core - I	22UPEVS1C01	Ecology and Biodiversity Conservation	4	4	25	75	100
2	Core – II	22UPEVS1C02	Environmental Chemistry	4	4	25	75	100
3	Core - III	22UPEVS1C03	Waste Management	4	4	25	75	100
4	Core - IV	22UPEVS1C04	Environmental Biochemistry and Toxicology	4	4	25	75	100
5	Elective - I	22UPEVS1E01- 12	Elective Paper I	4	4	25	75	100
6	Practical-I	22UPEVS1P01	Practical Paper I	6	3	40	60	100
			Field Studies/Library/Seminar	1 + 2 +1	-	-	-	-
			Sub Total	**30**	**23**	**165**	**435**	**600**
SEMESTER - II								
7	Core - V	22UPEVS1C05	Environmental Pollution and Control Strategies	4	4	25	75	100
8	Core - VI	22UPEVS1C06	Environmental Microbiology	4	4	25	75	100
9	Core - VII	22UPEVS1C07	Climate Change and Current Issues	4	4	25	75	100
10	Elective-II	22UPEVS1E01-12	Elective Paper II	4	4	25	75	100
11	Supportive	22UPEVS1S01-05	Supportive Paper	4	4	25	75	100
12	Practical-II	22UPEVS1P02	Practical Paper II	6	3	40	60	100
13	HR	22UPEVS1HR1	Human Rights	2	2	25	75	100
	MOOC		Online Courses (SWAYAM/MOOC)	-	2	-	100	100
			Library / Seminar	1 + 1				
			Sub Total	**30**	**27**	**190**	**610**	**800**

SEMESTER – III								
14	Core - VIII	22UPEVS1C08	Environmental Biotechnology	4	4	25	75	100
15	Core - IX	22UPEVS1C09	Environmental Impact Assessment	4	4	25	75	100
16	Core - X	22UPEVS1C10	Environmental Geoinformatics	4	4	25	75	100
17	Core - XI	22UPEVS1C11	Research Methodology and Instrumentation	4	4	25	75	100
19	Practical-III	22UPEVS1P03	Practical Paper III	6	3	40	60	100
20	Elective III	22UPEVS1E01-12	Elective Paper III	4	4	25	75	100
21	Internship	22UPEVS1CIN	Internship (Summer Internship)	-	2	25	75	100
			Field Studies/Library/Seminar	1+2+1				
			Sub Total	**30**	**25**	**190**	**510**	**700**
SEMESTER – IV								
22	Core - XII	22UPEVS1C12	Environmental Law and Policies	4	4	25	75	100
23	Elective IV	22UPEVS1E01-12	Elective Paper IV	4	4	25	75	100
24	Core Project	22UPEVS1CPR	Research Project & Industrial Visit	20	10	50	100	150
25	Core	22UPEVS1CRS	Research Seminar	1	1	25	25	50
			Library	1	-	-	-	-
			Sub Total	**30**	**19**	**125**	**275**	**400**
			Total	**120**	**94**	**670**	**1830**	**2500**

Elective Courses							
S.No.	**Course Code**	**Title of the Paper**	**Contact Hours/Week**	**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
Environmental Microbial Biotechnology & Nanotechnology							
1	22UPEVS1E01	Marine Biotechnology	4	4	25	75	100
2	22UPEVS1E02	Microbial Enzyme Technology	4	4	25	75	100
3	22UPEVS1E03	Environmental Nanotechnology	4	4	25	75	100
4	22UPEVS1E04	Industrial Biotechnology	4	4	25	75	100
Waste Management and Remediation Technologies							
5	22UPEVS1E05	Phytoremediation	4	4	25	75	100
6	22UPEVS1E06	Engineering Designs for Waste Management and Energy	4	4	25	75	100
7	22UPEVS1E07	Bioremediation And Bioeconomy	4	4	25	75	100
8	22UPEVS1E08	Sludge Management	4	4	25	75	100
Environmental Toxicology and Risk Assessment							
9	22UPEVS1E09	Principles of Toxicology	4	4	25	75	100
10	22UPEVS1E10	Pesticide Toxicology	4	4	25	75	100
11	22UPEVS1E11	Applied Toxicology	4	4	25	75	100
12	22UPEVS1E12	Occupational and Industrial Toxicology	4	4	25	75	100

Supportive Courses (Non-Major Course)							
S. No.	**Course Code**	**Title of the Paper**	**Contact Hours/Week**	**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
1	22UPEVS1S01	Ecology and Environment	4	4	25	75	100
2	22UPEVS1S02	Environmental Pollution	4	4	25	75	100
3	22UPEVS1S03	Environmental Health and Safety	4	4	25	75	100
4	22UPEVS1S04	Global Environmental Issues	4	4	25	75	100
5	22UPEVS1S05	Disaster Management	4	4	25	75	100

Add On Course / Value Added Course:

Value Added Course:

Value Added / Add on Courses							
S. No.	**Course Code**	**Title of the Paper**	**Contact Hours**	**Credits**	**Internal Marks**	**External Marks**	**Total Marks**
1	21UPEVS1VA1	Environmental Safety and Lab Safety	30	-	25	75	100
2	21UPEVS1VA2	Environmental Sanitation	30	-	25	75	100
3	21UPEVS1VA3	Soil Analysis	30	-	25	75	100
4	21UPEVS1VA4	Waste Recycling	30	-	25	75	100
5	21UPEVS1VA5	Analytical Toxicology	30	-	25	75	100
6	21UPEVS1VA6	Environmental Analytical Techniques	30	-	25	75	100

11. Examinations

Examinations are conducted in semester pattern. The examination for the Semester I & III will be held in November/December and that for the Semester II and IV will be in the month of April/May. Candidates failing in any subject (both theory, practical and skill) will be permitted to appear for such failed subjects in the same syllabus structure at subsequent examinations within next 5 years. Failing which, the candidate has to complete the course in the present existing syllabus structure.

12. Scheme for Evaluation and Attainment Rubrics

Evaluation will be done on a continuous basis and will be evaluated four times during the course work. The first evaluation will be in the 7th week, the second in the 11th week, third in the 16th week and the end–semester examination in the 19th week. Evaluation may be by objective type questions, short answers, essays or a combination of these, but the end semester examination is a University main examination with prescribed question paper pattern.

Attainment Rubrics for Theory Courses

Internal *(Max. Marks - 25)*

Attendance	Seminar	Assignment	Cycle Test	Total
5	5	5	10	25

External *(Max. Marks - 75)*

Question Paper Pattern *(Theory)*

Section	Approaches	Mark Pattern	K Level
A	One Word (Answer all questions)	20 x 1 = 20 (Multiple Choice Questions)	K1 & K2
B	100 to 200 words (Answer any three out of five questions)	3 x 5 = 15 (Analytical type questions)	K3 & K4
C	500 to 1000 words	5 x 8 = 40 (Evaluation and Creativity type questions)	K5 & K6

Attainment Rubrics for Lab Courses

Internal *(Max. Marks - 40)*

Attendance	Practical Test	Periodical Performance/Observation	Total Marks
5	25	10	40

External *(Max. Marks - 60)*

Major Experiment	Minor Experiment	Spotters	Record	Viva-Voce	Total Marks
20	15	15	5	5	60

Attainment Rubrics for Research

Internal *(Max. Marks - 50)*

Periodical Review and Results Presentation	50 Marks

External *(Max. Marks - 100)*

Viva-Voce Presentation	25 Marks
Dissertation	75 Marks

Research Seminar:

Internal Seminar 4 - Weeks	25 Marks
Final Seminar	25 Marks

Passing Minimum

- There shall be no Passing minimum for Internal.
- For External Examination, the passing minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for the paper.
- In the aggregate (External + Internal) the passing minimum shall be of 50% for each Paper/Practical/Project and Viva-Voce.
- Grading shall be based on overall marks obtained (Internal + External).

13. Grading System

Performance evaluation of students is based on ten-point scale grading system as given below:

Ten Point Scale			
Grade of Marks	**Grade points**	**Letter Grade**	**Description**
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
00-49	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

Core Course – I

ECOLOGY AND BIODIVERSITY CONSERVATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS1C01	100	4	4	-	-	4

Course Objectives

To gain an understanding of the value of biodiversity and drivers of its loss; current efforts to conserve biodiversity on global, national and local scales; practical issues with local conservation and organizations, policies and programmes for sustainable management of bioresources.

Course Outcomes

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

CO1 Understand the relationship between biodiversity and ecosystem functions

CO2 Understand the direct and indirect values of biodiversity resources and their bioprospecting opportunities

CO3 Outline the factors responsible for the threats and loss of global biodiversity

CO4 Understand the various *in situ* and *ex situ* conservation measures and make critical judgments on the conflict between conservation and development

CO5 Know more knowledge about the recent policies and programmes for sustainable management of bioresources and apply the rules and recommendations related to environmental protection

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2		*						
CO3	*					*		*
CO4	*					*		*
CO5	*					*		*

Core Course – I

ECOLOGY AND BIODIVERSITY CONSERVATION

Unit I Introduction **Contact Hours: 12**

Ecology: Types of ecosystem – Terrestrial and Aquatic ecosystems - Ecological pyramids - Food Chain - Food Web - Energy flow (K1, K2) - Types of Biodiversity: Species, Genetic and Ecosystem diversity – Alpha, beta, and gamma diversity (K1, K2) – Biodiversity and ecosystem function (K4, K5) – Megadiversity zones and Biodiversity Hot Spots in India (K2, K3) –Ecologically Sensitive Areas (ESA) in India (K4, K5) - Values of Biodiversity (K4, K5) - Biodiversity Prospecting - Examples of biopiracy and bioprospecting (K2, K5)

Unit II Threats to Biodiversity **Contact Hours: 12**

Endangered and endemic species of flora and fauna in India (K1, K2) - Biodiversity threats under Anthropocene era: Habitat loss, fragmentation and degradation – Impacts of plastic pollution on marine biodiversity resources - Overexploitation (K2, K4, K5) – Food system impact on biodiversity loss - IUCN Threat Categories – Red Data Book (K2, K4) – Climate change on species extinction - Causes and Impacts of Invasive species to biodiversity (K2, K3, K4 & K5) - Threats to soil biodiversity (K2, K4, K5) - Human-Animal conflict with special reference to elephants (K3, K4 , K5, K6)

Unit III Conservation Strategies **Contact Hours: 12**

In situ conservation: Afforestation, Social Forestry, Agro-forestry, Zoo, Biosphere Reserves, National Parks, Sanctuaries, Protected Area Network, Sacred Groves (K1, K2, K3) – Protected Area: Direct benefits and co-benefits and its contribution to Sustainable Development Goals – *Ex-situ* conservation: Botanical gardens, Cryopreservation, Gene Bank, Seed Bank, Pollen Bank, Sperm Bank, cDNA Bank (K1, K2, K3)

Unit IV Sustainable Management of Bioresources **Contact Hours: 12**

National Biodiversity Authority (NBA) – Functions of State Biodiversity Board (SBB) and Biodiversity Management Committee's (BMC) – People's Biodiversity Register (PBR) (K3, K4, K5, K6) – International Organizations and biodiversity conservation: Objectives and Targets 2011-2020 of Global Strategy for Plant Conservation (GSPC), WWF-India for priority and threatened species conservation, UNESCO - Man and Biosphere Programme (MAB), UNDP - Biodiversity Finance Initiative (BIOFIN) and UNEP – Global Environment Facility (GEF) for biodiversity conservation - UNEP Medium-Term Strategy 2022-2025: on the road to 2030 (K3, K4, K5)

Unit V Policies, Programmes, and Acts for Conservation **Contact Hours: 12**

Salient features of Biological Diversity Act 2002 (K2, K3) - Status and protection of species in National and International levels – Policies implemented by MoEF & CC for biodiversity conservation - Role of CITES, IUCN and Convention on Biological Diversity (CBD) in biodiversity conservation (K2, K3, K4) – Nagoya Protocol on Access and Benefit-Sharing – Cartagena Protocol on Biosafety - The Aichi Biodiversity Targets (K3) – Monitoring the Illegal Killing of Elephants (MIKE) programme – SAWEN and TRAFFIC Networks – Wildlife Trafficking Through India's Airports (2011-2020) - Natural Resource Management Principles for Biodiversity - CBD CoP15 outcomes – Kunming Biodiversity Fund and 30 by 30 targets - CoP26 Climate Summit pledge to end deforestation by 2030 (K4, K5)

Core Course – I

ECOLOGY AND BIODIVERSITY CONSERVATION

References

Text Books

1. Eugene P. Odum and Gary W. Barrett (2004) Fundamentals of Ecology (5th Edition) Brooks/Cole Publishers.
2. Sharma PD (2012) Ecology and Environment, Rastogi Publications, India.
3. Simon A. Levin (2009) The Princeton Guide to Ecology, Princeton University Press, UK.
4. Krishnamurthy KV (2003) An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.

Reference Books

1. Alonso A. Aguirre and Raman Sukumar (2017) Tropical Conservation. Perspectives on Local and Global Priorities, Oxford University Press, USA
2. Ana Cano Ortiz, Carmelo Maria Musarella, Ricardo Quinto Canas (2020) Habitats of the World Biodiversity and Threats, IntechOpen.
3. Anzar A. Khuroo, Ghulam Hassan Dar (2020) Biodiversity of the Himalaya: Jammu and Kashmir State, Springer Nature Singapore Pte Ltd.
4. Beatrice Frank, Jenny A. Glikman, Silvio Marchini (2019) Human-Wildlife Interactions Turning Conflict into Coexistence, Cambridge University Press, UK.
5. Chandrakasan Sivaperuman, Krishnamoorthy Venkataraman (2018) Indian Hotspots Vertebrate Faunal Diversity, Conservation and Management. Volume 1, Springer Nature Singapore Pte Ltd.
6. Chaudhuri AB and Sarkar DD (2003) Megadiversity Conservation, Flora, Fauna and Medicinal Plants of India's Hot Spots. Daya Publishing House, New Delhi.
7. Dadhich LK and Sharma AP (2002) Biodiversity –Strategies for Conservation, APH Publishing Corporation, New Delhi.
8. David Dudgeon (2020) Freshwater Biodiversity Status, Threats and Conservation, Cambridge University Press, UK.
9. Kapoor L and Usha S (2020) Biodiversity and Conservation: India's Panoramic View. In: Roy N., Roychoudhury S., Nautiyal S., Agarwal S., Baksi S. (eds), Socio-economic and Eco-biological Dimensions in Resource use and Conservation. Environmental Science and Engineering. Springer, Cham. https://doi.org/10.1007/978-3-030-32463-6_16
10. Münir Öztürk, Dilfuza Egamberdieva, Milica Pešić (2020) Biodiversity and Biomedicine Our Future. Academic Press, UK.
11. Münir Öztürk, Recep Efe, Volkan Altay (2021) Volume 1: Prospects and Challenges in West Asia and Caucasus - Volume 1, Springer Nature, Switzerland.
12. Muthuchelian K (2013) Glimpses of Animal Biodiversity, Astral International (P) Ltd., New Delhi.
13. Muthuchelian K (2013) Uyir Virimam (Tamil), Pranisha Pathippagam, Madurai.
14. Muthuchelian K (2016) Bioinformatics, Barcoding and Benefit Sharing in Biodiversity Educationist Press, New Delhi.
15. Nitin Kamboj, Pankaj Kumar, Sonika Kumari, Sunil Kumar, Temin Payum, Vinod Kumar (2021) Biological Diversity: Current Status and Conservation Policies, Agro Environ Media, Publication Cell of AESA, Agriculture and Environmental Science Academy.
16. Santosh Kumar Upadhyay and Sudhir P Singh (2021) Bioprospecting of Plant Biodiversity for Industrial Molecules, John Wiley & Sons Ltd., USA.
17. Tim Burt and Des Thompson (2020) Ecology, Biodiversity and Conservation, Cambridge University Press, UK.

18. William V. Holt, Janine L. Brown and Pierre Comizzoli (2014) Reproductive Sciences in Animal Conservation. Progress and Prospects, Springer, New York.

Journal articles

1. Trew BT, Maclean IM (2021) Vulnerability of global biodiversity hotspots to climate change. Global Ecology and Biogeography 30(4):768-783.
2. Sutherland WJ, Atkinson PW, Butchart SH, Capaja M, Dicks LV, Fleishman E, Gaston KJ, Hails RS, Hughes AC, Le Anstey B, Le Roux X (2022) A horizon scan of global biological conservation issues for 2022. Trends in Ecology & Evolution 37(1):95-104.
3. Walters C, Pence VC (2021) The unique role of seed banking and cryobiotechnologies in plant conservation. Plants, People, Planet 3(1):83-91.

Online resources

1. www.iucn.org
2. www.cites.org
3. www.cbd.int
4. www.wri.org
5. http://www.sawen.org
6. https://theconversation.com
7. http://www.ramsar.org/sites/default/files/hb2_5ed_strategic_plan_ 2016_24_e.pdf
8. https://www.thegef.org/topics/biodiversity
9. https://www.cbd.int/gspc/strategy.shtml
10. https://www.zsl.org/sites/default/files/LPR%202020%20Full%20report.pdf
11. http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf
12. https://stg-wedocs.unep.org/bitstream/handle/20.500.11822/34331/Agenda%20Item%206%20POW-2rev.pdf

Core Course – II

ENVIRONMENTAL CHEMISTRY

Semester	Paper Code	Marks	Hours/Wee	L	T	P	Credit
I	22UPEVS1C02	100	4	4	-	-	4

Course Objectives

To develop an understanding fundamental chemical processes occurred in environment and various chemical reactions and their effects on the environment.

Course Outcomes

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

CO1 Have knowledge of basic theories and problems of Environmental Chemistry.

CO2 Describe important chemical reactions and cyclic processes of chemical species in the atmosphere, hydrosphere and in lithosphere.

CO3 Demonstrate knowledge of chemical principles of various fundamental environmental phenomena.

CO4 Apply basic chemical concepts in understanding the behaviour of pollutants.

CO5 Analyze chemical processes involved in air, water and soil environmental issues and know the different types of toxic, hazardous substances and analyze their toxicological information.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							*
CO2		*				*		
CO3		*				*		*
CO4		*						
CO5		*	*	*		*		*

Core Course – II

ENVIRONMENTAL CHEMISTRY

Unit I Fundamentals of Environmental Chemistry Contact Hours: 12

Environmental Chemistry: Definition, Concept and Scope. Elements - Atomic structure, Atomic number, Atomic mass, Electronic configuration, Periodic properties of elements, Types of chemical bonds. Preparation of Standard Solutions – Molarity, Molality, Normality, Percent and ppm (mg/L) Solutions - Stoichiometry (K1, K2) - Gibb's free energy - Chemical Potential - Chemical Equilibria - Acid-base theories - pH and pOH and Buffer Solutions (K3) - Solubility and Solubility Product - Solubility of gases in water - The carbonate system - Unsaturated and saturated hydrocarbons - Radionuclides (K4)

Unit II Atmospheric Chemistry Contact Hours: 12

Atmosphere: Structure and Composition - Particles, Ions and Radicals (K2) - Tropospheric Chemistry: Formation of inorganic and Organic particulate matter (K3, K4) - Chemistry of Air Pollutants: SO_2, NOx, CO_2 (Acid Rain, Photochemical Smog, Greenhouse Effect, Global Warming) (K4). Stratospheric Chemistry: Chapman mechanism and catalytic process of ozone destruction - Role of CFCs in ozone depletion, NOx, halogen cycles (K4)

Unit III Aquatic Chemistry Contact Hours: 12

Formation of Water (K1) - Sources and Types of water resource (K1) - Hydrological cycle - Unique properties of water (K2) - Role of water in the environment (K3)- Physical, Chemical and Biological properties of water - Temperature, colour, odour, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS), alkalinity, acidity and hardness - Phenomenon of Eutrophication (K4) - Concept of DO, BOD, COD - Chemistry of metals in aqueous systems - Metal complex formation and chelation - Types of reactions in various water bodies including marine environment (K4, K5)

Unit IV Soil Chemistry Contact Hours: 12

Soil: Nature, Formation, Types (K1 & K2) – Physico-chemical Properties of Soil: Soil Structure, Texture (K3 & K4), Inorganic and organic components of soil, Chemical properties of saline, acidic and alkaline soils (K5), Macro and Micronutrients in soil and their functions, Relation between organic carbon and organic matter, C/N Ratio, Chemical reactions in soil (K5)

Unit V Pollutant Chemistry Contact Hours: 12

Pesticides: Classification, Degradation, Analysis - Pollution due to pesticides - DDT and Endosulphan, Hydrocarbons: Classification, Hydrocarbon decay (K3) - Effects of hydrocarbon on macro and microorganisms (K4) – Toxic effects of heavy metals - As, Cd, Pb & Hg

References

Text Books

1. De AK (2007) Environmental Chemistry, Seventh Edition, New Age International Publishers.
2. Balram Pani (2007) Text Book of Environmental Chemistry, I.K. International Publishing House Pvt. Ltd.
3. Girard JE (2015) Principles of Environmental Chemistry.
4. Rao CS (2018) Environmental Pollution Control Engineering, 3rd Edition, New Age International (P) Ltd. Publishers.
5. Sharma BK and Kaur H (1994) Environmental Chemistry, Goel Publishing House Ltd., Meerut, UP

Core Course – II

ENVIRONMENTAL CHEMISTRY

Reference Books

1. Manahan, Stanley E (2009) Fundamentals of Environmental Chemistry, 9th Edition, Boca Raton: CRC Press LLC.
2. Eugene R. Weiner (2000) Applications of Environmental Chemistry, CRC Press, LLC.
3. Ahluwalia VK (2015) Environmental Pollution and Health, The Energy And Resource Institute (TERI).
4. Vanloon GW and Duffy SJ (2011) Environmental Chemistry: A Global Perspectives, 3rd Edition, Oxford University Press.
5. Ibanez, JG, Hernandez-Esparza M, Doria-Serrano C, Fregoso-Infante A, and Singh MM (2007) Environmental Chemistry. Springer Press.
6. Farwa Nadeem, Ijaz Ahmad Bhatti, Muhammad A. Hanif, Hafiz Muhammad Tauqeer (2020) Environmental Chemistry A Comprehensive Approach, Wiley & Sons, Inc., USA.

Web References

1. http://www.nptel.ac.in/courses/122106030/Pdfs/3_1.pdf
2. http://www.crystal.med.upenn.edu/sharp-lab-pdfs/sharp_EncLifeSci.pdf
3. http://www.fao.org/docrep/field/003/AC172E/AC172E04.htm
4. http://www.essentialchemicalindustry.org/materials-and-applications/surfactants.html
5. http://agriinfo.in/?page=topic&superid=5&topicid=174

Core Course – III

WASTE MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS1C03	100	4	4	-	-	4

Course Objectives

To understand the problems of different kinds of wastes and the proper collection, segregation and reduction methods for municipal waste, biomedical waste, hazardous waste, e-waste, industrial waste etc., To identify waste nature and proper disposal methods for each type of wastes and identify the energy producing wastes and recovery of the energy from the wastes using different techniques.

Course Outcomes

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

CO1 Understand health and environmental issues related to solid waste management; Select the appropriate method for solid waste collection, transportation, redistribution and disposal

CO2 Become aware of environment and health impacts solid waste mismanagement

CO3 Understand engineering, financial and technical options for waste management and wealth from waste management techniques

CO4 Understand industrial specific wastes and their efficient management

CO5 Describe methods of disposal of hazardous solid waste and understand the energy recovery and industrial specific treatment techniques

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*	*					
CO2		*					*	
CO3			*			*	*	
CO4		*				*	*	*
CO5				*		*	*	

Core Course – III

WASTE MANAGEMENT

Unit I Municipal Solid Waste Management Contact Hours: 12

Municipal Solid Wastes (MSW): Definition, Source, Types, Classification, Characterization, Composition, Per Capita generation and global scenario, Factors affecting waste generation (K3) - Methods of collection, Storage and Transportation, Waste Processing and Material Recovery (K4), Effects of improper disposal of wastes (Public health and Environment) - Disposal methods - Aerobic and Anaerobic methods (Landfill, Sanitary Landfill, Composting, Burning, Incineration, Pyrolysis, Anaerobic Digestion) - Management of leachate and landfill gas, Dumpsite Rehabilitation - Rules and Regulation of MSW, Creating Public Awareness, Role of NGO's.

Unit II Hazardous & Radioactive Waste Management Contact Hours: 12

Hazardous waste: Definition, Characteristics and Classification (Industrial, Hospital, and Domestic) (K1, K2, & K3) - Labelling and handling of hazardous solid wastes (Segregation, Recovery of hazardous waste substances) (K3 & K4); Rules and Regulation of hazardous waste - Disposal Techniques (K5). Radioactive Wastes: Sources, Classification and Characterization (K1 & K2) - Radiation Units, Measurements (K3), Regulations, Legal framework and responsible bodies, Effects, Control, and Disposal Methods (Treatment, Conditioning, Storage and Disposal) (K3, K4 & K5)

Unit III Biomedical, Plastic & E-waste Management Contact Hours: 12

Biomedical Wastes: Sources and Types (K1 & K2), Impacts of biomedical wastes on environment (K3 & K4) - Biomedical Waste Management Rules, 2016 and Amendments - Labelling and transport (K4), Control measures and disposal (K5) - Plastic Wastes: Sources, Types (K1 & K2) and Global Scenario (K3, K4), Plastic Waste Management Rules 2016 - Effects of plastic wastes on marine life, wildlife, human health, and environment - Control measures - Reduce, Reuse, Recycle (3Rs), Construction of plastic roads, Alternate to plastics (K5 & K6). E-wastes: Sources, Types, and Composition (K2) - Impacts on environment (K3) - Control measures - Recycling and Recovery technologies (K3 & K6)

Unit IV Energy Recovery from Wastes Contact Hours: 12

Biocomposting, Vermicomposting, Mushroom cultivation, Fly ash generation and utilization, Coir Bricks, Heat recovery, Biogas production; Microbial fuel cells - Production of methane, ethanol, and electricity.

Unit V Industrial Waste Management Contact Hours: 12

Cradle to Grave Processes in Pulp and Paper, Tanneries, Textiles, Thermal Power Plants, Mining and Ore Processing, Refineries, Iron Casting, Cement, Sugar, Distillery, Pharmaceuticals, and Asbestos - Sludge Dewatering and Its disposal.

References

Text Books

1. Kinnaman T C and Takeuchi K (2014) Handbook on Waste Management, Edward Elgar Publishing, UK.
2. Ramesha Chandrappa and Jeff Brown (2012) Solid Waste Management: Principles and Practice, Springer Science and Business Media Publishers.

3. Bhide and Sundaresan (2000) Solid Waste Management in Developing Countries – Indian National Scientific Documentation Center, New Delhi.
4. Basarkar Shishir (2009) Hospital Waste Management: A Guide for Self-Assessment and Review, JAYPEEDIGITAL
5. Surendra Kumar (2009) Solid Waste Management, Northern Book Centre

Reference Books

1. Hieronymi C K, Kahhat R and Williams E (2012) E-waste Management: From waste to resource. Routledge Taylor Francis Group Publishers.
2. Lagrega M D, Buckingham P L and Evans J V (2001) Hazardous Waste Management, McGraw Hill Int. Ed. New York.
3. Lie D H F and Liptak B G (2000) Hazardous Wastes and Solid Wastes, Lewis Publishers, New York
4. John Pitchel (2014) Waste Management Practices, Municipal, Hazardous, and Industrial, 2nd Edition, CRC Press
5. Subramanian M N (2019) Plastic Waste Management Processing and Disposal, 2nd Edition, Scrivener Publishing.
6. Varsha Bhagat-Ganguly (2021) E-Waste Management Challenges and Opportunities in India, Taylor & Francis.
7. Siming You (2022) Waste-to-Resource System Design for Low-Carbon Circular Economy, Elsevier Science.
8. Deepak Kumar Yadav, Pradeep Kumar, Pardeep Singh and Daniel A. Vallero (2022) Hazardous Waste Management An Overview of Advanced and Cost-Effective Solutions, Elsevier Science.
9. Chaudhery Mustansar Hussain, Lalit Goswami, Sunpreet Singh (2021) Emerging Trends to Approaching Zero Waste Environmental and Social Perspectives, Elsevier Science.

Web References

1. http://www.cpeo.org/techtree/ttdescript/pyrols.htm
2. www.satavic.org/vermicomposting.htm
3. http://web.mit.edu/urbanupgrading/urbanenvironment/sectors/solid-waste-landfills.html
4. www.cement.org/waste/wt_apps_radioactive.asp
5. www.ipma.co.in/recycle.asp
6. linkinghub.elsevier.com/retrieve/pii/S026974910600042X
7. https://www.researchgate.net/publication/42339862_Biomedical_waste_management_An_overview
8. https://aces.nmsu.edu/pubs/_g/G314.pdf
9. http://cbs.teriin.org/pdf/Waste_Management_Handbook.pdf
10. https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/E-Learning/Moocs/Solid_Waste/W2/Solid_waste_management_UNEP_2005.pdf

Core Course – IV

ENVIRONMENTAL BIOCHEMISTRY AND TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS1C04	100	4	4	-	-	4

Course Objectives

To focus on understanding the role of pollutants, and xenobiotics in the natural environment; to understand the basics of environmental toxicology, cell biology, and biochemistry; and to characterize the adverse effects of chemical substances on the ecosystem and humans.

Course Outcomes

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

CO1 Acquire broad knowledge in the field of environmental toxicology and biochemistry and understand the basic principles, target organ toxicity, and the toxicity of a select group of chemical compounds.

CO2 Synthesize and apply concepts from multiple sub-disciplines in environmental cell biology, biochemistry, and toxicology.

CO3 Use technical and analytical skills to quantify the level of xenobiotics in environmental compartments and their impacts on human health.

CO4 Understand relationships between chemical/drug exposure and its effects on physiological systems.

CO5 Acquire skills in toxicological bioassays and design strategies for the study of dose-response relationships.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2		*						
CO3			*					
CO4			*					
CO5					*			

Core Course – IV

ENVIRONMENTAL BIOCHEMISTRY AND TOXICOLOGY

Unit I Basic Cell Biology **Contact Hours: 12**

Introduction to Cell biology - Cell theory - Prokaryotes and Eukaryotes - Structure and function of eukaryotic cell organelles - Cell wall, Plasma membrane, Mitochondria, Chloroplast, Endoplasmic reticulum, Ribosomes, Nucleus, Plant vacuoles, and Plastids. Cell division - Meiosis and Mitosis, Genotype and Phenotype (K1, K2)

Unit II Cellular Processes **Contact Hours: 12**

Cellular transport - Permeability, Diffusion, Osmosis, Absorption of water, Translocation of solutes, Transpiration, Photosynthesis, Respiration, Cellular adaptations to environmental stress - Atrophy, Hypertrophy, Hyperplasia and Metaplasia (K1, K2)

Unit III Basics of Toxicology **Contact Hours: 12**

Scope and types - Classification of toxic agents. Routes of exposure, duration, and frequency of exposure, Dose-response relationship - LC_{50} and LD_{50}, Threshold limit value, Therapeutic index levels. Environmental Risk - Definition, Risk Characterization - Hazard Identification, Exposure Assessment Methods, Environmental Risk Assessment - National and International guidelines (K3, K4, K5)

Unit IV Mechanisms of Toxicity **Contact Hours: 12**

Toxicity testing methods - Laboratory animals - Acute and chronic toxicity tests - Absorption, distribution, metabolism and excretion of toxic agents - Biotransformation reactions - Concepts of bioassay - Types and characteristics - Test models and methods (K5, K6)

Unit V Xenobiotics Toxicity **Contact Hours: 12**

Xenobiotics - Bioaccumulation and Biomagnification of toxic chemicals: Pesticides, heavy metal(loid)s, PAHs, VOCs and POPs – Toxicity of Carcinogens, Emerging Pollutants – Biomonitoring studies – Principles and applications – Environmental specimen banks (K4, K5)

References

Text Books

1. Alberts B, Bray D, Hopkin K *et al.* (2009) Essential Cell Biology, 3rd edition,
2. Alberts B, Johmson A, Lewis J, Raff M, Roberts K and Walter P (2002) Molecular Biology of the Cell, Garland Science, New York.

Reference Books

1. Buchanan B B, Gruissem W and Jones R L (2002) Biochemistry and Molecular Biology of Plants, ASPB, USA.
2. Cooper G M and Hausman R E (2013) The Cell: A Molecular Approach, 6th edition, Sinauer Associates, Sunderland, MA, USA.
3. David L. Nelson, Michael M. Cox (2004) Lehninger Principles of Biochemistry (1970) by Albert L. Lehninger Published 23rd April 2004 by W. H. Freeman (first published).

ENVIRONMENTAL BIOCHEMISTRY AND TOXICOLOGY

4. Gerald Karp (2002) Cell and Molecular Biology: Concepts and Experiments, 7th edition.
5. Felix D'Mello (2020) A Handbook of Environmental Toxicology - Human Disorders and Ecotoxicology, CABI, USA.
6. Jing Liu, Carey N. Pope (2020) An Introduction to Interdisciplinary Toxicology - From Molecules to Man, Academic Press, USA.
7. Klaassen, Curtis D, Casarett, Louis J, Doull, J (2013) Casarett and Doull's Toxicology: The basic science of poisons (8th Edition) McGraw Hill Publishers.
8. Max Costa, Gunnar F. Nordberg (2021) Handbook on the Toxicology of Metals: Volume II: Specific Metals Volume 2, Fifth edition, Academic Press, USA.
9. Ted A. Loomis, A. Wallace Hayes (1996) Loomis's Essentials of Toxicology 4th Edition, Academic Press Publishers.
10. Sharma P D, Rastogi and Lamporary (1994) Environmental Biology and Toxicology, Rajpal and Sons Publishing, New Delhi.
11. Ted A Simon (2014) Environmental Risk Assessment: A Toxicological Approach. CRC Press, FL.
12. Wayne Landis, Ruth Sofield, Ming-Ho Yu (2017) Introduction to Environmental Toxicology Molecular Substructures to Ecological Landscapes, 5th edition, CRC Press, USA.

Core Course – V

ENVIRONMENTAL POLLUTION AND CONTROL STRATEGIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS1C05	100	4	4	-	-	4

Course Objectives

To gain knowledge of causes and consequences to natural, economic and social systems to understand the fundamental principles governing the interactions between the transport of pollutants in the environment and treatment technologies.

Course Outcomes

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

CO1 Learn about the air, water and soil pollutants, sources and its effects, and have clear understanding on the air, water, noise, and radiation standards and its techniques

CO2 Apply relevant techniques, skills and modern engineering tools to solve the environmental problems

CO3 Get exposed good practice of technologies and options used to remediate reduce/eliminate pollution of the environment

CO4 Understand problems in order to select control measures and techniques concerning atmospheric, water and terrestrial contaminants

CO5 Understand the ill effects of pollution and create awareness to public on environmental pollution and its control

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							*
CO2		*				*		
CO3		*				*		*
CO4		*						
CO5		*	*	*		*		*

Core Course – V

ENVIRONMENTAL POLLUTION AND CONTROL STRATEGIES

Unit I Air Pollution and Control strategies **Contact Hours: 12**

Definition (K1) - Natural and anthropogenic sources (K1)- Types of air pollutants: Primary and Secondary - Classification of air pollutants (K2 & K3) - Air pollution episodes - Effects of air pollution on environment (K3) - Transport and diffusion of pollutants (Gaussian Plume Model) - Monitoring of air pollution (K4) - Sampling and analysis techniques of SOx, NOx and particulate matter (K4 & (K5) - Ambient Air Quality Standards of CPCB - Air Pollution Control Methods: Particulate matter (Settling Chamber, Cyclones, Fabric Filter, Electrostatic Precipitator and Scrubbers) and Gaseous Pollutants (NO_x, SO_2, CO, CO_2 and Hydrocarbons)

Unit II Water Pollution and Control strategies - Aerobic Treatment **Contact Hours: 12**

Definition (K1) – Sources, types and effects (K1 & K2) - Water sampling techniques - Water quality parameters and standards (K3 & K4) - Drinking (Sedimentation, Filtration & Chlorination) and Wastewater treatment methods: Concept of ETP and CETP - Primary treatment methods (Screening, Grit Removal, Neutralization, Coagulation, Skimming, Sedimentation) - Secondary treatment methods [Aeration, Activated Sludge Process, Trickling Filters, Biological Contact Filters, Rotating Filters, Sequential Batch Reactor (SBR) and Oxidation Ponds (Aerobic stabilization ponds, Facultative ponds, Constructed wetlands)] - Tertiary treatment methods (Ozonation, Chlorination, Activated carbon filtration, UV, Reverse Osmosis) - Advanced Treatment - Nutrient removal (Nitrates and Phosphates)

Unit III Anaerobic Treatment Methods and Water Management Strategies **Contact Hours: 12**

Anaerobic Digestion - Fixed bed, Moving bed, Expanded bed, Fluidised bed Reactors, UASB, Septic Tanks, Lagoons and Anaerobic Ponds - Water Management Strategies: Rain Water Harvesting Methods, Recycling & Reuse of domestic and industrial wastewater

Unit IV Soil Pollution and Control strategies **Contact Hours: 12**

Definition (K1) - Sources (Industrial, Domestic and Agricultural) (K1 & K2) - Effects of soil pollution on environment (K2) - Soil sampling devices, Methods and Analysis - Soil Remediation Techniques: *In situ* and *Ex situ* - Physical (Soil Covering, Excavation, Electrokinetic Remediation, Air Sparging and Encapsulation) - Chemical (Soil Washing, Solidification and Vitrification) - Biological (Bioremediation and Phytoremediation)

Unit V Noise & Thermal Pollution and Control strategies **Contact Hours: 12**

Noise Pollution: Definition (K1) - Sources (K1 & K2) - Properties of sound waves, Sound pressure levels, Decibel, Intensity and duration (K3) - Effects of noise pollution on humans and animals (K3 & K4) - Noise permissible standards of CPCB (Industrial and domestic zones) - Noise control measures (Greenbelt and Protective Instruments) - Thermal Pollution: Definition (K1) - Sources (K1 & K2) - Chemical and biological effects - Thermal pollution from power plants and their control & treatment

References

Text Books

1. Khopkar S M (2005) Environmental Pollution Monitoring and Control, New Age International (P) Ltd Publishers.
2. Rao C S (2018) Environmental Pollution Control Engineering, 3rd Edition, New Age International (P) Ltd Publishers.

3. Avinash Chauhan (2020) Environmental Pollution and Management. IK International Publishers Ltd.
4. Singal S P (2000) Noise Pollution and Control, Narosa Publishing House, New Delhi.
5. Jeffrey Peirce J, Ruth F, Weiner P, and Aarne Vesilind (1997) Environmental Pollution Control, 4th Edition, Elsevier Science.

Reference Books

1. Yung –Tse Hung, Lawrence K wang and Nazih K Shammas (2012) Handbook of Environment and Waste Management Vol. 1 Air and Water Pollution Control, World Scientific Press.
2. Yung –Tse Hung, Lawrence K Wang and Nazih K Shammas (2014) Handbook of Environment and Waste Management Vol. 2 Land and Groundwater Pollution Control, World Scientific Press.
3. Yung –Tse Hung, Lawrence K Wang and Nazih K Shammas (2020) Handbook of Environment and Waste Management Vol. 3 Acid Rain and Greenhouse Gas Pollution Control, World Scientific Press
4. Mary K. Theodore, Louis Theodore (2010) Introduction to Environmental Management, CRC Press.
5. Meuser Helmut (2013) Soil Remediation and Rehabilitation T reatment of Contaminated and Disturbed Land, Springer.
6. Spellman F R (2013) Handbook of Water and Wastewater Treatment Plant Operations, Third Edition, CRC Press, FL.
7. Farwa Nadeem, Ijaz Ahmad Bhatti, Muhammad A. Hanif, Hafiz Muhammad Tauqeer (2020) Environmental Chemistry. A Comprehensive Approach, Wiley & Sons, Inc., USA.
8. Pardeep Singh, Sanchayita Rajkhowa, Joao Paulo Bassin, Chaudhery Mustansar Hussain and Ramesh Oraon (2022) Environmental Sustainability and Industries Technologies for Solid Waste, Wastewater, and Air Treatment, Elsevier Science.
9. Pardeep Singh, Ajay Kumar and Anwesha Borthakur (2019) Abatement of Environmental Pollutants Trends and Strategies, Elsevier Science.
10. Hemen Sarma, Delfina C. Dominguez, Wen-Yee Lee (2022) Emerging Contaminants in the Environment Challenges and Sustainable Practices, Elsevier Science.

Web References

1. http://www.ilocis.org/documents/chpt55e.htm
2. http://www.bbau.ac.in/dept/UIET/Study%20Materials%20for%20TCE-0.pdf
3. https://www.jica.go.jp/jica-ri/IFIC_and_JBICI-Studies/english/publications/reports/study/topical/health/pdf/health_08.pdf
4. https://www.researchgate.net/publication/236179607_Strategies_for_Prevention_and Control of Air Pollution in India
5. https://iums.ac.ir/uploads/Air_Pollution_Control_Engineerin%D8%B8%E2%80%9E_95694.pdf
6. http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.agro-0c6457fb-fa78-4aa1-9eca-5f4483681a90/c/ILNS-3-2014-1-6.pdf
7. https://shodhganga.inflibnet.ac.in/bitstream/10603/21577/8/ch-5.pdf
8. https://www.mdpi.com/1660-4601/15/8/1657/pdf
9. https://udghoshna.files.wordpress.com/2014/08/noise-pollution.pdf

Core Course – VI

ENVIRONMENTAL MICROBIOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS1C06	100	4	4	-	-	4

Course Objectives

To learn the basic knowledge about the role of microbes and microbial interactions in soil and other soil activities, to the biogeochemical cycles prevail in environment, and to enhance the skill in microbial analysis.

Course Outcomes

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

CO1 Able to understand about microbes in the environmental field

CO2 Understand the role of microbes in soil fertility

CO3 Understand the role of microbes in biogeochemical cycles, plant growth promotion

CO4 Know about the impact of microbial air and water pollutants and understand the microbial diseases related to the environment

CO5 Apply the microbial processes to clean the environment and to enhance the skill in microbial analysis

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2		*						
CO3			*					
CO4			*					
CO5					*			

Core Course – VI

ENVIRONMENTAL MICROBIOLOGY

Unit I Introduction to Microbiology **Contact Hours: 12**

History and Scope of Microbiology - General structure of bacteria, viruses, and fungi - Sterilization techniques: Physical and chemical methods - Microbiological media preparation and its types - Adaptations of microorganisms in the extreme environment: Archaebacteria, Acidophilic, Alkalophilic, Thermophilic, Barophilic, Halophilic, Xerophilic, Radiophilic and Osmophilic (K1, K2)

Unit II Geomicrobiology **Contact Hours: 12**

Soil microflora - Factors influencing the soil microflora - Role of microorganisms in soil fertility -Microbial interactions: Mutualism, Commensalism, Competition, Amensalism, Parasitism and Predation - Interaction between microbes and plants: Role of PGPR and AM on plant growth (K1, K2)

Unit III Biogeochemical Cycles **Contact Hours: 12**

Carbon cycle - Role of microbes in the Carbon cycle - Nitrogen cycle - Mechanism of biological nitrogen fixation - Ammonification, Nitrification, Denitrification - Phosphorous cycle, Sulphur cycle and Oxygen cycle (K3, K4, K5)

Unit IV Air and Water Borne Diseases **Contact Hours: 12**

Microbial air pollutants - Bioaerosols, Aero allergens - Airborne diseases, Symptoms and preventive measures (Tuberculosis and Chickenpox) - Water pollution: Sources and nature of pollutants in water - Waterborne diseases, Symptoms and preventive measures (Cholera and Typhoid) - Microbial assessment of water quality - MPN technique and Biological Oxygen Demand (K5, K6)

Unit V Applied Microbiology **Contact Hours: 12**

Microbial conversion of solid waste to food (Mushroom, SCP), fuels (Biogas, Ethanol) - Biofouling – Biodegradation and xenobiotics in the environment (Crude oil, hydrocarbon) - Bioremediation: Types and its application - Biosurfactants: Types and its application - Biodeterioration of paper and wood - Metal corrosion (K4, K5)

References

Text Books

1. Dubey and Maheshwari (1999) A Text Book of Microbiology, Chand Publications, New Delhi.
2. Mohapatra P K (2008) Text Book of Environmental Microbiology, I K International Publishing House Limited

Reference Books

1. Subba Rao N S (2004) Soil Microbiology.4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Subba Rao N S (1995) Biofertilizers in Agriculture and Forestry, 3rd Edition, Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
3. Singh D P and Dwivedi S K (2005). Environmental Microbiology and Biotechnology. 1st Edition, New Age International (P) Ltd., Publishers, New Delhi.

4. Brock T D, Madigan M T, Martinko J M and Parker J (1994) Biology of Microorganisms, VII Ed., Prentice-Hall, New Jersey, USA.
5. Ronald M Atlas and Richard Bartha (1997) Microbial Ecology, 4th Edition, Benjamin Cummings Publishing Company, USA.
6. Junaid Ahmad Malik (2022) Microbes and Microbial Biotechnology for Green Remediation, Elsevier Science.
7. Maulin P. Shah, Susana Rodriguez-Couto and S Sevinc Sengor (2020) Emerging Technologies in Environmental Bioremediation, Elsevier Science.

Web References

1. www.wastewatertreatment.co.in/index.php
2. www.microbialfuelcell.org
3. www.pollutionissues.com/A-Bo/Bioremediation.html
4. www.bioreactors.net
5. http://www.cpeo.org/techtree/ttdescript/biorec.htm
6. http://www.personal.psu.edu/jel5/biofilms/
7. www.rdp.cme.msu.edu

Core Course – VII

CLIMATE CHANGE AND CURRENT ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS1C07	100	4	4	-	-	4

Course Objectives

To focus on improving understanding of the climate system, climate science, impacts of climate change, mitigation and/or adaptation to climate change and related issues.

Course Outcomes

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

CO1 Understand the climate and climate change processes at local to global scales

CO2 Understand the sources and impacts of climate change due to anthropogenic activities including energy utilization.

CO3 Understand the existing novel technologies used for measurement of climate change and weather forecasting

CO4 Understand the recent initiatives and policy framework by UNFCCC, IPCC, CoP, MoEF & CC and other Ministries

CO5 Evaluate the pros and cons of past National and International efforts to address climate change mitigation and adaptation

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*			*		*	*	*
CO2	*			*		*	*	*
CO3	*				*	*	*	*
CO4	*	*			*	*	*	*
CO5	*				*	*	*	*

Core Course – VII

CLIMATE CHANGE AND CURRENT ISSUES

Unit I Meteorological Elements for Climate Change Contact Hours: 12

Structure of atmosphere: Vertical structure of atmosphere - Atmospheric stability: Adiabatic process – Air Temperature, Humidity, Condensation: Dew and Frost, Fog, and clouds - Clouds: Classification of clouds - Precipitation processes: Collison and Co-alescence process and Ice-crystal or Bergeron process - Cloud seeding - Precipitation types (Rain, snow, sleet and freezing rain, snow grains and snow pellets, hail) - Air Pressure and Winds: Atmospheric pressure - Forces that influence the wind (Pressure gradient force, Coriolis force, centripetal force, friction) (K1 & K2)

Unit II Atmospheric Circulation, Air masses and Fronts Contact Hours: 12

Atmospheric circulation: Intertropical Convergence Zone (ITCZ) - Jet streams - Global wind patterns: Trade winds, Westerlies and Polar Easterlies - Thermal circulations: Sea and land breezes, Mountain and valley breezes, Katabatic winds, Chinook (Foehn) winds, Santa Ana winds, Desert winds - Air masses: Classification and characteristics of air masses - Types of air masses - Fronts: Type of fronts: Stationary fronts, cold fronts, warm fronts, occluded fronts (K1 & K2)

Unit III Air Quality and Consequences of Climate Change Contact Hours: 12

Global Air Quality and CO_2 concentration scenario - Sources of greenhouse gases: Coal burning, Transportation sectors (vehicle, railways, shipping and aviation) - Ozone depleting substances – Facts and figures of current global warming scenarios in the world – Extreme events of climate change: - El Niño, La Niña and El Niño Southern Oscillation (ENSO) – Alarming features of IPCC Report 2022 - Recent extreme events in the world – Global consequences of El Niño: Changes in the SW and NE monsoon patterns in India – Melting of ice glaciers and Sea levels - Water scarcity - Food security – Species extinction – Human health – Civil Wars and Migration – Global swarming: Locust plaque (K2, K3, K4& K5)

Unit IV Climate Classification, Measurement of Climate Change and Weather forecasting Contact Hours: 12

Classification of climate: Koppen's and Thornthwaite' scheme - The measurement of climate change: Tree rings, ice cores, ocean sediments, pollen records, Boreholes and other proxy measurements - Weather forecasting tools: AWIPS computer work station, Doppler radar data, metogram, satellites and weather forecasting - Types of forecasts: Nowcast, short-range forecasts, medium and long - range forecasts (K2, K3 & K4)

Unit V Global/National Action Plans to Combat Climate Change Issues Contact Hours: 12

Key steps taken by UNFCCC to combat climate change: Kyoto Protocol - Copenhagen Accord 2009 - Cancun Agreements 2010 to establish Green Climate Funds - Paris Climate Agreement 2015, Intended Nationally Determined Contribution (INDC) to cut greenhouse gas emissions at CoP 21 - Montreal Protocol for ODS, Kigali Amendment 2016 to phase out hydroflurocarbons (HFC) - Green Climate Funds - Climate Change Information Network (CC: iNet) - National Action Plan on Climate Change (Eight missions) - Recent initiatives related to climate change adaptation and mitigation in India (K4 & K5) - CoP26 major outcomes: Pledges to attain Net Zero commitments in India by 2070 - Methane phase out - Coal 'Phase down' Policy - International Solar Alliance (ISA) - Green Tamil Nadu Mission (K4 & K5)

CLIMATE CHANGE AND CURRENT ISSUES

References

Text Books

1. Donald Ahrens C and Robert Henson (2018) Meteorology Today: An Invitation to the Atmosphere. Eighth Edition, Brooks/Cole, Cengage Learning, USA.
2. Galvin JFP (2016) An Introduction to the Meteorology and Climate of the Tropics. John Wiley & Sons Ltd., UK.

Reference Books

1. Alberto Troccoli, Laurent Dubus and Sue Ellen Haupt (2014) Weather Matters for Energy. Springer, New York.
2. Ali Fares (2021) Climate Change and Extreme Events, Elsevier Inc., UK.
3. Asit K. Biswas, Cecilia Tortajada (2022) Water Security Under Climate Change, Springer, Singapore.
4. Barry Buzan and Robert Falkner (2022) Great Powers, Climate Change, and Global Environmental Responsibilities, Oxford University Press, UK.
5. Cowie J (2007) Climate Change: Biological and Human Aspects, Cambridge University Press, UK. 32
6. Cynthia Rosenzweig, Martin Parry, Manishka De Mel (2022) Our Warming Planet: Climate Change Impacts and Adaptation, World Scientific Publishing Co. Pte. Ltd., Singapore.
7. Dogra N and Srivastava S (2012) Climate Change and Disease Dynamics in India, TERI, New Delhi.
8. Federico Castillo, Michael Wehner, Dáithí A. Stone (2021) Extreme Events and Climate Change - A Multidisciplinary Approach, John Wiley & Sons, Inc., USA.
9. Friel S (2019) Climate Change and the People's Health (Vol. 2). Small Books Big Ideas in Popul.
10. Kala CP and Silori CS (2013) Biodiversity Communities and Climate Change, TERI, New Delhi.
11. Krishnan R, Sanjay J, Chellappan Gnanaseelan, Milind Mujumdar, Ashwini Kulkarni and Supriyo Chakraborty (2021) Assessment of Climate Change Over the Indian Region - A Report of the Ministry of Earth Sciences (MoES), Government of India, Springer, Singapore.
12. Lawrence A. Palinkas (2020) Global Climate Change, Population Displacement, and Public Health. The Next Wave of Migration. Springer Nature Switzerland.
13. Lyla Mehta, Hans Nicolai Adam, Shilpi Srivastava (2022) The Politics of Climate Change and Uncertainty in India, Routledge, USA.
14. Navroz K. Dubash (2019) India in a Warming World - Integrating Climate Change and Development, Oxford University Press, India.
15. Parry M L (2019). Climate Change and World Agriculture. Routledge.
16. Quaschning VV (2019) Renewable Energy and Climate Change. John Wiley & Sons.
17. Saurabh Sonwani and Pallavi Saxena (2022) Greenhouse Gases: Sources, Sinks and Mitigation, Springer, Singapore.
18. Vinay Kumar, Ashish Kumar Srivastava and Penna Suprasanna (2021) Plant Nutrition and Food Security in the Era of Climate Change, Academic Press, UK.

Core Course – VII

CLIMATE CHANGE AND CURRENT ISSUES

Journal articles

1. Agache I, Sampath V, Aguilera J, Akdis CA, Akdis M, Barry M, Bouagnon A, Chinthrajah S, Collins W, Dulitzki C, Erny B (2022) Climate change and global health: a call to more research and more action. Allergy 77(5):1389-1407.
2. Fankhauser S, Smith SM, Allen M, Axelsson K, Hale T, Hepburn C, Kendall JM, Khosla R, Lezaun J, Mitchell-Larson E, Obersteiner M (2022) The meaning of net zero and how to get it right. Nature Climate Change 12(1):15-21.
3. Figueres C. (2020). Paris taught me how to do what is necessary to combat climate change.
4. Ford HV, Jones NH, Davies AJ, Godley BJ, Jambeck JR, Napper IE, Suckling CC, Williams GJ, Woodall LC, Koldewey HJ (2022) The fundamental links between climate change and marine plastic pollution. Science of the Total Environment. 806:150392.
5. Olabi AG, Abdelkareem MA (2022) Renewable energy and climate change. Renewable and Sustainable Energy Reviews 158:112111.
6. O'Riordan T (2022) COP 26 and Sustainability Science. Environment: Science and Policy for Sustainable Development 64(1):2-3.
7. Zsögön A, Peres LE, Xiao Y, Yan J, Fernie AR (2022) Enhancing crop diversity for food security in the face of climate uncertainty. The Plant Journal 109(2):402-414.

Online resources

1. http://www.un-redd.org/
2. http://unfccc.int/
3. https://www.ipcc.ch
4. https://www.co2.earth/
5. http://www.climatecentral.org/
6. http://climate.nasa.gov/
7. http://www.who.int/mediacentre/news/
8. http://aqicn.org/map/

Core Course – VIII

ENVIRONMENTAL BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS1CO8	100	4	4	-	-	4

Course Objectives

To acquaint students with knowledge in environmental biotechnology for gene cloning, skills in bioremediation of environmental pollutants, and developing innovative biotechnological processes for waste conversion, resource recovery, and production of bioproducts.

Course Outcomes

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

CO1 Understand the principles and methods of DNA manipulation, gene cloning and PCR process

CO2 Understand the basic principles of bioremediation of environmental pollutants

CO3 Explain the role of microbes in the degradation of environmental pollutants

CO4 Acquire skills in manipulating the microbes for the biodegradation of pollutants and develop processes for waste bioconversion to value-added products

CO5 Apply the process for recovery of resources from different wastes and become an entrepreneur/researcher in the area of Environmental Biotechnology.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*		*					
CO2	*	*						
CO3			*					
CO4	*	*	*	*			*	
CO5		*				*		

Core Course – VIII

ENVIRONMENTAL BIOTECHNOLOGY

Unit I: Recombinant DNA Technology and Environment **Contact Hours: 12**

Introduction to Biotechnology - Prokaryotic and Eukaryotic Genome structure - DNA modifying enzymes - Recombinant DNA Technology (R-DNA): Types, Tools, Techniques - Cloning, Cloning vectors, Environmental Genome - Applications of R-DNA Technology in Environment -PCR Techniques: Principles, types, and applications in Environmental Biotechnology (K1, K2, K3, K4) - Role of Environmental Biotechnology in Sustainable Development Goals (K3, K4, K5)

Unit II: Environmental Bioprocess **Contact Hours: 12**

Environmental decontamination: Principles, mechanisms and applications of Biodegradation, Biosorption, Biotransformation, Bioaugmentation, and Biostimulation - Bioremediation - Rhizoremediation - Mycoremediation - Phycoremediation - Bioleaching and Biomining - Microbially Enhanced Oil Recovery (MEOR) - Air Pollution Treatment: Bioscrubber & Biofilters. (K3, K4, K4, K6). Case Study: Bioremediation of Emerging Pollutants.

Unit III: Biotechnology for Resource Recovery **Contact Hours: 12**

Biotechnology for Waste Management: Methods, Biochemical and Molecular insights of Sewage Treatment Process - Activated Sludge Process, Anaerobic Treatment - Sludge treatment: Aerobic Composting, Anaerobic Digestion (Biogas Production) - Sewage Treatment using Algae - Nutrient Removal and Recovery. Solid Waste Treatment and Resource Recovery (K3, K4, K5, K6). Case Study: Sludge Recycling.

Unit IV: Biotechnological Products for Environmental Applications **Contact Hours: 12**

Biotechnological Products for Environmental Clean-up - Microbial biomass - Biosorbents - Biosurfactants - Microbial biocatalyst: Lignocellulases, lipases, Dioxygenases - Bioflocculants - Bioplastics - Biofertilizers - Biopesticides - Microbial fuels: Bioethanol, Biobutanol, and Biohydrogen (K4, K5, K6). Case Study: Bioenergy.

Unit V: Environmental Biomonitoring **Contact Hours: 12**

Principles, Types, and Applications: Bioindicators, Biomarkers, Biosensors, and Biocatalysts - Monitoring of water pollutants through Biosensors (K4, K5, K6) - Biocatalysts - Immobilization of Biocatalysts for Pollutants Monitoring and Remediation (K6). Case Study: Sensor-Based Remediation of Water Pollutants.

References

Text Books

1. Bharani A & K Senthilraja (2022) Introduction to Environmental Biotechnology an Insight into its Latest Advancements. Scientific Publishers. ISBN: 9789390495177
2. Brown T A (1995) Gene cloning - A Introduction - Chapman & Hall, London.
3. Deepak V. et al., (2011) Microbial Biotechnology and Ecology, Daya Publishing House, 9788170356943
4. Mohapatra P K (2008) Text Book of Environmental Biotechnology. IK International Publishers Ltd
5. Thakur I K (2013) Environmental Biotechnology: Basic Concepts and Applications. 2nd Edition.

ENVIRONMENTAL BIOTECHNOLOGY

Reference Books

1. Akinola Rasheed Popoola, Emeka Godfrey Nwoba, James Chukwuma Ogbonna, Charles Oluwaseun Adetunji, Nwadiuto (Diuto) Esiobu, Abdulrazak B. Ibrahim, Benjamin Ewa Ubi. (2022) Bioenergy and Environmental Biotechnology for Sustainable Development. CRC Press, ISBN 9780367767051
2. Alexander N Glazer and Hiroshi Nikaido (1995) Microbial Biotechnology, WH Freeman and Company, NY, USA.
3. Bernaral R. Glick and Jack J. Pastemak (1994) Molecular Biotechnology:
4. Bruce E. Rittmann, Perry L. McCarty (2020) Environmental Biotechnology: Principles and Applications, Second Edition, McGraw-Hill Education, New York.
5. Cheremisinoff N P (1997) Biotechnology for Waste and Wastewater Treatment. Science Direct.
6. Daniel Vallero (2015) Environmental Biotechnology: A Biosystem Approach. 2nd Edition, Elsevier.
7. Fulekar M H (2010) Environmental Biotechnology, CRC Press.
8. Gothandam KM, Shivendu Ranjan, Nandita Dasgupta and Eric Lichtfouse (2020) Environmental Biotechnology Volume 2, Springer Nature Switzerland.
9. Hemen Sarma, Delfina C. Dominguez, Wen-Yee Lee (2022) Emerging Contaminants in the Environment Challenges and Sustainable Practices, Elsevier Science.
10. Indu Bhushan, Durgesh Kumar Tripathi, Vivek K. Singh (2020) Nanomaterials and Environmental Biotechnology, Springer Nature Switzerland AG.
11. Jayanta Kumar Patra, Gitishree Das, Swagat Kumar Das, Hrudayanath Thatoi (2020) A Practical Guide to Environmental Biotechnology, Springer Nature Singapore Pte Ltd.
12. Neetu Sharma, Abhinashi Singh Sodhi, Navneet Batra (2021) Basic Concepts in Environmental Biotechnology. CRC Press.
13. Old R W and Primrose S B (1994) Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, UK.
14. Primrose SB (1994) Molecular Biotechnology, 2nd edition, Blackwell Scientific Publications, UK.
15. Principles and Applications of Recombinant DNA, ASM Press. Washington, DC USA.
16. Ram Lakhan Singh (2017) Principles and Applications of Environmental Biotechnology for a Sustainable Future, Springer.
17. Shah Shachi, Venkatramanan V., Prasad Ram (2021) Bio-valorization of Waste, 1st ed. Springer
18. Sukanta Mondal, Shivesh Pratap Singh, Yogendra Kumar Lahir (2022) Emerging Trends in Environmental Biotechnology, CRC Press.

Web References

1. https://library.senecacollege.ca/
2. www.pollutionissues.com/A-Bo/Bioremediation.html
3. www.bioreactors.net
4. https://dbtindia.gov.in/
5. www.wastewatertreatment.co.in
6. https://www.epa.gov/recycle/composting-home
7. https://www.energy.gov/eere/bioenergy/biofuel-basics
8. https://www.intechopen.com/chapters/51915
9. https://www.redalyc.org/journal/2913/291368646008/html/
10. https://www.netsolwater.com/biotechnology-and-its-use-in-sewage-water-treatment.php?blog=1868
11. https://amapex.net/wastewater-treatment-biotechnology/?lang=en
12. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5609238/
13. https://www.cseindia.org/soil-bio-technology-sbt-3774
14. https://www.climate-policy-watcher.org/industrial-wastes/application-of-biotechnology-for-industrial-waste-treatment.html
15. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750672/
16. https://www.mdpi.com/1424-8220/22/4/1513/htm

Core Course – IX

ENVIRONMENTAL IMPACT ASSESSMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS1C09	100	4	4	-	-	4

Course Objectives

To introduce the methodology of environmental impact assessment (EIA) as a vital tool for sound environmental management and decision-making and to provide an overview of the concepts, methods, issues and various forms and stages of the EIA process.

Course Outcomes

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

CO1 Explain the major principles and components of EIA processes

CO2 List and comply with the environmental clearance procedures in India

CO3 Understand the methods used for EIA studies

CO4 Understand how to liaise with and the importance of stakeholders in the EIA process and access different case studies/examples of EIA in practice

CO5 Summarize the EIA report with suitable environmental management plan

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*			*	*	*	*	*
CO2	*			*	*	*	*	*
CO3	*			*	*	*	*	*
CO4	*			*	*	*	*	*
CO5	*			*	*	*	*	*

Core Course – IX

ENVIRONMENTAL IMPACT ASSESSMENT

Unit I EIA and Environmental Clearance in India Contact Hours: 12

Definition - Principles of EIA - Short-term and Long-term objectives - Evolution of EIA worldwide and in India - Types of EIA: Rapid EIA, Comprehensive EIA and Strategic EIA - General conditions for categorization of projects subject to EIA - Institutional Mechanism – Projects subject to EIA (Category A, B1 and B2) Steps in EIA process - Stages and time frame for obtaining Environmental Clearance from MoEF & CC according to EIA notification 2006 – Merits and Demerits of EIA (K1, K2 & K3) – EIA Draft 2020-\ – Validity of EC for major projects according to EIA 2020 – Pros and Cons of EIA Draft 2020 (K4 & K5)

Unit II Impact assessment and prediction Contact Hours: 12

Impact assessment: Impact characterization - Identifying impacted components - Impacts on land, air, water, noise, biological, and socioeconomic environments (K5 & K6) Impact prediction: EIA Methodologies - Adhoc Method – Checklist Approach – Matrix Method - Network Methods – Overlay Method - 'BEES' (Battelle Environmental Evaluation System) (K2, K3 & K4)

Unit III Public Participation, Preparation and Review of EIA Report Contact Hours: 12

Public participation: Objectives and procedures for Public Participation - Modes of public consultation - Advantages and Disadvantages of Public Participation - Preparation and Review of EIA Report: EIA Reports Content - Basis and Criteria for Evaluation of EIA Reports and EIA (K2, K3 & K4)

Unit IV EIA case studies for major development projects Contact Hours: 12

Major Highways Projects - Airport - River valley Projects – Mining and quarrying - Thermal and Hydroelectric Power Projects - Cement Industries (K3, K4, K5 & K6)

Unit V Environmental Management System Contact Hours: 12

Environmental Management System: Core elements of EMS - Benefits of EMS - Certification body assessments of EMS - Documentation for EMS – ISO 14001 standard – PDCA (Plan-Do-Check-Act) in ISO 14001 Certification – Corporate Social Responsibility (CSR) Plan in India (K4, K5 & K6)

Core Course – IX

ENVIRONMENTAL IMPACT ASSESSMENT

References

Text Books

1. Canter LW (1996) Environmental Impact Assessment. McGraw Hill, New York.
2. EIA Manual (2001) Ministry of Environment, Forest and Climate Change, New Delhi.
3. Tor Hundloe (2021) Environmental Impact Assessment - Incorporating Sustainability Principles, Springer Nature Switzerland.

Reference Books

1. Anjaneyulu Y and Valli Manickam (2021) Environmental Impact Assessment Methodologies, B.S. Publications (ISBN: 9789391910495, 9391910491).
2. Anji Reddy Mareddy (2017) Environmental Impact Assessment - Theory and Practice, BSP Books Pvt. Ltd., India.
3. Bregman JI (1999) Environmental Impact Statements. Lewis Publishers, London.
4. Carroll B, Fothergill J, Murphy J & Turpin T (2019) Environmental Impact Assessment Handbook: A practical guide for planners, developers and communities. ICE Publishing.
5. Christopher S and Mark Y (2007) Environmental Management Systems, (third edition), Earthscan Publications, First South Asian Edition.
6. David LG and Stanley BD (2001) ISO 14000 Environmental Management, Prentice Hall.
7. Eccleston CH (2011) Environmental Impact Assessment - A Guide to Best Professional Practice, CRC Press, USA.
8. Hart SL (2019) Improving impact assessment: Increasing the relevance and utilization of scientific and technical information. Routledge.
9. Peter Wathern (2015) Environmental Impact Assessment: Theory and Practice, Taylor & Francis, London.
10. Singleton R, Castle, P and Sort, D (1999) Environmental Assessment, Thomas Telford Publishing, London.
11. Whitelaw K and Butterworth (1997) ISO 14001: Environmental System Handbook.

Journal articles

1. Chowdhury N (2014) Environmental impact assessment in India: Reviewing two decades of jurisprudence. IUCN Academy of Environmental Law eJournal, 5, 28-32.
2. Dilay A, Diduck AP, Patel K (2020) Environmental justice in India: a case study of environmental impact assessment, community engagement and public interest litigation. Impact Assessment and Project Appraisal 38(1):16-27.
3. Hegde M, Patel K, Diduck AP (2022) Environmental clearance conditions in impact assessment in India: moving beyond greenwash. Impact Assessment and Project Appraisal. 214-227.
4. Rathi AK (2022) Is “consideration of alternatives” in project level environmental impact assessment studies in developing countries an eyewash: an Indian case-study. Journal of Environmental Planning and Management. 65(3):418-440.
5. Singh GG, Lerner J, Mach M, Murray CC, Ranieri B, St-Laurent GP.... & Chan KM (2020) Scientific shortcomings in environmental impact statements internationally. People and Nature 2(2):369-379.

ENVIRONMENTAL IMPACT ASSESSMENT

Online resources

1. http://environmentclearance.nic.in/
2. www.fao.org/docrep/V8350E/v8350e06.htm
3. http://www.moef.nic.in/division/eia-manual
4. http://www.moef.nic.in/circulars
5. https://www.adb.org/documents/adb-environmental-assessment-guidelines
6. http://environmentclearance.nic.in/writereaddata/Draft_EIA_2020.pdf
7. http://environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/GuidanceManual .htm

Core Course – X

ENVIRONMENTAL GEOINFORMATICS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS1C10	100	4	4	-	-	4

Course Objectives

To introduce the principle, process and application of Remote Sensing and GIS, and to impart practical knowledge on the use of environmental geoinformatics and its techniques for environmental management.

Course Outcomes

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

CO1 Acquire adequate knowledge on principles and basic concept of environmental geoinformatics

CO2 Understand the basic concept of GIS and its mechanisms and know the various types of GPS systems

CO3 Learn to interpret satellite images and understand Image Classification Techniques, Image enhancement

CO4 Use GPS for various environmental applications

CO5 Able to apply the tools of remote sensing and GIS for environmental disaster management and conservation

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*				*		*	
CO2				*				
CO3				*	*		*	*
CO4				*	*			*
CO5				*				*

Core Course – X

ENVIRONMENTAL GEOINFORMATICS

Unit I Environmental Geoinformatics **Contact Hours: 12**

Introduction - Principles of Remote Sensing (RS) and GIS - Electromagnetic Radiation: EMR Spectrum and Properties - Use in Environmental Geoinformatics - Types of Satellites, Sensors and Platforms - Geoinformatics in India **(K1, K2)**

Unit II Geographical Information Systems (GIS) **Contact Hours: 12**

Introduction - Components of GIS - Data structures: Vector and Raster data, Conversion of Vector and Raster Data - GIS Layers, Map Registration, Map Projections - Geo Referencing, Digitization and data attributes- Map data representation (K5, K6)

Unit III Global Positioning System (GPS) **Contact Hours: 12**

Introduction - Error Sources and Positioning, GPS Satellite Systems, Types of GPS machines and its applications for surveying and mapping - Global Navigation Satellite System (K1, K2, K3)

Unit IV Image Interpretation and Analysis **Contact Hours: 12**

Principles of Visual Interpretation: Recognition Elements and Interpretation keys - Image Enhancement Techniques: Linear, Non-linear, Contrast Enhancement and Filtering - Principles of Image Classification: Supervised Classification and Unsupervised Classification (K2, K5, K6)

Unit V Applications of RS and GIS **Contact Hours: 12**

Landuse / landcover mapping, Resource mapping, Vegetation analysis, Climate Change Studies, Urban Planning, Disaster Management, Hydrogeology, Pollution and Watershed Management - Emerging new softwares for RS and GIS (K4, K5, K6)

References

Text Books

1. Chouhan T S (2020) Geoinformatics – Fundamentals and Applications, Scientific Publishers.
2. George Joseph (2003) Fundamentals of Remote Sensing, Universities Press (India) Pvt Ltd., Hyderabad.
3. Burrough P. and McDonnel R A (1998) Principles of GIS. Oxford University Press.

Reference Books

1. Chang K T (2006) Introduction to Geographic Information Systems. The McGraw-Hill Publishers.
2. Michael N Demers (2008) Fundamentals of Geographical Information Systems. John Wiley & Sons, Inc.
3. Jenson J R (1996) Introductory Digital Image Processing: Prentice Hall Series.
4. Joseph Awange and John Kiema (2013) Environmental Geoinformatics: Monitoring and Management. Springer Publications.
5. Bhatta B (2008) Remote Sensing and GIS. Oxford Publications.

6. Kang Tsung Chang (2019) Introduction to Geographical Information System. 9th Edition, McGraw Hill Publishers.
7. Anji Reddy M (2016) Geoinformatics for Environmental Management, BS Publications.
8. Xuan Shu (2005) GIS for Environmental Applications: A Practical Approach 1st Edition, New Age International (P) Ltd., Publishers, New Delhi.

Web References

1. https://webapps.itc.utwente.nl/librarywww/papers_2009/general/principlesremotesensing.pdf
2. https://crisp.nus.edu.sg/~research/tutorial/intro.htm
3. https://learn.canvas.net/courses/464/pages/unit-6-dot-2-basic-principles
4. http://www.ai.soc.i.kyoto-u.ac.jp/field_en/english_textbook/RemoteSensing_1.pdf
5. http://www.creaf.cat/earth-observation/gis-and-remote-sensing-methodologies-and- applications
6. https://gisgeography.com/100-earth-remote-sensing-applications-uses/
7. https://dphu.org/uploads/attachements/books/books_4518_0.pdf

Core Course – XI

RESEARCH METHODOLOGY AND INSTRUMENTATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS1C11	100	4	4	-	-	4

Course Objectives

To acquire students about various types of research methodologies, instrument and their working principle, data process, report generation and to train the students to handle various research instruments.

Course Outcomes

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

CO1 Know the types of research and scientific databases, report writing and plagiarism.
CO2 Choose the research thrust areas identify, and design research problems.
CO3 Understand the principles of research methods and instruments required for the research experiments.
CO4 Apply their knowledge on instrumentation for analysis, and field works and data collection.
CO5 Apply the software's for statistical analysis and data interpretation.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2							*	*
CO3				*				*
CO4					*			*
CO5					*		*	*
CO6	*			*		*	*	

Core Course – XI

RESEARCH METHODOLOGY AND INSTRUMENTATION

Unit I Research Methods **Contact Hours: 12**

Basics of Fundamental and Applied Research, Types, scope, hypothesis (K1, K2) - Outcome of research, experimental findings and interpretations, Collection of data and analysis - Types of articles: Research and review articles, short communications, scientific popular articles, reports, editorial note - Components of a Research Article - References - Copyright Act - Plagiarism - Scientific ethics - Process of reviewing - Citation index: h-index - i-10 index and SCI Impact factor (K1, K2, K3)

Unit II Analytical Equipment **Contact Hours: 12**

Principle, Working mechanism and applications of pH meter, Conductivity meter and Nephlometer (K1, K2, K3) - Microcopy: Principles and Applications of light and electron microscopes - Centrifuge: Types, function and applications (K4, K5) - Electrophoretic Techniques: Principles, types and applications - Radioimmune assay techniques - ELISA (K4, K5)

Unit III Separation Techniques **Contact Hours: 12**

Principle and concept of chromatography - stationary phase, mobile phase, partition and adsorption, coefficients (K1, K2, K3) - Instrumentation and applications of Thin layer and Ion-exchange Chromatography, HPLC, HPTLC,

Unit IV Spectrometry **Contact Hours: 12**

Principle and concept of Electromagnetic Radiation - Principle, Components, and Applications of UV-Vis Spectroscopy, Fluorescence Spectroscopy, Fourier-transform infrared spectroscopy (FTIR), Mass spectrometry and X-ray diffraction (XRD) – Liquid Chromatography and Mass Spectrometry (LC-MS), GC-MS (K4, K5, K6)

Unit V Statistical Analyses **Contact Hours: 12**

Statistical Analysis: Sampling Methods and Data Collection - Questionnaire Survey, Experiments and Field works. (K3, K4) Measures of central tendency: Mean, Median and Mode - Merits and demerits - Measures of dispersion: Range, Standard Deviation, Standard Error, Variance, Skewness and Kurtosis; Distribution - Normal, 't' test and chi-square test, Difference among means - ANOVA (K3, K4, K5) - Correlation and Regression - Linear and Multiple - Introduction to statistical Software's (SPSS, R, GraphPad Prism) (K3, K4, K5, K6).

References

Text Books

1. Rt Kumar (2010) Research Methodology: A Step-by-Step Guide for Beginners, SAGE Pub.
2. Gurumani N (2011) Research Methodology for Biological Science. MJP Publishers. ISBN: 9788180940163

Reference Books

1. Christian G D (2001) Analytical Chemistry, 5th edition, John Wiley and Sons Inc., India.
2. Khopkar S M (1993) Environmental Pollution Analysis, Wiley Eastern Ltd.

3. Manahan SE (2007) Environmental Chemistry, 7th edition, Lewis Publications, Florida, USA.
4. Banerjee P K (2004) Introduction to Biostatistics. S. Chand and Co., New Delhi.
5. Manly, Bryan F J (2001) Statistics for Environmental Science and Management, Chapman and Hall / CRC Press, Boca Raton, FL, USA.
6. Skoog D A, Holler F J and Nieman T A (1980) Principles of Instrumental Analysis –5th edition, Thomson Asia Pvt., Singapore.
7. Vogel A I (1998) Quantitative Analysis, 6th edition, Prentice Hall Inc., Willard H H, Merrit L L and Dean J A (1976) Instrumental Methods of Analysis, 5th Edition, Van Nostrand Reinhold.
8. Rastogi V B (2007) Fundamentals of Biostatistics. Ane Books India, New Delhi.
9. Wilson K and Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University Press.

Web References

1. https://www.bio.umass.edu/biology/forms/content/499e-research-methodology
2. www.computerhope.com/os.htm
3. http://www.fao.org/docrep/005/ac665e/ac665e05.htm#TopOfPage
4. http://www.rss.hku.hk/plagiarism/page2s.htm
5. https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/bes2.1258
6. www.fao.org/docrep/W7295E/w7295e08.htm
7. https://chemistrynotesblog.wordpress.com/seperation-techniques/introduction-to-separation-techniques-2/
8. https://www.epa.gov/sites/production/files/2015-05/documents/402-b-04-001b-14-final.pdf
9. https://en.wikibooks.org/wiki/Proteomics/Protein_Identification_-_Mass_Spectrometry/Types_Mass_Spectrometry

Core Course – XII

ENVIRONMENTAL LAW AND POLICIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	22UPEVS1C12	100	4	4	-	-	4

Course Objectives

To introduce the students to the vast field of Law and Policies both at the National and International level relating to the environment.

Course Outcomes

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

CO1 Understand environmental legislation and policies of National and International regime.

CO2 Have an insight into major acts and rules applicable for pollution control and natural resource conservation.

CO3 To develop the skills needed for interpreting laws, policies and judicial decisions about the environment.

CO4 Know regulations applicable to industries and other organizations with significant environmental aspects.

CO5 Apply the legislation concepts for solving the local environmental problems.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				*		*		
CO2				*				
CO3						*		*
CO4				*		*		
CO5						*		

Core Course – XII

ENVIRONMENTAL LAW AND POLICIES

Unit I Environmental Legislation **Contact Hours: 12**

Constitutional provisions in India (Article 48A and 51A), Duties and responsibilities of Indian citizens for environmental protection - Environmental Regulatory Framework in India - Central and State boards for the prevention and control of environmental pollution - Powers and functions of Pollution Control Boards, Penalties and procedure (K1, K2)

Unit II Environmental Laws and their amendments in India **Contact Hours: 12**

Wildlife Protection Act, 1972 amendments1991 - 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 amendments 2022 - Motor Vehicle Act, 1988 - Public Liability and Insurance Act, 1991 - National Green Tribunal Act 2010 - ESA and ESZ Notifications (**K1, K2)**

Unit III Rules for Environmental Protection in India **Contact Hours: 12**

The Hazardous and other Waste (Management and Transboundary Movement) Rules, 2016 - Plastic Waste Management (Amendment) Rules, 2022 - The Bio-Medical Waste Management Rules, 2016 - The Solid Waste Management Rules, 2016 - The e-waste (Management) Rules 2016 with amendments 2022 - The Construction and Demolition Waste Management Rules, 2016 - The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000 - Battery Waste Management Rules, 2022 - Noise Pollution (Regulation and Control) Rules, 2000 - Coastal Regulation Zones (CRZ) 1991 amended from time to time - National Forest Policy, 1988 - Wildlife (Protection) Act 1972, National Water Policy, 2012 - National Environmental Policy, 2006 - Atomic Energy Rules, 1987 - Vehicular emission norms in India (**K1, K2)**

Unit IV International Treaties and Conventions **Contact Hours: 12**

Stockholm Conference on Human Environment 1972 - Montreal Protocol 1987 - 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, IPCC, UNEP, IGBP - Kyoto Protocol 1997, Clean Development Mechanism (CDM), Copenhagen Summit 2009, COP 21 Paris Agreement 2015, COP 26 Glasgow Summit 2021, IPCC Climate Report 2021 - Earth Summit at Johannesburg 2002, RIO+20 - UNDP Sustainable Development Goals (SDGs) 2030 **(K1, K2, K5, K6)**

Unit V Major Initiatives/Policies from Union and State Governments **Contact Hours: 12**

National Policies for Environmental Protection in India: National River Conservation Plan (NRCP), NationalGanga River Basin Authority (NGRBA), Ganga Action Plan Phase I and II, Green India Mission - Environmental Clearances: National Environmental Assessment and Monitoring Authority (NEAMA) - National Green Corps (NGC) - National Missions on Environment – EV Policy in Tamil Nadu - National Policy on Biofuels-2018 Amendment, 2022 - National Hydrogen Policy 2022 (K4, K5, K6)

Core Course – XII

ENVIRONMENTAL LAW AND POLICIES

References

Text Books

1. Leelakrishnan P (2000) Environmental Law in India, Butterworths India Publishers.
2. Maheshwara Swamy N (2010) Textbook on Environmental Law, Asia Law House Publishers.
3. Environmental Administration & Law - Paras Diwaa.
4. Environmental Planning, Policies & Programs in India - K.D. Saxena.
5. Shyam Divan and Armin Rosencranz (2005) Environmental Law and Policy in India, Oxford University Press, New Delhi.
6. Leelakrishnan P (2008) Environmental Law Case Book, Lexis Nexis, Butterworths.

Reference Books

1. Gurudeep Singh (2005) Environmental Law in India, McMillan, New Delhi.
2. Shyam Diwan and Armin Rosencrany (2001) Environmental Law and Policy in India, Oxford University Press, New Delhi.
3. Singh G (1995) Environmental Law: International & National Perspectives.
4. Tamil Nadu Pollution Control Board (1999) Pollution Control Legislation Vol. I and II, Chennai.
5. Maheshwara Swamy (2008) Textbook on Environmental Law, (2nd Edn.), Asia Law House, Hyderabad,
6. Khan I A (2002) Environmental Law, (2nd Edn.), Central Law Agency, Allahabad.
7. Asthana D K and Meera Asthana (2001) Environment Problems and Solutions, (2nd Edn.), S. Chand & Co. Ltd., New Delhi.
8. Shantakumar S (2005) Introduction to Environmental Law, (2nd Edn.), Wadhwa & Company, Nagpur.
9. Shastri SC (2008) Environmental Law, (3rd Edn.), Eastern Book Company, Lucknow

Web References

1. cpcb.nic.in/
2. www.tnpcb.gov.in/
3. www.thesummitbali.com/
4. envfor.nic.in/legis/legis.html
5. edugreen.teri.res.in/explore/laws.htm
6. envfor.nic.in/legis/crz/crznew.html
7. rti.gov.in/
8. www.ngosindia.com/resources/pil.php

Elective Course – I

MARINE BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E01	100	4	4	-	-	4

Course Objectives

To make the student understand the major components of the marine environment and to enable the students with biomedicinal compounds from marine Bioresources. To enrich the students in areas of Probiotics and transgenic fish.

Course Outcomes

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

CO1 Awareness on the physical and chemical elements present in marine environment.

CO2 Knowledge on the biodiversity of different organisms in marine environment

CO3 Understand the bioactive compounds of the marine resources

CO4 Application of marine organisms for production of antibiotics.

CO5 Knowledge on Probiotics microbes to enhanced the aquaculture biotechnology

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2		*						
CO3		*						
CO4			*					*
CO5			*					

Elective Course – I

MARINE BIOTECHNOLOGY

Unit I Introduction to Marine Biotechnology **Contact Hours: 12**

Introduction of Marine Biotechnology - Definition, tools and application - Physical and chemical oceanography - Marine Environment - Deep Sea - Coral reef - Estuaries - Mangrove ecosystems - Diversity of Plankton- Phytoplankton - Zooplankton. (K1, K2, K3)

Unit II Ecology of Marine Biotechnology **Contact Hours: 12**

Ecology of marine flora and fauna - Microscopic (Bacteria, Fungi, Microalgae) - Macroscopic (Sponge and fishes) - Marine Plants-Seaweeds - Seagrasses - Mangrove and their associate plants - Live feed culture Technology - Artemia - Rotifer - Microalgae. (K1, K2, K3)

Unit III Marine Microorganisms **Contact Hours: 12**

Drugs from Marine organisms - Sponge- Coral - Seaweeds- Seagrasses - Mangrove - Drugs from Marine Microbes - Bacteria - Fungi - Actinomycetes - Drugs from marine microalgae Cyanobacteria – Blue-green algae (K1, K2, K3)

Unit IV Application of Marine Biotechnology **Contact Hours: 12**

Biotechnological application of Marine Enzymes - Amylase, Protease, Lipase, Cellulases, from microalgal, Bacteria, Fungi, Actinomycetes - Marine Polysaccharides - Alginic acid - Agar Agar - Carrageen from marine seaweeds (K3, K4, K5, K6)

Unit V Aquaculture Biotechnology **Contact Hours: 12**

Aquaculture Biotechnology-Microbial disease - Vibriosis – Aeromonosis - Viral Disease WSSV (White Spot Syndrome Viral infection) - IHHNV (Infections Hypodermal and Hematopoietic Necrosis Virus) - Probiotics Microbe - Bacteria - Fungi used for Fin and Shell fish's production (K4, K5)

References

Text Books

1. Kim, S. K. "Handbook of Marine Biotechnology", Springer Dordrecht Heidelberg, London New York, 2015.
2. Lavens, P. and Sorgerloos, P. "Manual on the production and use of live food for aquaculture", Food and Agriculture Organization (FAO) of the United Nations, Rome, 1996.
3. Pillay, T.V.R. and Kutty, M.N. "Aquaculture Principles and Practices", Blackwell Publishing Asia Pvt. Ltd, Australia, Second Edition, 2005.

Reference Books

1. Hart, P.J.B. and Reynolds, J.D. "Hand Book of Fish biology and Fisheries-Fish Biology Vol-1," Blackwell Science Pvt. Ltd, USA, 2004.
2. Ravi Shankar, P. "Fish Biology and Ecology", University College of Science, Osmania University, Hyderabad, 2006.

Elective Course - II

MICROBIAL ENZYME TECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E02	100	4	4	-	-	4

Course Objectives

To provide the students with knowledge, understanding, analytical skills in enzymes, their functions, catalytic mechanisms, kinetics, and enzyme applications in various fields.

Course Outcomes

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

CO1 Understand the types, classification, sources, and mechanisms of enzymes and enzyme properties.

CO2 Describe methods of isolation, purification and characterization of enzymes and their kinetics.

CO3 Distinguish the different processes employed in enzyme immobilization and stabilization.

CO4 Identify the various types of enzymes applied in different industries.

CO5 Recognize the role of enzymes in various environmental applications.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*		*					
CO2	*		*					
CO3			*	*				
CO4			*					
CO5		*	*				*	*

Elective Course - II

MICROBIAL ENZYME TECHNOLOGY

Unit I: Introduction to Enzymes **Contact Hours: 12**

Enzymes - Classification, chemical and structural components, sources, types, general properties and functions - Structure: primary, secondary, tertiary and quaternary structure of enzymes - Mechanisms of enzyme action - Techniques used in enzymatic analysis - Commercial values of enzymes. (K1, K2, K3)

Unit II: Enzyme Production, Purification and Characterization **Contact Hours: 12**

Enzyme production methods - enzyme production media - Submerged fermentation (SmF) and solid-state fermentation (SSF) - Optimization of enzyme production - Methods of enzyme purification: Isolation and chromatographic fractionation - Characterization of enzymes and enzyme kinetics. (K1, K2, K3, K4)

Unit III: Biogeochemical Cycles **Contact Hours: 12**

Methods of enzyme immobilization - Physical adsorption, ionic and covalent bonds, binding, entrapment, encapsulation, and cross-linking. Organic and inorganic enzyme immobilization carriers - Natural and synthetic enzyme carriers - Stabilization and Application of immobilized enzymes. (K3, K4, K5)

Unit IV: Industrial Applications of Enzymes **Contact Hours: 12**

Overview of applications of enzymes in biotechnology and various industries – Industrial enzymes - Biotransformation and biocatalysis with crude enzymes, purified enzymes, immobilized enzymes, and whole cell biocatalyst. Extremozymes and their applications. (K1, K2, K3,

Unit V: Environmental Applications of Enzymes **Contact Hours: 12**

Microbial enzymes in environmental applications - Enzymes for soil decontamination and detoxification - Enzymes for water and wastewater treatment and remediation - Enzymes for dehalogenation of organic pollutants - Enzyme catalyzed transformation and detoxification of heavy metals - Role of enzymes in pollution monitoring - Enzymes for waste management.

References

Text Books

1. Aditya Arya, Amit Kumar, Jayanti Jha (2018) Understanding Enzymes: An Introductory Text. Drawing Pin Publishing, New Delhi, India. ISBN: 9788193674000.
2. Devasena, T. (2010) Enzymology, Oxford University Press, India. ISBN: 9780198064435
3. Khan, M Y. and Khan F. (2015) Principles of Enzyme Technology, PHI Learning Pvt Ltd. ISBN: 9788120350410.
4. Nicholas C. Price (2009) Fundamentals of Enzymology, 3rd Edition. Oxford University Press. ISBN: 9780198064398.
5. Prasad N K. Enzyme Technology: Pacemaker of Biotechnology (2012) Prentice-Hall of India Pvt. Ltd. ISBN: 9788120342392.
6. Shanmugam S. and Sathishkumar T. (2009) Enzyme Technology. I K International Publishing House Pvt. Ltd. ISBN: 9789380026053

Elective Course - II

MICROBIAL ENZYME TECHNOLOGY

Reference Books

1. Alka Dwevedi (2016) Enzyme Immobilization. Springer. ISBN: 9783319414188
2. Andreas Vogel, Oliver May (2019) Industrial Enzyme Applications, Wiley-VCH Verlag GmbH & Co. KGaA. ISBN: 9783527343850
3. Bernhard Sonnleitner (2020) Bioanalysis and Biosensors For Bioprocess Monitoring, Springer Nature (Sie) ISBN: 9783662599204
4. Dayananda K. S. (2017) Protein Purification: Theory and Techniques. Viva Books Private Limited. ISBN: 9788130900384
5. Fu J (2016) Immobilized Enzyme Principles, Auris Publishing. ISBN: 9781781548431
6. Neha Srivastava, P.K Mishra, S. N. Upadhyay (2020) Industrial Enzymes for Biofuels Production. ISBN: 9780128210109
7. Peter Grunwald (2009) Biocatalysis Biochemical Fundamentals and Applications. ISBN: 9781860947445

Web References

1. https://www.phindia.com/Books/BookDetail/9788120350410/principles-of-enzyme-technology-khan-khan
2. https://www.brenda-enzymes.org/
3. https://enzyme.expasy.org/
4. https://www.enzyme-database.org/class.php
5. https://www.genome.jp/kegg/annotation/enzyme.html
6. https://comis.med.uvm.edu/vic/coursefiles/MD540/MD540-Protein_Methods_Learning_Module_10400_593281210/Protein-methods/Protein_Methods_print.html
7. http://dedicaciontotal.udelar.edu.uy/adjuntos/produccion/465_academicas__academicaarchivo.pdf
8. https://onlinelibrary.wiley.com/doi/full/10.1002/anie.202006648
9. https://www.easybiologyclass.com/enzyme-cell-immobilization-techniques/
10. https://www.cheric.org/files/education/cyberlecture/e200405/e200405-201.pdf
11. https://application.wiley-vch.de/books/sample/352734683X_c01.pdf

Elective Course – III

ENVIRONMENTAL NANOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E03	100	4	4	-	-	4

Course Objectives

The purpose of this course is to provide background, principles, development of nanomaterials and their applications pertaining to remediation of environmental contaminants, water purification, and to understand the impact of nanomaterials on environment.

Course Outcomes

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

CO1 Understand the background of nanotechnology and its importance

CO2 Understand different types of nanomaterials and their use

CO3 Obtain knowledge on synthesis the of nanomaterials by different methods

CO4 Acquire knowledge on characterization and properties of the nanomaterials

CO5 Understand the application of nanomaterials for the degradation of environmental pollutants

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2		*						
CO3		*						
CO4			*					*
CO5			*					

Elective Course – III

ENVIRONMENTAL NANOTECHNOLOGY

Unit I: Introduction to Nanotechnology **Contact Hours: 12**

Introduction to Nanoscience and Nanotechnology - Nanoscale Properties - Electrical, Optical, Chemical (K1, K2) - Bio-nanotechnology, environmental nanotechnology, Nanotechnology Health risk, Nanotechnology- Ethics, Environmental Regulations of Nanomaterials (K1, K2, K3)

Unit II: Types of Nanomaterials **Contact Hours: 12**

Types of Nanomaterials - Natural Nanomaterials: Nano Biomaterials, Natural adsorbents, polymer adsorbents, viral adsorbents, Biopolymers, Nanobacterium; Engineered Nanomaterials - Carbon-based nanomaterials (K1, K2) - Fullerenes, Carbon Nanotubes; Graphenes, Metal-based Nanomaterials - Metal and Metal oxide Nanoparticles; Dendrimers - Nanocomposites - Nonporous materials.

Unit III: Synthesis and Characterization of Nanomaterials **Contact Hours: 12**

General methods for synthesis of nanomaterials - Bottom-up approach - Top-down approach - Physical methods - ball milling, melt mixing, physical vapour deposition, sputter deposition, evaporation; Chemical methods - chemical reduction, sol-gel method, photochemical synthesis, electrochemical synthesis, emulsion synthesis, sonochemical methods, microwave-assisted synthesis; Biological methods - Green synthesis of nanoparticles using microorganisms: Bacteria, fungi and plants metabolites (K1, K2, K3)

Unit IV: Environmental Applications of Nanomaterials **Contact Hours: 12**

Nanomaterials for environmental remediation - Nanoscale zero-valent iron (NZVI), Titanium dioxide nanoparticles - Bimetallic nanoparticles - Silver nanoparticles - Metal oxide nanoparticles - Nanoadsorbents - Nanocatalysts - Nanoflocculant. Degradation and transformation of environmental pollutants - Halogenated Organic Solvents, Persistent Organic Pollutants, PPCPs, dyes, explosives, toxic heavy metals - arsenic and chromium. Nanoremediation - Ground Water Remediation - Permeable Reactive Barrier - Air purification - Soil remediation. (K3, K4, K5, K6) - Nano biosensors - types and applications.

Unit V: Environmental Impacts of Nanomaterials **Contact Hours: 12**

Engineered Nanomaterials - environmental contamination, exposure, behavior, risks and impacts in water and soil environment - Harmful effects of engineered nanomaterials on Human, Animal Health (K1, K2), Microbial community structure and functions and bioaccumulation - cytotoxic - genotoxic effects (K4, K5)

References

Text Books

1. Pradeep T (2008) Nano: The Essentials - Understanding Nanoscience and Nanotechnology, Tata Mc. Graw Hill Professional.
2. Rao C N R, Muller A, Cheetham A K (2004) The Chemistry of nanomaterials:

Elective Course – III

ENVIRONMENTAL NANOTECHNOLOGY

Synthesis, Properties and Applications.

Reference Books

1. Jeff Norton (2019) Green Nanotechnology, Callisto Reference ISBN: 978-1641161336
2. Giusy Lofrano, Giovanni Libralato, and Jeanette Brown (2017) Nanotechnologies for Environmental Remediation. Springer. ISBN: 978-3-319-53162-5
3. Sung Hee Joo, (2016) Applying Nanotechnology for Environmental Sustainability, IGI Global Publisher.
4. Niemeyer C M, Mirkin C A, (2004) Nanobiotechnology: Concepts, Applications and Perspectives, Wiley VCH.
5. Mirkin C A, Niemeyer C M (2007) Nanobiotechnology - II more concepts and applications, Wiley VCH.
6. Zhang T C, Hu Z, Surampalli R, Tyagi R D, Lai K C K, and Lao I Mc, (2009) Nanotechnologies for Water Environment Applications. American Society of Civil Engineers (ASCE) Publications.
7. Mark Wiesner and Jean-Yves Bottero, (2007) Environmental Nanotechnology: Applications and Impacts of Nanomaterials, McGraw, Hill Professional.
8. Simeonova P P, Opopol N, and Luster M I, (2006) Nanotechnology - Toxicological Issues and Environmental Safety, Springer.
9. Poole C P, and Jr. Owens F J (2003) Introduction to Nano Technology Wiley India Pvt. Ltd.

Web References

1. http://www.gogreenmechanisms.com/service/environment-audit/
2. http://cpcbenvis.nic.in/scanned%20reports/PROBES%2050%20Guidelines%20for%20Environmental%20Audit.pdf
3. http://kb.icai.org/pdfs/PDFFile5b28e322df0fd2.63902464.pdf
4. https://www.sciencedirect.com/topics/engineering/ecodesign
5. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/cleaner-production
6. https://www.gdrc.org/sustdev/concepts/02-c-prod.html
7. http://www.cprac.org/en/sustainable/production/cleaner
8. https://isoconsultantkuwait.com/2019/06/21/iso-140012015-environment-management-system/
9. https://blogs.rsc.org/en/category/board-news/

Elective Course – IV

INDUSTRIAL BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E04	100	4	4	-	-	4

Course Objectives

To learn the screening of industrial strains, fermenters, media, fermentation and downstream processes and to promote the applications of microbes in various industries.

Course Outcomes

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

CO1 Learn the basics of screening and storage of industrially important microorganisms
CO2 Learn the basics of the fermentor and its types
CO3 Learn the production of industrially important fermentation medium
CO4 Develop knowledge about industrial products and their types of the fermentation process
CO5 Develop knowledge about the various biosafety levels of industrial microbiology

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2		*					*	*
CO3		*		*				*
CO4					*			*
CO5					*		*	*

Elective Course – IV

INDUSTRIAL BIOTECHNOLOGY

Unit I Introduction **Contact Hours: 12**

Screening of industrially important microbes - Primary and Secondary screening techniques - Strain development - Preservation: Mineral oil and Lyophilization - Inoculum preparation and Inoculum build-up (K1, K2)

Unit II Fermentor and its types **Contact Hours: 12**

Fermentor: Basic design parts and function - Types of fermentor: Batch, CSTF, Tower fermentor and packed bed bioreactor - Computer applications in fermentation technology (K1, K2)

Unit III Raw materials for fermentation **Contact Hours: 12**

Ideal production medium - Raw materials: Carbon sources (molasses, cheese whey and sulfite waste liquor) - Lipid sources (hydrocarbons and vegetable oils) - Nitrogen sources (corn steep liquor and soya bean meal) (K1, K2, K3)

Unit IV Types of fermentation **Contact Hours: 12**

Fermentation Types: Aerobic fermentation (Penicillin, Vitamin B12), Anaerobic (Ethanol), Solid state (Gibberellic acid) - Organic acid (Citric acid) (K1, K2, K3)

Unit V Downstream process **Contact Hours: 12**

Downstream process - Solid-liquid separation, flotation, flocculation, filtration, centrifugation, release of intracellular products - Cell disruption - Mechanical, chemical and enzymatic, Concentration, evaporation, extraction, membrane filtration, precipitation, purification by chromatography - Formulation - Biosafety levels - Type I, II, III and IV. (K1, K3, K4)

References

Text Books

1. Casida LE Jr, (1993) Industrial Microbiology, 5th edition, Wiley Eastern Ltd, New Delhi.
2. Crueger W and Crueger A, (2000) Biotechnology: A Test Book of Industrial Microbiology, 2nd edition, Panima Publishing Corporation, New Delhi. .
3. Glazer NA and Nikaido H, (2007) Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd edition, Cambridge University Press.
4. Sathyanarayana U, (2017) Biotechnology, Book and Allied (P) Ltd.

Reference Books

1. Patel A H, (2005) Industrial Microbiology, MacMillan India Ltd, Chennai.
2. Peppler H J and Pearlman D, (2004) Microbial Technology – Fermentation Technology, Vol.1 and 2, 2nd edition, Academic Press, London.,
3. Prescott L M, Harley J P and Helin D A, (2002) Microbiology, 5th edition, McGraw Hill, New Delhi.
4. Stanbury P F, (2008) Principles of Fermentation Technology, Elsevier Publications.
5. Glazer A N and Nikaido H, (2007) Microbial Biotechnology. Second edition. Cambridge University Press.

Elective Course – V

PHYTOREMEDIATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E05	100	4	4	-	-	4

Course Objectives

The aim of this course is to introduce students to various novel, eco-friendly phytotechnologies used for decontamination programmes globally.

Course Outcomes

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

CO1 Understand the different types and sources of pollutants and learn how to identify metalliferous habitat types

CO2 Acquire knowledge in different categories of phytotechnologies for the remediation of contaminated substrates

CO3 Understand the basic strategies of metal tolerance mechanism in plants and identify plant species that can be used for phytoremediation

CO4 Understand the important role of hyperaccumulator plants in the conservation of the environment, and will be able to apply their knowledge

CO5 Discuss the practical problems and their solutions, through case studies

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*	*	*				
CO2	*		*	*				
CO3			*	*				
CO4			*	*		*		*
CO5			*	*		*	*	*

Elective Course – V

PHYTOREMEDIATION

Unit I Pollutants and metalliferous habitats **Contact Hours: 12**

Types and Sources of organic and inorganic pollutants– Emerging contaminants (K1, K2) - Extent of global soil pollution (K1, K2) - Classification of primary and secondary metalliferous habitats: Serpentine soils, Calamine soils, Soils rich in Cu and/or Co and Seleniferous soils (K3, K4, K5)

Unit II Categories of phytoremediation **Contact Hours: 12**

Phytoextraction, Phytostabilization, Phytodegradation, Phytovolatilization, Rhizofiltration, Blastofiltration (K1, K2) - Role of PGPR and AMF in phytoremediation (K3, K4, K5)

Unit III Phytoextraction **Contact Hours: 12**

Strategies of phytoextraction: Natural and chelate-assisted hyperaccumulation (K1, K2) - Bioavailability of metals for plant uptake (K1, K2) - Basic strategies for metal tolerance (accumulator, indicator, excluder) (K3, K4, K5) - Heavy metal stress response to plants (K4, K5)

Unit IV Role of hyperaccumulators in phytoextraction **Contact Hours: 12**

Threshold values and biological factor for hyperaccumulators (K1, K2)-Hyperaccumulators for remediation of metal contaminated sites (K3, K4, K5) - Criteria for selection of hyperaccumulators (K1, K2, K3) - Geographical distribution of hyperaccumulators (K2, K3, K4) - Advantages and limitations of phytoextraction (K5) - Disposal and utilization of phytoremediation plants containing heavy metals (K4, K5)

Unit V Global Case Studies **Contact Hours: 12**

Global remediation industry and trends (K4, K5) - Phytomining of Nickel (Ni) - Agromining - Global target regions for phytomining/Agromining - Benefits of agromining agrosystems (K3, K4, K5) - Phytoremediation of Selenium in California (K4, K5) - Phytostabilization of mine tailings (K4, K5) - Application of Artificial Intelligence (AI) to detect and recover contaminated soils (K4, K5)

References

Text Books

1. Antony van der Ent, Guillaume Echevarria, Alan J.M. Baker and Jean Louis Morel (2018) Agromining: Farming for Metals - Extracting Unconventional Resources Using Plants, Springer International Publishing AG.
2. Junaid Ahmad Malik (2022) Advances in Bioremediation and Phytoremediation for Sustainable Soil Management - Principles, Monitoring and Remediation, Springer Nature Switzerland AG.

Reference Books

1. Bhanse P, Kumar M, Singh L, Awasthi MK and Qureshi A, (2022) Role of plant growth-promoting rhizobacteria in boosting the phytoremediation of stressed soils: Opportunities, challenges, and prospects. Chemosphere, 134954.
2. Bolan NS, Kirkham MB and Ok YS, (2018) Spoil to Soil: Mine Site Rehabilitation and Revegetation, CRC Press, USA.
3. Dharmendra K. Gupta, (2013) Plant-Based Remediation Processes, Springer-Verlag Berlin Heidelberg.
4. Khalid Hakeem, Muhammad Sabir, Munir Ozturk and Ahmet Mermut, (2015) Soil Remediation and Plants Prospects and Challenges, Academic Press.

5. Kuldeep Bauddh, John Korstad, and Pallavi Sharma, (2020) Phytorestoration of Abandoned Mining and Oil Drilling Sites, Elsevier Science.
6. Naser A. Anjum, Maria E. Pereira, Iqbal Ahmad, Armando C. Duarte, Shahid Umar and Nafees A. Khan, (2013) Phytotechnologies Remediation of Environmental Contaminants, CRC Press, USA.
7. Prasad MNV, Paulo Jorge de Campos Favas and Subodh Kumar Maiti, (2018) Bio-Geotechnologies for Mine Site Rehabilitation, Elsevier Science.
8. Prasad MNV, (2021) Handbook of Assisted and Amendment-Enhanced Sustainable Remediation Technology, John Wiley & Sons Ltd.
9. Rouf Ahmad Bhat, Fernanda Maria Policarpo Tonelli, Gowhar Hamid Dar and Khalid Rehman Hakeem, (2021) Phytoremediation - Biotechnological Strategies for Promoting Invigorating Environs, Elsevier Science.
10. Vimal Chandra Pandey, (2022) Assisted Phytoremediation, Elsevier Science.
11. Vineet Kumar, Sushil Kumar Shahi, Maulin P. Shah, (2022) Phytoremediation Technology for the Removal of Heavy Metals and Other Contaminants from Soil and Water, Elsevier Science.

Journal articles

1. Chengatt A P, Sarath N G, Sebastian D P, Mohanan N S, Sindhu E S, George S and Puthur J T, (2022) Chelate assisted phytoextraction for effective rehabilitation of heavy metal(loid)s contaminated lands. International Journal of Phytoremediation, 1-16.
2. Karalija E, Selović A, Bešta-Gajević R and Šamec D, (2022) Thinking for the future: Phytoextraction of cadmium using primed plants for sustainable soil clean-up. Physiologia Plantarum, 174(4): e13739.
3. Liu Z and Tran K Q, (2021) A review on disposal and utilization of phytoremediation plants containing heavy metals. Ecotoxicology and Environmental Safety, 226:112821.
4. Nedjimi B (2021) Phytoremediation: a sustainable environmental technology for heavy metals decontamination. SN Applied Sciences, 3:286.
5. Rajendran S, Priya T A K, Khoo K S, Hoang T K, Ng H S, Munawaroh H S H, ... & Show PL (2022) A critical review on various remediation approaches for heavy metal contaminants removal from contaminated soils. Chemosphere, 287:132369.

Online resources

1. https://www.epa.gov/wqc/contaminants-emerging-concern-including-pharmaceuticals-and-personal-care-products
2. https://reliefweb.int/report/world/soil-pollution-hidden-reality
3. https://www.eea.europa.eu/signals/signals-2020/articles/land-and-soil-pollution
4. https://www.fao.org/global-soil-partnership/resources/highlights/detail /en/c/ 1398176/
5. https://resoilfoundation.org/en/environment/fao-soil-pollution-report/
6. https://grist.org/science/phytomining-nickel-kinabalu-park-malaysia/
7. https://kiwiscience.com/phytomining.html
8. https://www.life-agromine.com/en/388-2/
9. https://www.abc.net.au/news/2021-04-09/trees-that-bleed-metal-could-help-power-the-future/100051066
10. https://www.tn.gov/environment/permit-permits/water-permits1/surface-mining-permit/mining-land-reclamation.html

Elective Course VI

Engineering Designs for Waste Management and Energy

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E06	100	4	4	-	-	4

Course Objectives

To gain awareness of environmental pollution and its types, sources, effects, monitoring & control techniques, and to understand the fundamental principles governing the interactions between transport of pollutants in the environment.

Course Outcomes	
On the successful completion of the course, students will be able to	
CO1	Understand the principle of different wastewater treatment engineering systems.
CO2	Have a clear understanding of various types of aerobic treatment reactors and their designs.
CO3	Explain the anaerobic processes and their types and products.
CO4	Understand the processes of design and operation of clean energy systems
CO5	Apply relevant techniques, skills, and modern engineering tools to design treatment reactors.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1			*	*		*		
CO2				*				
CO3								*
CO4				*			*	
CO5						*	*	*

Elective Course VI

Engineering Designs for Waste Management and Energy

Unit I: Design and Principles of Pre and Primary Water Treatment Hours: 12

Water Treatment Process - Overview- Sewer system - design of sewers, estimation of sewage flow. Principle and design of screens, equalization tank, grit chambers, rectangular and circular coagulation, and flocculation tank, and sedimentation tank. Chemically Enhanced Primary Treatment (CEPT) - Design for a Small Community level

Unit II: Design and Principles of Aerobic Treatment Hours: 12

Principles and design of aerobic biological treatment of sewage - Activated sludge process, Oxidation Ditch, Aerobic lagoons, Trickling filters, Sequencing batch reactors, Fluidized-bed bioreactors - Nutrient removal and pathogen reduction.

Unit III: Design and Principles of Anaerobic Treatment Hours: 12

Design of facilities for anaerobic treatment of wastewater and sludge (K5) - Anaerobic digesters and septic tanks, Anaerobic filters, Up-flow anaerobic sludge blanket reactor - Sludge thickening and digestion - Biogas production - Sludge dewatering process, Biosolids - drying and disposal.

Unit IV: Design and Principles of Air Pollution Control Devices Hours: 12

Principle and design of minimum stack height - Settling chamber - Cyclone collector - Fabric filter and Electrostatic Precipitators (ESP) - Scrubbers.

Unit V: Wind Mill, Solar Panel Designs Hours: 12

Wind Turbines- Types - Site Assessment- Turbine, Wind Tower, Foundation, Offshore Turbine - Design. Solar Panels - Types, Specifications Solar Cells - Generic Product Design and Development Process, Energy Output.

References

1. P. Venugopala Rao (2002). Textbook of Environmental Engineering PHI Learning Pvt. Ltd.
2. N. N. Basak (2017). Environmental Engineering Tata McGraw Hill Publishing Company.
3. Air Pollution Control Technology Manual (1998) Overseas Environmental Cooperation Center, Japan.
4. Anne Maczulak (2010) Environmental Engineering: Designing a Sustainable Future, Infobase Publishing, NY, USA.
5. Louis Theodore (2008) Air Pollution Control Equipment Calculations, John Wiley & Sons, NJ, USA.

Elective Course VI

Engineering Designs for Waste Management and Energy

6. Mihelcic JR, Fry LM, Myre EA, Phillips L and Barkdoll BD (2009) Field Guide to Environmental Engineering for Development Workers - Water, Sanitation, and Indoor Air, American Society of Civil Engineers, USA.
7. Pawlowski A, Dudzinska MR and Pawlowski L (2013) Environmental Engineering, CRC Press, Boca Raton, FL, USA.
8. Banshi D. Shukla, (2018) Engineering of Wind Energy, 1st edition Jain Brothers, India
9. Povl Brøndsted and Rogier P.L. Nijssen (Ed.) (2013). Advances in Wind Turbine Blade Design and Materials, Woodhead Publishing Series in Energy.
10. Tiwari G. N. (2012) Energy: Fundamentals, Design, Modelling and Application (Revised Edition), Narosa Publishing House Pvt. Ltd. - New Delhi.
11. Yogi Goswami, D. (2015) Principles of Solar Engineering, 3rd Edition, CRC Press.

Online Resources

1. http://www.suez-environnement.com/design-construction-water-plants/
2. https://www.dsd.gov.hk/EN/Sewerage/Sewerage_Strategy/index.html
3. http://www.eolss.net/sample-chapters/c09/e4-11-05.pdf
4. http://onsite.tennessee.edu/Aerobic%20Treatment%20&%20ATUs.pdf
5. http://www.thomasnet.com/products/air-pollution-control-equipment-780809-1.html
6. https://www.env.go.jp/earth/coop/coop/document/01-apctme/contents.html
7. https://engineeringonline.ucr.edu/blog/what-are-advanced-water-treatment-processes/
8. http://gcus.jp/wp/wp-content/uploads/2014/06/ebd9e233be72625b03c96047573177f9.pdf
9. https://www.diva-portal.org/smash/get/diva2:808135/FULLTEXT02.pdf
10. https://www.host.nl/en/biogas-plants/sludge-treatment/
11. https://www.powerelectronicsnews.com/smart-energy-design-notes-solar-systems/
12. https://courses.edx.org/c4x/DelftX/ET.3034TU/asset/solar_energy_v1.1.pdf
13. https://www.alternative-energy-tutorials.com/wind-energy/wind-turbine-design.html
14. https://web.wpi.edu/Pubs/E-project/Available/E-project-031410-225604/ unrestricted/ Turbine_MQP.pdf

,

Elective Course - VII

BIOREMEDIATION AND BIOECONOMY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E07	100	4	4	-	-	4

Course Objectives

To mainly focus on understanding the different types of in situ and ex situ bioremediation techniques and acquire extensive knowledge pertaining to sustainable bioeconomy opportunities from these techniques.

Course Outcomes

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

CO1 Understand the principles, types and factors influencing bioremediation

CO2 Acquire knowledge of different types of bioremediation techniques including phytoremediation

CO3 Explore the knowledge in different *ex situ* bioremediation technologies with advantages and limitations

CO4 Understand the advanced technologies like nanomaterials used for bioremediation

CO5 Explore the knowledge pertaining to sustainable bioeconomy opportunities from these techniques

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*		*			*	*	*
CO2	*		*	*		*	*	*
CO3			*	*	*	*	*	*
CO4			*			*	*	*
CO5	*		*			*	*	*

Elective Course - VII

BIOREMEDIATION AND BIOECONOMY

Unit I Bioremediation: Principles and Applications Contact Hours: 12

Introduction – Principles of bioremediation - Types of bioremediations - Factors affecting bioremediation process (K1, K2) - Application of bioremediation in environmental management (K3, K4, K5)

Unit II *In-situ* bioremediation techniques Contact Hours: 12

Intrinsic *in situ* bioremediation (K1, K2) - Enhanced *in-situ* bioremediation (K1, K2) - Bioventing - Biosparging - Bioaugmentation - Bioslurping - Biostimulation (K3, K4, K5) - *Phytoremediation*: Phytoextraction, Phytodegradation, Phytostabilization, Phytovolatilization, Rhizofiltration (K3, K4, K5) - Advantages and Disadvantages (K5)

Unit III *Ex-situ* bioremediation techniques Contact Hours: 12

Solid-phase treatment - Slurry-phase bioremediation - Land farming - Biopiling - Biocomposting - Bioreactors (K3, K4, K5) - Advantages and Disadvantages (K5)

Unit IV Recent advances and challenges in bioremediation Contact Hours: 12

Nanomaterials used for remediation of environmental contaminants - Application of metal nanomaterials - Microbial nano-biomolecules in the removal of pollutants - Challenges and opportunities in bioremediation of micro-nano plastics (K4, K5) - Challenges in bioremediation (from lab to land) (K5)

Unit V Sustainable bioeconomy opportunities Contact Hours: 12

Sustainable bioremediation prospects of rice paddies - Ornamental plants for phytoremediation and bioeconomy - Utilization of contaminated lands for cultivation of dye-producing plants - *Prosopis juliflora* and Giant reed as potential candidates for remediation and sustainable bioeconomy - Phycoremediation for biofuels and bioeconomy (K3, K4, K5)

References

Text Books

1. Amitava Rakshit, Manoj Parihar, Binoy Sarkar, Harikesh B. Singh, and Leonardo Fernandes Fraceto, (2021) Bioremediation Science - From Theory to Practice, CRC Press, USA.
2. Prasad M N V, (2016) Bioremediation and Bioeconomy. Elsevier Inc.

Reference Books

1. Junaid Ahmad Malik, (2022) Microbes and Microbial Biotechnology for Green Remediation, Elsevier Inc.
2. Gaurav Saxena, Maulin P. Shah, and Vineet Kumar, (2020) Bioremediation for Environmental Sustainability Toxicity, Mechanisms of Contaminants Degradation, Detoxification and Challenges. Elsevier Inc.
3. Deep Chandra Suyal, and Ravindra Soni, (2022) Bioremediation of Environmental Pollutants - Emerging Trends and Strategies, Springer Nature, Switzerland.
4. Hafiz M.N. Iqbal, Muhammad Bilal, and Tuan Anh Nguyen, (2022) Nano-Bioremediation: Fundamentals and Applications, Elsevier Inc.
5. Junaid Ahmad Malik, (2022) Advances in Bioremediation and Phytoremediation for Sustainable Soil Management Principles, Monitoring and Remediation, Springer Cham.

6. Deep Chandra Suyal, and Ravindra Soni, (2022) Bioremediation of Environmental Pollutants Emerging Trends and Strategies, Springer Nature Switzerland.
7. Prasad MNV and Mirza Hasanuzzaman, (2021) Handbook of Bioremediation Physiological, Molecular and Biotechnological Interventions, Elsevier Inc.

Journal articles

1. Misra M, and Ghosh Sachan S, (2022) Nanobioremediation of heavy metals: Perspectives and challenges. Journal of Basic Microbiology 62(3-4):428-443.
2. Yaashikaa P R, Kumar P S, Jeevanantham S, and Saravanan R, (2022) A review on bioremediation approach for heavy metal detoxification and accumulation in plants. Environmental Pollution 119035.
3. Zhou Y, Kumar M, Sarsaiya S, Sirohi R, Awasthi S K, Sindhu R, Binod P, Pandey A, Bolan N S, Zhang Z, and Singh L, (2022) Challenges and opportunities in bioremediation of micro-nano plastics: a review. Science of The Total Environment 802:149823.
4. Jain M, Khan S A, Sharma K, Jadhao P R, Pant K K, Ziora Z M, and Blaskovich M A, (2022) Current perspective of innovative strategies for bioremediation of organic pollutants from wastewater. Bioresource Technology 344:126305.
5. Patel A K, Singhania R R, Albarico F P, Pandey A, Chen CW, and Dong C D, (2022) Organic wastes bioremediation and its changing prospects. Science of The Total Environment 153889.
6. Yan C, Qu Z, Wang J, Cao L, and Han Q, (2022) Microalgal bioremediation of heavy metal pollution in water: Recent advances, challenges, and prospects. Chemosphere 286:131870.

Online resources

1. https://www.environmentalpollution.in/bioremediation-2/bioremediation-principle-need-advantages-and-limitations-environment/7259
2. http://learnbioremediation.weebly.com/in-situ--ex-situ-bioremediation-treatments.html
3. https://www.iberdrola.com/sustainability/bioeconomy-what-is-it
4. https://www.wbcsd.org/Archive/Factor-10/Circular-bioeconomy-the-business-opportunity-contributing-to-a-sustainable-world
5. https://biotechnologyforbiofuels.biomedcentral.com/articles/10.1186/s13068-021-01939-5

Elective Course – VIII

Sludge Management

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E08	100	4	4	-	-	4

Course objectives

The purpose of this course is to develop an understand the characteristics of industrial and municipal sewage sludge's and the options available for subsequent treatment technologies such as sludge removal and consolidation, conditioning, anaerobic digestion, mechanical dewatering, thermal drying and incineration, combined heat and power, and land application of stabilized sludges for agriculture, horticulture and reclamation uses.

Course Outcomes

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

CO1 Understand how sludge is produced in various wastewater treatment units and its types

CO2 Be able to identify the principle elements of sludge treatment including sludge dewatering techniques.

CO3 Have a clear view of the physical , chemical and biological sludge stabilization techniques

CO4 Acquire broad knowledge on sludge disinfection and final disposal methods and its merits.

CO5 Understand the wide range of potential resource recovery opportunities from sludge and assessing the economic feasibility of the techniques.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*	*	*		*	*	*
CO2	*				*	*		*
CO3		*		*	*	*		
CO4			*	*	*		*	*
CO5	*		*			*	*	*

Elective Course – VIII

Sludge Management

Unit I: Sludge – An Overview **Contact Hours: 12**

Introduction - Sources of sludge (Water treatment plants, Sewage treatment plants, Industrial effluent treatment plants) - Sludge categorization (Primary sludge, Chemical sludge, Biofilter sludge, Activated sludge, Aerobically and anaerobically digested sludge, Septage and Industrial sludge) – Sludge characteristics (Physical, Chemical, Biological) – Sludge generation (Sedimentation sludge, Chemical coagulation sludge, Activated sludge and Municipal waterworks sludge)

Unit II: Sludge Treatment **Contact Hours: 12**

Methods of sludge treatment: Thickening of sludge – Operational principles - Sludge conditioning: Chemical conditioning, Thermal conditioning, Freeze-thaw conditioning, Conditioning process optimization - Factors affecting sludge conditioning - Sludge dewatering – Natural methods (Sludge drying beds and Sludge drying lagoons), Mechanical methods (Vacuum filters, Pressure filter press, Centrifugal dewatering)

Unit III: Sludge Stabilization **Contact Hours: 12**

Introduction - Biological stabilization of sludge - Anaerobic and Aerobic digestion processes - Non-biological sludge stabilization – Alkaline stabilization, Thermal treatment - Chlorine oxidation process and Advancement in physico-chemical methods (Chemical fixation and Cementitious stabilization)

Unit IV: Sludge Disinfection, Thermal Drying & Disposal **Contact Hours: 12**

Disinfection of sludge (Sludge Pasteurization and Sludge storage) - Thermal drying of sludge - Thermal treatment and sludge disposal - Process types: Incineration, Incomplete combustion, Pyrolysis and Thermal processes - Sludge disposal problems and solution (Land, Air and water)

Unit V: Sludge – Resource Recovery **Contact Hours: 12**

Energy and Resource Recovery from sludge – Biofuels (Biogas, Syngas, Hydrogen, Bio-oil, Bio-diesel, Bio-methanol) – Electricity - Beneficial reuse of sludge across the globe - Techno-economic and social feasibility

References

Text Books

1. Bhola R. Gurjar and Vinay Kumar Tyagi (2017) Sludge management, CRC Press, The Netherlands.

2. Tyagi RD, Rao Yadagiri Surampalli, Song Yan, Tian C. Zhang,Cao CM and Lohani BN (2009) Sustainable Sludge Management: Production of Value Added Products, American Society of Civil Engineers.
3. Cleverson Vitorio Andreoli, Fernando Fernandes and Marcos von Sperling (2007) Sludge Treatment and Disposal In: Biological Wastewater Treatment Series, Volume 6, IWA Publishing. London.

Elective Course – VIII

Sludge Management

Web References

1. https://www.iwapublishing.com/sites/default/files/ebooks/9781780402130.pdf
2. https://www.esru.strath.ac.uk/Documents/MSc_2009/Garg.pdf
3. https://www.eea.europa.eu/publications/GH-10-97-106-EN-C/file
4. https://www.eolss.net/sample-chapters/C09/E4-13-01-11.pdf

Elective Course - IX

Principles of Toxicology

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E09	100	4	4	-	-	4

Course Objectives

To introduce and provide basic knowledge on the concept and principles of toxicology, toxic responses and mechanism of toxicity and to give adequate knowledge on xenobiotics and their environmental effects.

Course Outcomes

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

CO1 Know the history, scope and branches of toxicology along with the types and classification of toxicants

CO2 Understand the principles of toxicity and the factors influencing toxicity

CO3 Obtain more knowledge about the mechanisms involved in toxicity and its relevant functions

CO4 Understand the reactions of toxins and their elimination mechanisms

CO5 Adequate knowledge of the immunotoxicity mechanisms and their effects.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2		*					*	*
CO3		*		*				*
CO4					*			*
CO5					*		*	*

Elective Course - IX

Principles of Toxicology

Unit I Toxicology **Contact Hours: 12**

Definition, history, scope & sub-divisions of toxicology - Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxicants (K1, K2, K3)

Unit II Toxicity Principles **Contact Hours: 12**

Dose-effect and dose-response relationship - Acute and chronic toxicity, Reversible and irreversible effects - Factors affecting toxicity: species and strain, age, sex, nutritional status, hormones, environmental factors and circadian rhythms (K1, K2, K3)

Unit III Toxicity Mechanisms **Contact Hours: 12**

Absorption and distribution of toxicants: Portals of entry - Skin, gastrointestinal tract, gills and respiratory system - Biodistribution, biomagnification biotransformation of xenobiotics - Brief introduction to Phase-I and Phase-II reactions (K1, K2, K3)

Unit IV Toxic Reactions **Contact Hours: 12**

Reactions of toxins with target molecules - Covalent bonding, non-covalent bonding, Hydrogen abstraction, Electron transfer, Enzymatic reactions - Elimination of toxicants: Renal, hepatic, DMES, pulmonary systems, milk, egg and foetus (K2, K3, K4)

Unit V Immunotoxicity **Contact Hours: 12**

Immunotoxicity: Mechanisms of immunotoxicity, immunosuppression - Direct effects and indirect effects of xenobiotics - immune-mediated diseases, immunotoxicity of lead and TCDD (K3, K4, K5)

References

Text Books

1. Karen E Stine and Thomas Miller Brown, (2015) Principles of Toxicology, CRC Press Publishers.
2. Gupta P K, (2016) Fundamentals of Toxicology: Essential Concepts and Applications, Academic Press.
3. Klaassen Curtis D, Casarett Louis J and Doull J, (2013) Casarett and Doull's Toxicology: The basic science of poisons (8th Edition), McGraw Hill.

Reference Books

1. Ted A. Loomis, Wallace Hayes A, (1996) Loomis's Essentials of Toxicology. 4th Edition, Academic Press.
2. Shaw I and Chadwick J, (1998) Principles of Environmental Toxicology, CRC Press LLC.
3. Ernest Hodgson, (2011) A Textbook of Modern Toxicology, 4th Edition, Wiley.

Web References

1. 0002199519.indd (wiley.com)
2. introtox-020909.ppt (ufl.edu)
3. lecnote_fm_degree and diploma Med Bacteriology (cartercenter.org)

Elective Course – X

PESTICIDE TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E10	100	4	4	-	-	4

Course Objectives

To focus and provide knowledge on the types of pesticides, their toxicity mechanisms and to characterize the adverse effects of pesticides on the ecosystem and humans.

Course Outcomes

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

CO1 Know about pesticides, their types and properties

CO2 Understand the mechanism of pesticide toxicity and relevant regulations

CO3 Obtain more knowledge about the systemic toxicity of pesticides

CO4 Understand the significance of environmental issues due to pesticide toxicity

CO5 Gains adequate knowledge on pesticide toxicity to humans and its relevant case studies.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2		*					*	
CO3		*						*
CO4			*					
CO5								*

Elective Course – X

PESTICIDE TOXICOLOGY

Unit I Pesticides **Contact Hours: 12**

Introduction to pesticides - Types, general classification - Pesticides in the environment - Bioaccumulation and bio-magnification of pesticides (K1, K2, K3)

Unit II Pesticide Toxicity - Mechanisms **Contact Hours: 12**

Pesticide Toxicity - Mode of Action – ADME Process - Biotransformation Reactions - Dose-Response Relationship - Quantification Endpoints - Safety Limits - National and International statutory guidelines (K1, K2, K3)

Unit III Systemic Toxicity of Pesticides **Contact Hours: 12**

Neurotoxicity of pesticides - Neuropathy, Reproductive & developmental effects, carcinogenicity, immunological effects - Toxicity of pesticides in fish, birds, wild animals - Bioindicators of pesticide exposure (K1, K2, K3)

Unit IV Pesticides – Environmental Issues **Contact Hours: 12**

Environmental problems by organochlorine pesticides - Case studies of DDT, Endosulphan, Benzene hexachloride (Lindane) - Environmental problems by organophosphate pesticides - Case studies of parathion, malathion and pyrethroids - Emerging new pesticides - Toxicological concerns (K2, K3, K4)

Unit V Pesticide Toxicity in Humans **Contact Hours: 12**

Toxicity of pesticides in man - Systemic toxicity - Assessment methods - Pesticide residues in food - Case studies: Handigodu syndrome, BHC poisoning in Turkey, and endosulfan toxicity in Kerala (K3, K4, K5)

References

Text Books

1. Jorgen Tenerson, (2004) Chemical Pesticides: Mode of Action and Toxicology 1st Edition, CRC Press.
2. Klaassen Curtis D, Casarett Louis J and Doull, J, (2013) Casarett and Doull's Toxicology: The basic science of poisons (8th Edition) McGraw Hill.
3. Ted A. Loomis, Wallace Hayes A, (1996) Loomis's Essentials of Toxicology, 4th Edition, Academic Press.

Reference Books

1. Robert Krieger, (2010) Haye's Hand Book of Pesticide Toxicology – Principles and Agents, 3rd Edition. Elsevier Science.
2. Dileep K Singh, (2012) Pesticide Chemistry and Toxicology, Bentham Publishers.
3. Baker S R, (1998) The Effects of Pesticides on Human Health (Advances in Modern Environmental Toxicology), Princeton Scientific Publishers.

Web References

1. ESRP532Lecture9092904.pdf (wsu.edu)
2. FM 1..4 (ethernet.edu.et)
3. Toxicology of Insecticides.pdf - APPLIED ENTOMOLOGY TOXICOLOGY OF INSECTICIDES Dileep K. Singh Department of Zoology University of | Course Hero

Elective Course - XI

APPLIED TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E11	100	4	4	-	-	4

Course Objectives

The overall aim of this course is to acquire theoretical and applied knowledge on the effects of toxic chemical substances on environment including human health.

Course Outcomes

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

CO1 Be able to describe the toxicology application in various fields.

CO2 To sign and symptoms of various toxicants

CO3 Make critical and independent assessments of methods and results.

CO4 Gains the adequate knowledge on toxicity to humans and its relevant case studies.

CO5 The objective of the toxicology graduate program is to train high-quality understanding in applied toxicology with a heightened respect for the environment and protection of the health of workers and consumers.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2		*			*			
CO3		*					*	
CO4						*		
CO5					*			*

Elective Course - XI

APPLIED TOXICOLOGY

Unit I Application toxicology **Contact Hours: 12**

Overview of Introduction: principles of applied toxicology, Academic applications, Industrial applications and various toxicology (K1, K2)

Unit II Veterinary and Wildlife Toxicology **Contact Hours: 12**

Veterinary Toxicology: Common toxicity in dogs, cats, horses and poultry by herbicides, household chemicals, heavy metals, mycotoxins, blue green algae and toxic plants - *Wildlife Toxicology*: Susceptibility of wildlife to chemicals - Acute ecological hazards - Toxicology of chemicals in birds and mammals - Integrated approach to Wildlife Toxicology (K3, K4, K5)

Unit III Cosmetic and Medical Toxicology **Contact Hours: 12**

Cosmetic Toxicology: Toxicity of shampoos, conditioners, bleachers, dyes, allergic and respiratory disorders - *Medical Toxicology:* Mission of Medical Toxicology - Comparative Toxicology - Human risk assessment - Toxicological database (K3, K6)

Unit IV Forensic and Preventive Toxicology **Contact Hours: 12**

Forensic Toxicology: Specimen sample collection - Types of testing - Detection of poisons - Applications of Forensic Toxicology - *Preventive Toxicology*: Bioremediation, Toxic site reclamation, prevention of occupational diseases (K3, K4, K5)

Unit V Toxicology of chemical warfare and Regulatory Toxicology **Contact Hours: 12**

Chemical weapons - Classification of chemical warfare agents, mustard gas, lewisite, nerve agents and hydrogen cyanide - Management of chemical warfare agents. Regulatory agencies - Regulation of Industrial chemicals in USA and EU - Regulation of pesticides, Regulation of pharmaceuticals - Regulation of food additives (K3, K4, K5, K6)

References

1. A Textbook of Modern Toxicology, Fourth Edition,2010, A John Wiley & Sons, Inc., Publication Ernest Hodgson, North Carolina, North Carolina, USA
2. Perspectives in Basic and Applied Toxicology, 1988, Bryan Ballantyne, Elsevier, UK
3. Introduction to Environmental Toxicology, 2010, Book by Ming-Ho Yu and Wayne Landis, CRC Press, London
4. Environmental Toxicology: Biological and Health Effects of Pollutants, Third Edition, Ming-Ho Yu, Humio Tsunoda, Masashi Tsunoda, 2011, CRC Press, London
5. A Textbook Of Applied Toxicology, Dr. Muneesh Kumar, Dr. Sangeeta Devi, 2021, Darshan Publishers, India

Elective Course - XI

APPLIED TOXICOLOGY

Journal References

1. https://www.longdom.org/scholarly/applied-toxicology-journals-articles-ppts-list-4173.html
2. https://analyticalsciencejournals.onlinelibrary.wiley.com/hub/journal/10991263/homepage/forauthors.html
3. https://home.liebertpub.com/publications/applied-in-vitro-toxicology/626/for-authors
4. https://watermark.silverchair.com/toxsci_1992_18_1
5. https://typeset.io/formats/wiley/journal-of-applied-toxicology/17388b2ed880c44413e67b371ec63418

Web References

1. http://pustaka.unp.ac.id/file/abstrak_kki/EBOOKS/Environmental%20Toxicology%203rd%20edition.pdf
2. https://phpt.uonbi.ac.ke/sites/default/files/cavs/vetmed/phpt/JLS%20105%20Environmental%20Toxicology-1.pdf
3. http://www.eolss.net/sample-chapters/c09/e4-12.pdf
4. https://analyticalsciencejournals.onlinelibrary.wiley.com/journal/10991263
5. https://www.academia.edu/49705482/General_and_Applied_Toxicology

Elective Course – XII

OCCUPATIONAL AND INDUSTRIAL TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I/II/III/IV	22UPEVS1E12	100	4	4	-	-	4

Course Objectives

Graduates will develop a broad range of skills, knowledge and experience required for successful careers in all sectors of the chemical industry, laboratories engaged in the analysis and biological activity of toxic substances, the food industry and the analysis of genetic material for forensic purposes.

Course Outcomes

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

CO1 Be able to describe the composition and functional toxicology principles

CO2 Be able to understand the regulatory perspective and risk assessment of toxic agents

CO3 Be able to independently plan, evaluate and improve animal experiments, under consideration of the latest ethical criteria and species-appropriate animal husbandry, in order to positively influence the well-being of the animals in line with the 3Rs while generating scientific data to the highest standards

CO4 To understand the nature of toxic agents and be able to understand the side effects and their management

CO5 To understand signs and symptoms of various toxicants

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2		*			*			
CO3		*		*			*	
CO4						*	*	
CO5			*		*			*

Elective Course – XII

OCCUPATIONAL AND INDUSTRIAL TOXICOLOGY

Unit I Toxic substances and Occupational hazards Contact Hours: 12

Toxic substances: Toxicity of monomers, solvents, intermediates and products – Toxic substrates – Metals and other inorganic chemicals - Organic compounds – Persistent chemicals - *Occupational hazards*: Physical hazards, Chemical hazards, Biological hazards, Mechanical hazards, and Psychosocial hazards (K1, K2, K3)

Unit II Occupational diseases and prevention Contact Hours: 12

Occupational diseases: Pneumoconiosis, silicosis, asbestosis, anthracosis, byssinosis, bagassosis, Farmers' lung diseases *Prevention of occupational diseases*: Medical measures, Engineering measures and Legislative measures - Occupational health in India (K1, K2, K3)

Unit III Occupational Cancer and Risk assessment Contact Hours: 12

Occupational Cancer: Skin cancer, Lung cancer, Bladder cancer and Leukaemia - *Risk assessment*: Risk assessment for industrial chemicals in EU, OECD and USA - Risk management of industrial chemicals (K3, K4, K6)

Unit IV Industrial Toxicology Contact Hours: 12

History and basic features - Industrial hygiene - Concepts of Industrial hygiene, TLV, MAK, OES, ACGIH and OSHA - Biological monitoring of industrial solvents, metals and pesticides (K3, K4, K5)

Unit V Case Studies Contact Hours: 12

Case Studies in Risk Assessment Pharmaceutical, Petroleum, Carbide industry, Textile and Leather Industries (K3, K4, K6)

Reference Books

1. Timothy C. Marrs and Bryan Ballantyne, 2004, Pesticide Toxicology and International Regulation; John Wiley and Sons; 2004, USA
2. Gunnar F. Nordberg, Bruce A. Fowler, Monica Nordberg, and Lars Friberg, 2007, Handbook on the Toxicology of Metals; 2007 Third Edition; Academic Press.
3. Ramesh C. Gupta, 2007, Veterinary Toxicology Basic and Clinical Principles, First Edition; Academic Press.
4. Michael J. Deralanko and Mannfred, 2002, A Hollinger, Handbook of Toxicology, Second Edition, Taylor and Francis.
5. John Davey and Mike Lord, 2003, Department of Biological Sciences, The University of Warwick, Coventry CV4 7AL, UK. Essential Cell Biology Volume 2: Cell Function A Practical Approach

6. Toxicity Testing in the 21st Century: A Vision and A Strategy; The National Academies Press; 2007.

7. Frank A. Barile, 2008, Principles of Toxicology Testing; Taylor and Francis Group.

8. Michael J. Deralanko and Mannfred A. Hollinger, 2002, Handbook of Toxicology. 2nd Edition, Taylor and Francis.

9. Phillip L. Williams Robert C. James, and Stephen M. Roberts, 2000, Principles of Toxicology Environmental and Industrial Applications; Second Edition; John Wiley and Sons.

Journal References

1. https://occup-med.biomedcentral.com/
2. https://occup-med.biomedcentral.com/articles
3. https://paperpile.com/s/journal-of-occupational-medicine-and-toxicology-citation-style/
4. https://journals.sagepub.com/home/tih
5. https://pubs.acs.org/doi/10.1021/ed027p585.3

Web References

1. https://accesspharmacy.mhmedical.com/content.aspx?bookid=1540&sectionid=92529122
2. https://journals.sagepub.com/doi/pdf/10.3109/10915818309140666
3. https://watermark.silverchair.com/kqg116.pdf?token=
4. https://www.routledge.com/Occupational-Toxicology/Winder-Stacey/p/book/9780367394554
5. https://vula.uct.ac.za/access/content/group/9c29ba04-b1ee-49b9-8c85-9a468b556ce2/DOH/Module%203%20_Toxom%20I_/toxom1/Tox-RE1.htm

Supportive Course - I

ECOLOGY AND ENVIRONMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS1SO1	100	4	4	-	-	4

Course Objectives

To introduce and provide basic knowledge on the concept and principles of Environmental Science, ecology and ecosystems, and to give adequate knowledge on natural resources, biodiversity and their conservation.

Course Outcomes

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

CO1 Understand the basic concept and functions of environment, ecology and ecosystem.

CO2 Understand the different environmental compartments and their structure and functions in the ecosystem.

CO3 Obtain more knowledge about population ecology and its specific relationships.

CO4 Understand the significance and need for environmental protection and sustainability.

CO5 Adequate knowledge on the status of available natural and biodiversity resources and their conservation.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*							
CO2	*							
CO3	*							
CO4	*		*			*		*
CO5	*					*		*

Supportive Course - I

ECOLOGY AND ENVIRONMENT

Unit I Environment and Ecology **Contact Hours: 12**

Ecology: History, Scope and Importance - Components and structure of the environment: Atmosphere, Hydrosphere, Lithosphere and Biosphere (K1, K2 & K3)

Unit II Ecosystem **Contact Hours: 12**

Types of ecosystem - Terrestrial and aquatic ecosystem - Structure and functional aspects of the ecosystem: Food Chain, Food Web, Ecological pyramids, Energy flows - Productivity of an ecosystem - Biogeochemical cycles (Carbon, Nitrogen, Sulphur, and Phosphorous) - Ecological succession: Types and stages (K1, K2 & K3)

Unit III Population Ecology **Contact Hours: 12**

Levels of Organization, Population characteristics: Density, Natality, Mortality, Survivorship curves, Age distribution, Growth curves - Population interactions: Co-evolution, Neutralism, Symbiosis, Commensalism, Mutualism, Antagonism, Antibiosis, Parasitism, Predation, and Inter and Intraspecific competitions (K1, K2 & K3)

Unit IV Natural Resources and Conservation **Contact Hours: 12**

Classification and significance of natural resources - Soil, Forest, Water, Wildlife and Mineral resources - Conservation strategies of natural resources (K2, K3 & K4)

Unit V Biodiversity and Conservation **Contact Hours: 12**

Types of Biodiversity: Species, Genetic, and Ecosystem diversity - Megadiversity Nation and Hot Spots in India (K2 and K4) - Biodiversity Conservation: *In situ* and *Ex-situ* conservation measures - Values of Biodiversity: Food, Medicine, Raw Material, Aesthetic and Cultural values - Biopiracy and Bioprospecting (K3, K4 & K5)

References

Text Books

1. Sharma P D (2015) Ecology and Environment (12th Edition). Rastogi Publications, New Delhi.
2. Eugene P. Odum and Gary W. Barrett (2004) Fundamentals of Ecology (5th Edition) Brooks/Cole Publishers.
3. Krishnamurthy KV (2003) An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.

Reference Books

1. Rana SVS (2005) Essentials of Ecology and Environmental Sciences, Prentice-Hall of India Private Limited, New Delhi, India.
2. Muthuchelian K (2013) Glimpses of Animal Biodiversity, Astral International (P) Ltd., New Delhi.
3. Muthuchelian K (2013) Uyir Virimam (Tamil), Pranisha Pathippagam, Madurai.

4. Muthuchelian K (2016) Bioinformatics, Barcoding and Benefit Sharing in Biodiversity Educationist Press, New Delhi.
5. Richard Frankham, Jonathan D Ballou and David A. Briscoe (2010) Introduction to Conservation Genetics, Second edition, Cambridge University Press, UK.
1. Santosh Kumar Upadhyay and Sudhir P Singh (2021) Bioprospecting of Plant Biodiversity for Industrial Molecules, John Wiley & Sons Ltd., USA.
2. Tim Burt and Des Thompson (2020) Ecology, Biodiversity and Conservation, Cambridge University Press, UK.

Web References

1. http://www.newagepublishers.com/samplechapter/000964.pdf
2. www.ecosystem.org/types-of-ecosystems
3. www.ecologyconnections.ca/pop3research.php
4. http://ocw.korea.edu/ocw/college-of-life-sciences-and-biotechnology/general-biology/PDF/10-1GeneralBiol%20CH50.pdf
5. www.uic.edu/classes/bios/bios101/competitionmurray.PPT
6. www.india.gov.in/topics/environment-forest/natural-resources
7. www.jamaicachm.org.jm/BHS/conservation.htm

Supportive Course – II

ENVIRONMENTAL POLLUTION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS1SO2	100	4	4	-	-	4

Course Objectives

To gain awareness of environmental pollution and its types, sources, effects, monitoring & control techniques, and to understand the fundamental principles governing the interactions between transport of pollutants in the environment.

Course Outcomes

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

CO1 Learn about the air, water and soil pollutants, sources and its effects

CO2 Have clear understanding on the air, water, noise and radiation standards and its techniques

CO3 Understand the different impacts on environment from various pollutants

CO4 Understand the emerging contaminants and their impacts on the environment

CO5 Apply relevant techniques, skills and modern engineering tools to solve the environmental problems

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		*						
CO2				*				
CO3		*		*				
CO4		*	*	*				*

Supportive Course – II

ENVIRONMENTAL POLLUTION

Unit I Introduction **Contact Hours: 12**

Environment: Introduction and Scope, Components of Environment: Structure and composition of Atmosphere, Hydrosphere, Lithosphere, and Biosphere - Pollution: Definition, Sources, Types, Pollution-related diseases and control measures.

Unit II Air Pollution **Contact Hours: 12**

Sources (Natural, Anthropogenic, Stationary, mobile and Area specific), Types of Air Pollutants (Primary and secondary; Organic and Inorganic) - History of air pollution, Transport and diffusion of pollutants - Atmospheric reactions: Ozone formation and depletion, Acid rain, Photochemical Smog - Effects of air pollutants in the environment - Methods of monitoring and control of air pollution: SO_2, NOx, CO, SPM.

Unit III Water Pollution **Contact Hours: 12**

Types, sources (Point and Non-point) and Water pollution episodes (K2 & K3) - Eutrophication - Water sampling (K3 & K4) - Water quality and standards - Wastewater treatment technologies (K4). *Marine Pollution*: Sources of marine pollution and its control (K2 & K4) - Effects of pollutants on human beings, plants, and animals. Emerging Water Pollutants: Microplastics, Personal Care Products, and nanomaterials.

Unit IV Soil Pollution **Contact Hours: 12**

Sources - Soil sampling methods - Soil quality: Soil organic carbon, Soil organic matter, Mineral nutrients - Effects of soil pollution on the environment - Soil pollution control and remediation techniques.

Unit V Noise, Thermal, and Radiation Pollution **Contact Hours: 12**

Sources of noise pollution (K1 & K2) - Measurement and indices (K4) - Effects and control measures (K3 & K4). Thermal Pollution - Sources & Effects (K2 & K4) - Radiation Pollution - Sources, Measurement, Units and control techniques.

References

Text Books

1. Shafi S M (2005) Environmental Pollution. Atlantic Publishers & Dist.

Reference Books

1. Khitoliya R K (2012) Environmental Pollution, 2nd edition, S. Chand Publishing.
2. Khopkar, S M (2013) Environmental Pollution: Monitoring and Control, New Age International Publishers.
3. Cunningham W P and Cunningham M A (2004) Principles of Environment Science. Enquiry and Applications. 2nd ed. Tata McGraw Hill, New Delhi.
4. Sharma B K (2000) Environmental Chemistry, Goel Publishing House, Meerut
5. Pardeep Singh, Ajay Kumar and Anwesha Borthakur (2019) Abatement of Environmental Pollutants Trends and Strategies, Elsevier Science.
6. Hemen Sarma, Delfina C. Dominguez, Wen-Yee Lee (2022) Emerging Contaminants in the Environment Challenges and Sustainable Practices, Elsevier Science.

Web References

1. www.uccee.org/Environmental_Pollution.html
2. www.who.int/topics/environmental_pollution/en/
3. www.nrdc.org/water/environment.nationalgeographic.com/environment
4. www.noisecontrol.com/the-common-causes-of-noise-pollution
5 www.conserve-energy-future.com/causes-and-effects-of-soil-pollution.php

Supportive Course – III

ENVIRONMENTAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS1SO3	100	4	4	-	-	4

Course Objectives

To understand the role of environmental health, protection, safety at work, occupational health and safety, compliance and best practices.

Course Outcomes

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

CO1 Understand the importance of maintaining a safe workplace, safety standards and with regulatory requirements

CO2 Acquire knowledge on industrial pollution and environmental diseases

CO3 Understand the workplace injury, its prevention, risk management, incident investigations and the role of safety in the business community

CO4 Understand the acute and chronic health effects of exposure to physical, chemical and biological agents in the workplace.

CO5 Demonstrate knowledge of different types of exposure and biological effects, exposure guidelines and basic workplace monitoring

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*			*				
CO2		*						
CO3		*		*				
CO4		*					*	
CO5	*			*			*	

Supportive Course – III

ENVIRONMENTAL HEALTH AND SAFETY

Unit I Environmental Health **Contact Hours: 12**

Concept and scope - Global and regional perspectives - Basic requirements for a healthy environment - Environmental quality, human exposure and health impact - impact of environmental factors on human health, Health and Safety Act, Environmental factors in community, occupational and residential settings impact health

Unit II Industrial Pollution and Chemical Safety **Contact Hours: 12**

The extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at the workplace, Industrial environmental accidents - Concept of threshold limit values – Air sampling strategies – Personal exposure monitoring

Unit III Environmental Diseases **Contact Hours: 12**

Asbestosis, Silicosis, Sycosis, Asthma, Fluorosis, Arsenicosis and Allergies; Epidemiological issues - Malaria and Kala –azar, Covid19.

Unit IV Occupational Safety and Health **Contact Hours: 12**

Occupational hygiene/safety and disease; Principles and methods of occupational health, Health problems due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazards in agriculture - Pesticide impacts on the environment and human health - Personal protective equipment, Viral and bacterial infections, Training for Safety and Health

Unit V Environmental Health Hazard, Risk Assessment and Management **Contact Hours: 12**

Hazard and risk, Biological, chemical, physical and psychological health hazard; Health risk assessment and management - Current environmental risk assessment methods - Major agencies and organizations involved in environmental health protection - Safety and Health Management System model - Participation and Representation, Training, Awareness and competence; Document Control: Safety and Health Management System records: Operational Control – Workplace Precautions

References

Text Books

1. Shaw J. Chadwick (1998) Principles of Environmental Toxicology, Taylor& Francis Ltd
2. AnnaleeYassi, TordKjellstr"om, Theo de Kok, Tee Guidotti (2001) Basic Environmental Health, Oxford University Press.

Reference Books

1. Shaw, J. Chadwick (1998) Principles of Environmental Toxicology, Taylor& Francis Ltd
2. Annalee Yassi, Tord Kjellstr"om, Theo de Kok, Tee Guidotti (2001) Basic Environmental Health, Oxford University Press
3. Monroe T. Morgan (2003) Environmental Health, Third Edition, Thomson/Wadsworth Publishers.
4. Koren H (2002) Handbook of Environmental Health and Safety - Principle and Practices, Fourth Edition, Lewis Publishers, CRC Press.
5. Risk assessment- A Practical Guide, (1993) Institution of Occupational Safety and Health, United Kingdom.

Supportive Course – III

ENVIRONMENTAL HEALTH AND SAFETY

Web References

1. www.ehs.ucsb.edu/
2. www.ifc.org/ehsguidelines
3. slintec.lk/wp-content/uploads/2011/08/HealthSafetyManual.pdf

Supportive Course – IV

GLOBAL ENVIRONMENTAL ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS1SO4	100	4	4	-	-	4

Course Objectives

To focus on major global environmental issues including population explosion, biodiversity loss, pollution, energy use, climate change and best environmental technologies for a sustainable development. To know how they are managed in various settings around the world.

Course Outcomes

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

CO1 Clearly identify important global, national, and local issues relating to population, food, and the environment

CO2 Understand the global consequences of climate change

CO3 Acquire knowledge pertaining to the overexploitation of natural and biodiversity resources

CO3 Understand various global disasters and their effective management

CO4 Acquire knowledge related to the sustainable environmental management practices

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				*		*		
CO2				*				
CO3						*		*
CO4				*		*		

Supportive Course – IV

GLOBAL ENVIRONMENTAL ISSUES

Unit I Human Population and Environment **Contact Hours: 12**

Basic demographic concepts: Growth, fertility, mortality and migration - Overview of population growth - Population distribution - Urbanization - Poverty, Food security, Waste Disposal - Environmental degradation and Public health - Development and Modernization versus Environment - Pandemic and social issues (K1, K2)

Unit II Global Atmospheric Changes **Contact Hours: 12**

Global Air Quality, Air Quality Index and CO_2 concentration scenario - Sources of greenhouse gases - Greenhouse effect and Global warming - Facts and figures of current global warming scenario in the world - El Niño and La Niña - Global consequences of El Niño (K1, K2) - Ozone-depleting substances (ODS) - Acid Rain - Persistent Organic Pollutants (POPs) - Impact of Air pollutants on human health (K3)

Unit III Overexploitation of Natural Resources **Contact Hours: 12**

Environment in Anthropocene era - Ecological footprint – Earth Overshoot Day - Water resources: Status of groundwater quality in India - Desertification - Soil and Mineral Resources: Global threats for soil quality, Loss of organic carbon, Land Degradation Neutrality (LDN) (K3), Mineral resources exploitation - Biodiversity Resources: Megadiversity Nation and Hot spots in India – Bioprospecting and biopiracy - Threats to biodiversity resources (K1, K2)

Unit IV Global Disasters **Contact Hours: 12**

Types of disasters - Earthquake: Origin of Earthquake, magnitude and intensity - Global Earthquake prone zones - Effects of earthquake - Volcanoes: Types of volcanic eruptions - Active volcanic belts in the world - Flash flood - Flood management strategies - Regions of flood prone zones in the World and India - Forecasting and warning of natural disasters - Manmade disasters: Oil spills, Forest fire, Industrial and Nuclear disasters (K1, K2) - Public health disaster: Covid-19 Pandemic - Microplastics - Case study: Recent global disasters

Unit V Sustainable Environmental Management **Contact Hours: 12**

Renewable energy resources: Solar, Wind, Hydroelectric and Biomass - Sustainable agricultural practices (Biofertilizers and Biopesticides) - National Action Plan on Climate Change (Eight missions) - Recent initiatives related to climate change adaptation and mitigation in India - UNDP Sustainable Development Goals 2030 (K4)

References

Text Books

1. Frances Harris (2012) Global Environmental Issues, 2nd edition, John Wiley & Sons Ltd., UK.
2. Stavros G. Poulopoulos and Vassilis J. Inglezakis (2016) Environment and Development: Basic Principles, Human Activities, and Environmental Implications. Elsevier, Netherlands.
3. Amy Long (2021) Global Environmental Issues, 2nd edition, Kendall Hunt Publishing Company.

Reference Books

1. Donald Hyndman and David (2005) Hyndman Natural Hazards & Disasters, Cengage Learning, USA.

GLOBAL ENVIRONMENTAL ISSUES

2. John V. Walther (2014) Earth's Natural Resources, Jones & Bartlett Learning, USA.
3. Prasad Modak (2018) Environmental Management towards Sustainability, CRC Press, FL, USA.
4. Prasenjit Mondal and Ajay K. Dalai (2017) Sustainable Utilization of Natural Resources, CRC Press, FL, USA.
5. Rajeev Pratap Singh, Anita Singh, VaibhavSrivastava (2017) Environmental Issues Surrounding Human Overpopulation, IGI Global, USA.
6 Raveendranathan D (2018) Development lead to Pollution and Depletion of Natural Resources, Notion Press, Chennai.
7 Serge Morand, Claire Lajaunie, RojchaiSatrawaha (2017) Biodiversity Conservation in Southeast Asia: Challenges in a Changing Environment, Earthscan from Routledge, UK.
8. Thangavel P and Sridevi G (2015) Environmental Sustainability: Role of Green Technologies, Springer, India.
9. Dogra N and Srivastava S (2012) Climate Change and Disease Dynamics in India, TERI, New Delhi.
10. Quaschning VV (2019) Renewable Energy and Climate Change. John Wiley & Sons.
11. Saurabh Sonwani and Pallavi Saxena (2022) Greenhouse Gases: Sources, Sinks and Mitigation, Springer, Singapore.

Web References

1. https://www.stateofglobalair.org/sites/default/files/soga-2018-report.pdf
2. www.who.int/airpollution/
3. https://unfccc.int/
4. re.indiaenvironmentportal.org.in/files/part%20II%20groundwater%20CPCB.pdf
5. https://www.footprintnetwork.org/our-work/earth-overshoot-day
6. https://www.elsevier.com/data/assets/pdf…/ElsevierDisasterScienceReport-PDF.pdf
7. www.siteresources.worldbank.org/INTDISMGMT/Resources/0821363328.pdf
8. https://link.springer.com/chapter/10.1007/978-981-10-1866-4_2
9. www.ipcc.ch/
10. https://climate.nasa.gov/
11. https://pressbooks.bccampus.ca/environmentalissues/

Supportive Course – V

DISASTER MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS1S05	100	4	4	-	-	4

Course Objectives

To mainly focus on understanding the different types of hazards and their impacts and the techniques for preparing effective disaster management plan including recovery and rehabilitation.

Course Outcomes

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

CO1 Develop an understanding of the different types of hazards and disaster-prone zones

CO2 Develop a basic understanding of prevention, mitigation, preparedness, response and recovery

CO3 Develop disaster assistance tools and disaster preparedness

CO4 Understand the disaster relief and recovery measures

CO5 Acquire knowledge of capacity building and institutional framework for disaster management

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*					*	*	*
CO2	*					*	*	*
CO3					*	*	*	*
CO4						*	*	*
CO5	*					*	*	*

Supportive Course – V

DISASTER MANAGEMENT

Unit I Types of Disasters **Contact Hours: 12**

Geological Disasters - Hydro-Meteorological Disasters - Biological Disasters - Technological Disasters - Global Outlook on Disaster Science (K1, K2)

Unit II Geological Hazards **Contact Hours: 12**

Earthquake: Origin of Earthquake, its magnitude and intensity - Earthquake prone zones in India - Effects of earthquake - Earthquake prediction & control (K1, K2) - Volcanoes: Types of volcanic eruptions - Active volcanic belts in the world (K1, K2) - Nature and magnitude of volcanic hazards - Prediction of volcanic eruptions - Mitigation of volcanic hazards (K3, K4) - Mass movement hazards: Landslides and Snow avalanche hazards (K1, K2)

Unit III Hydrological and Meteorological Hazards **Contact Hours: 12**

Hydrological Hazards - Floods: Flooded geographical land types – Flash flood (K1, K2) - Flood management strategies (K3, K4) - Regions of flood prone zones in India (K1, K2) – Flood forecasting and warning (K3, K4, K5) - Droughts: Types of droughts – Drought assessment parameters: Drought indices (meteorological indices, hydrological indices and agriculture index) (K1, K2) - Preventive measures and preparedness plan for drought mitigation (K3, K4, K5) - Meteorological hazards - Cyclones: Tropical cyclones & Local storms – Heat waves and cold waves (K1, K2)

Unit IV Disaster Management Cycle and Framework **Contact Hours: 12**

Disaster Management Cycle - Pre-Disaster: Risk Mapping - Zonation and Microzonation - Prevention and Mitigation of Disasters - Early Warning System - Preparedness - Capacity Development – Awareness (K2, K3, K4) During Disaster: Evacuation - Disaster Communication – Search and Rescue - Emergency Operation Centre - Incident Response System – Relief and Rehabilitation (K2, K4, K5) - Post-disaster: Damage and Needs Assessment - Restoration of Critical Infrastructure - Early Recovery - Reconstruction and Redevelopment (K2, K4, K5)

Unit V Disaster Management in India **Contact Hours: 12**

Disaster Management Act 2005 - National Guidelines and Plans on Disaster Management (K1, K2) - Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies: National Disaster Management Authority (NDMA) - NIDM (National Institute of Disaster Management) - State Disaster Management Authorities - National Disaster Response Force (K3, K4)

References

Text Books

1. Brenda D. Phillips, David M. Neal, Gary R. Webb (2021) Introduction to Emergency Management and Disaster Science, Taylor & Francis.
2. Bryant Edwards (2005) Natural Hazards, Cambridge University Press, UK.
3. Donald Hyndman and David (2005) Hyndman Natural Hazards & Disasters, Cengage Learning.
4. Dylan Sandler and Anna K. Schwab (2021) Hazard Mitigation and Preparedness - An Introductory Text for Emergency Management and Planning Professionals, Taylor & Francis.
5. Palanivel K, Saravanavel K and Gunasekaran S (2015) Disaster Management, Allied Publishers Pvt Ltd., New Delhi.

Supportive Course – V

DISASTER MANAGEMENT

Reference Books

1. BimalKanti Paul (2011) Environmental Hazards and Disasters - Contexts, Perspectives and Management, John Wiley & Sons, UK.
2. Collins Larry R and Schneid Thomas D (2000) Disaster Management and Preparedness, Taylor and Francis.
3. Coppola DP (2011) Introduction to International Disaster Management, 2nd Edition, Elsevier Science (B/H), London.
4. Debarata Mondal and Debarata Basu (2020) Disaster Management - Concepts and Approaches, CBS Publishers & Distributors.
5. Indrajit Pal and Rajib Shaw (2018) Disaster Risk Governance in India and Cross Cutting Issues, Springer Nature, Singapore.
6. Jha and Kumar M (2010) Natural and Anthropogenic Disasters; Vulnerability, Preparedness and Mitigation, Springer.
7. Joanne McGlown (2022) Case Studies in Disaster Preparedness - A Volume in the Disaster and Emergency Management: Case Studies in Adaptation and Innovation Series, Elsevier Science, UK.
8. Musavi SHA (2020) Early Warning –based Multihazard and Disaster Management Systems. CRC Press, Boca Raton, USA.
9. Pandey RK (2020) Disaster Management in India. SAGE Publications.
10. Robert B. Olshansky, Mizan B. F. Bisri, Andri N. R. Mardiah (2021) Post-Disaster Governance in Southeast Asia - Response, Recovery, and Resilient Societies. Springer Nature Singapore.
11. Sharma RK and Sharma G (2005) Natural Disaster, APH Publishing Corporation, New Delhi.
12. Shruti Kanga, Gowhar Meraj, Majid Farooq, Suraj Kumar Singh, Mahendra Singh Nathawat (2022) Disaster Management in the Complex Himalayan Terrains, Springer Cham.
13. Srivastava PK, Singh SK, Mohanty UC and Murty T (2020) Techniques for Disaster Risk Management and Mitigation. John Wiley & Sons Inc., USA
14. Tomaszewski B (2020) Geographic Information Systems for Disaster Management. Taylor & Francis Limited.
15. Zhi Liu and Kaoru Ota (2018) Smart Technologies for Emergency Response and Disaster Management, IGI Global, USA.

Journal articles

1. Du, Lei, Yingbin Feng, Li Yaning Tang, Wei Kang, and Wei Lu (2020). Networks in disaster emergency management: a systematic review. Natural Hazards 1-27.
2. Makwana, Nikunj (2019) Disaster and its impact on mental health: A narrative review. Journal of Family Medicine and Primary Care 8 (10): 3090.
3. Modgil, Sachin, Rohit Kumar Singh, and Cyril Foropon (2020). Quality management in humanitarian operations and disaster relief management: a review and future research directions. Annals of Operations Research 1-54.
4. Raikes J, Smith TF, Jacobson C and Baldwin C (2019). Pre-disaster planning and preparedness for floods and droughts: A systematic review. International Journal of Disaster Risk Reduction 38: 101207.
5. Seba, Abderazek, Nadia Nouali-Taboudjemat, Nadjib Badache, and Hamida Seba. (2019). A review on security challenges of wireless communications in disaster emergency response and crisis management situations. Journal of Network and Computer Applications 126: 150-161.

6. Shaluf IM and Said AM (2003). A review of disaster and crisis. Disaster Prevention and Management: An International Journal.
7. Sim KB, Lee ML, Wong SY (2022) A review of landslide acceptable risk and tolerable risk. Geoenvironmental Disasters 9(1):1-7.
8. Torani, Sogand, Parisa Moradi Majd, Shahnam Sedigh Maroufi, Mohsen Dowlati, and Rahim Ali Sheikhi (2019). The importance of education on disasters and emergencies: A review article. Journal of Education and Health Promotion 8.
9. Wirth EA, Sahakian VJ, Wallace LM, Melnick D (2022) The occurrence and hazards of great subduction zone earthquakes. Nature Reviews Earth & Environment 3:125-140.

Online resources

1. www.nidmindia.nic.in
2. http://www.cambridge.org
3. Web based course material on Disaster Management of the University of Wisconsin Disaster Management Center (http://epdweb.engr.wise.sedu/dmc)
4. http://www.worldbank.org/html/fpd/dmf/risk_managemnt.htm

PRACTICAL I

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS1P01	100	6	-	-	6	3

Ecology, Biodiversity and Conservation, Environmental Chemistry, Waste Management, and Environmental Biochemistry and Toxicology

1. Estimation of primary productivity of an ecosystem
2. Determination of minimum quadrat size for community study.
3. Measurement of water quality parameters: pH, acidity, alkalinity, coagulation, TSS and TDS.
4. Estimation of soil moisture and soil specific gravity
5. Segregation of wastes.
6. Composting techniques for wastes
7. Mitotic cell division
8. Meiotic cell division
9. Comet assay technique
10. LC_{50} and LD_{50} determination of pesticide

Reference

Ruth Ann Murphy (2022) Environmental Chemistry in the Lab, CRC Press.

PRACTICAL II

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS1P02	100	6	-	-	6	3

Environmental Pollution and Control Strategies, Environmental Microbiology & Climate change and Current Issues

1. Measurement of SPM, SO_2, and NO_2 levels in the atmospheric air.
2. Estimation of DO, BOD, and COD
3. Measurement of noise levels in different locations.
4. Determination of soil properties: sodium, potassium, calcium, magnesium, nitrogen and phosphorus.
5. Simple staining
6. Grams staining
7. Fungal staining (Lacto phenol cotton blue)
8. Plating techniques (Streak, Spread and Pour)
9. Enumeration of microorganisms from water and soil
10. MPN Techniques
11. Demonstration of the greenhouse effect and global warming.

Reference:

James G. Cappuccino and Sherman (2020) Microbiology: A Laboratory Manual, 10th Edition

Gunasekaran. P (2007) Laboratory Manual in Microbiology, New Age International

PRACTICAL III

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS1P03	100	6	-	-	6	3

Environmental Biotechnology, Environmental Geoinformatics & Environmental Impact Assessment

1. Isolation of Genomic DNA
2. Agarose Gel Electrophoresis
3. PCR Techniques - Amplification of 16S rRNA gene
4. Production of microbial enzymes - Cellulase and Xylanase
5. Production of Bioflocculant
6. Biodegradation of Pollutants - Aromatic Compounds
7. Geo referencing of Toposheets / Satellite Imagery
8. Thematic layer digitization and image processing techniques
9. FT-IR and Fluorescence Spectroscopy Techniques
10. HPLC and GC-MS Techniques
11. Preparation of EIA report for environmental clearance (EC)
12. Preparation of checklists for EIA study

Reference:

Jayanta Kumar Patra, Gitishree Das, Swagat Kumar Das, Hrudayanath Thatoi (2020) A Practical Guide to Environmental Biotechnology, Springer Nature Singapore Pte Ltd.