PERIYAR UNIVERSITY

Salem-636 011

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

DEPARTMENT OF ENVIRONMENTAL SCIENCE

FIVE YEAR INTEGRATED M.Sc. ENVIRONMENTAL SCIENCE

[Choice Based Credit System (CBCS)]

OBE SYLLABUS

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

FIVE YEAR INTEGRATED M. Sc. ENVIRONMENTAL SCIENCE

OBE REGULATIONS AND SYLLABUS

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

1. Preamble

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

2. General Graduate Attributes

1. ***Environmental Knowledge***

   Apply the basic knowledge of environmental components and its 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. ***Problem Solving Skills***

   Identify, analyze and assess the complex environmental issues and to apply the knowledge to solve the issues

4. ***Technical Skills***

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

5. ***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

6. ***Research Skills***

   Improve the research-oriented skills by involving the basic, applied and field-based research works

7. ***Individual and Team Work***

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

8. ***Project Management***

To manage and coordinate specific environmental work, tasks or projects and to apply specific principles and methodologies to carry out environmental projects

9. ***Societal and Environmental Concern***

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

10. ***Environmental Management***

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

11. ***Innovation and Entrepreneurship***

To apply the acquired skills and knowledge in the field of environmental science and 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 can 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)

Graduates of Integrated 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 Five years Integrated 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, environmental remediation bioprocess, 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, (EIA), pollution monitoring and management.
PO5	Skills in methods used for environmental cleanup, EIA process, GIS to monitor the environmental issues and critically analyzing the global climate change.
PO6	Expertise to become an 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 development, and environmental safety trainer.
PO8	Qualification to be employed as a researcher / scientist / faculty in Colleges / Universities / Government sectors / Research and Development organizations.

6. Candidate's eligibility for admission

Candidate who has passed in Higher Secondary Examinations with science subjects (Physics, Chemistry, Mathematics/ Biology/ Botany/ Zoology/ Agriculture/ Microbiology/ Computer Science or any other Life Science subjects or any other Examination as equivalent thereto under the Board of Higher Secondary Education, Government of Tamil Nadu / CBSE / ICSE or any other boards equivalent thereto shall be eligible for admission to Five years Integrated M.Sc. Degree Programme in Environmental Science.

7. Duration of the programme

The duration of the Integrated M.Sc. Environmental Science shall be over a period of **Five Years** from the commencement of the course. Undergraduate degree shall be awarded after successful completion of three years (up to VI Semester).

8. CBCS- Structure of the Programme

The programme structure comprises of two parts.

Course Component	No. of Courses	Credit /Course	Hours of Learning	Marks	Credits
	Part A (Credit Courses)				
Language Courses	4	3	4 h/ Week / Course	400	12
Communicative & Foundation English Courses	4	3	4 h/ Week / Course	400	12
Professional English Courses	2	-	4 h/ Week / Course	200	-
Core Courses	22	4	4 h/ Week / Course	2200	88
Allied Courses	4	4	4 h/ Week / Course	400	16
Elective Courses	6	4	4 h/ Week / Course	600	16
Non-Major Elective Courses	4	2	2 h/ Week / Course	400	08
Skill Based Elective Courses	6	2	2 h/ Week / Course	600	12
Practical Courses - Major	10	2	3 h/ Week / Course	1000	20
Practical Courses - Allied	4	2	3 h/ Week / Course	400	08
Research Projects	2	5	12 h & 30 h / week	300	10
Field Projects/Work	8	1	2 h/ Week / Course	400	08
Industrial Visits/Study Tour	2	2	2 to 5 Visits/Tours	100	04
Value Education/Yoga	1	2	2 h/ Week / Course	100	02
Human Rights	1	2	2 h/ Week / Course	100	02
Environmental Studies (UGC mandatory course)	1	2	1 h / week / course	100	02
Sub Total	**80**			**7700**	**220**
	Part B (Self-Learning Credit Courses)				
Online Courses (MOOC /SWAYAM)	1	2		100	2
Industry Oriented Courses (Certificate courses)	2	1		100	2
Total	**3**			**200**	**04**

9. Curriculum structure for each semester as per courses alignment

The curriculum for the Integrated M.Sc. Environmental Science Degree Programme shall comprise of the following courses according to the syllabus and books prescribed from time to time.

Part - I	Tamil / Other languages
Part - II	Coomunicative & Foundation English
Part - III	1. Core Courses
	2. Allied Courses
	3. Major Elective Courses
	4. Research Projects
	5. Field Studies
Part - IV	1. Non-Major Elective Courses
	2. Skill Based Elective Courses
	3. Industry Oriented Self-Learning Courses
	4. Environmental Studies (UGC mandatory course)
	5. SWAYAM/ MOOC Courses
	6. Value Education
	7. Human Rights
Part - V	Extension Activities (NSS / NCC / Sports / YRC and other co- and extracurricular activities offered under Part V)

Semester-wise Courses

Semester I		**Semester II**	
S.No.	**Courses**	**S.No.**	**Courses**
1	Language - I	10	Language - II
2	Communicative English - I	11	Communicative English - II
3	Professional English –I	12	Professional English –II
4	Core - I	13	Core - II
5	Core - Practical I	14	Core - Practical II
6	Allied Chemistry - I	15	Allied Chemistry II
7	Allied Chemistry - Practical I	16	Allied Chemistry - Practical II
8	Field Studies I	17	Field Studies II
9	Value Education - Yoga	18	Skill Based Elective II
		19	Environmental Studies (UGC mandatory)
Semester III		**Semester IV**	
20	Language - III	29	Language - IV
21	Foundation English - III	30	Foundation English - IV
22	Core - III	31	Major Core - IV
23	Core - Practical III	32	Core - Practical IV
24	Allied Botany - III	33	Allied Zoology - IV
25	Allied Botany Practical	34	Allied Zoology Practical
26	Field Studies III	35	Field Studies IV
27	Skill Based Elective II	36	Skill Based Elective - III
28	Non-Major Elective -I	37	Non-Major Elective - II

Semester V		Semester VI	
S.No.	**Courses**	**S.No.**	**Courses**
38	Core - V	47	Core - IX
39	Core - VI	48	Core - X
40	Core - VII	49	Core - XI
41	Core - VIII	50	Core - Practical VII
42	Core - Practical V	51	Core - Project I
43	Core - Practical VI	52	Elective - II
44	Elective –I	53	Skill Based Elective V
45	Field Studies V	54	Industrial Visits/Study Tour I
46	Skill Based Elective IV		
Semester VII		**Semester VIII**	
55	Core - XII	63	Core - XVI
56	Core - XIII	64	Core - XVII
57	Core - XIV	65	Core - XVIII
58	Core - XV	66	Core - Practical IX
59	Core - Practical VIII	67	Field Studies VII
60	Field Studies VI	68	Elective - IV
61	Elective - III	69	Non-Major Elective III
62	SWAYAM -MOOC	70	Human Rights
		71	Industry Oriented Course I
Semester IX		**Semester X**	
72	Core - XIX	81	Core - Project II
73	Core – XX	82	Elective VI
74	Core - XXI	83	Industrial Visits/Study Tour II
75	Core - XXII		
76	Core - Practical X		
77	Field Studies VIII		
78	Elective - V		
79	Non-Major Elective IV		
80	Industry Oriented Course II		

- Non-Major Elective Course (NMEC) can be chosen by the candidate from other Department courses offered in the University Departments.
- Skill Based Elective Course (SBEC) papers can be chosen by the candidates from the list of SBEC prescribed in this syllabus.
- SWAYAM/MOOC Course can be chosen by the candidates from the list of courses offered by SWAYAM Portal during their specific semester of study.

List of Courses and Course Codes

S. No.	Sem	Language Courses	Code
1	I	Tamil I/Hindi I/Malayalam I	22UPEVS2T01/22UPEVS2H01/22UPEVS2M01
2	II	Tamil II/Hindi II/Malayalam II	22UPEVS2T02/22UPEVS2H02/22UPEVS2M02
3	III	Tamil III/Hindi III/Malayalam III	22UPEVS2T03/22UPEVS2H03/22UPEVS2M03
4	IV	Tamil IV/Hindi IV/Malayalam IV	22UPEVS2T04/22UPEVS2H04/22UPEVS2M04

S. No.	Semester	English Courses	Code
1	I	Communicative English I	22UPEVS2E01
2	I	Professional English I	22UPEVS2PE1
3	II	Communicative English II	22UPEVS2E02
4	II	Professional English II	22UPEVS2PE2
5	III	Foundation English III	22UPEVS2E03
6	IV	Foundation English IV	22UPEVS2E04

S. No.	Semester	Core Courses	Code
1	I	Earth Ecology and Environment	22UPEVS2C01
2	II	Environmental Chemistry	22UPEVS2C02
3	III	Environmental Microbiology	22UPEVS2C03
4	IV	Environmental Biochemistry and Toxicology	22UPEVS2C04
5	V	Biodiversity and Conservation	22UPEVS2C05
6	V	Environmental Pollution-I	22UPEVS2C06
7	V	Waste Management	22UPEVS2C07
8	V	Biostatistics and Environmental Modelling	22UPEVS2C08
9	VI	Energy and Environment	22UPEVS2C09
10	VI	Environmental Pollution-II	22UPEVS2C10
11	VI	Environmental Analysis and Techniques	22UPEVS2C11
12	VII	Natural Resources Management	22UPEVS2C12
13	VII	Environmental Impact Assessment	22UPEVS2C13
14	VII	Environmental Biotechnology	22UPEVS2C14
15	VII	Environmental Engineering	22UPEVS2C15
16	VIII	Climate Change and Current Issues	22UPEVS2C16
17	VIII	Environmental Geoinformatics	22UPEVS2C17
18	VIII	Pollution Control Strategies	22UPEVS2C18
19	IX	Environmental Health and Safety	22UPEVS2C19
20	IX	Research Methodology and Instrumentation	22UPEVS2C20
21	IX	Disaster Management	22UPEVS2C21
22	IX	Environmental Laws and Policies	22UPEVS2C22

S. No.	Semester	Allied Courses	Code
1	I	Chemistry - I (Inorganic, Organic, Phy-I)	22UPEVS2A01
2	II	Chemistry - II (Inorganic, Organic, Phy-II)	22UPEVS2A02
3	III	Botany	22UPEVS2A03
4	IV	Zoology	22UPEVS2A04

S. No.	Semester	Core Elective Courses	Code
1	V / VI	Cancer Biology and Environmental Carcinogens	22UPEVS2E01
2		Ecotourism	22UPEVS2E02
3		Environmental Management System	22UPEVS2E03
4		Forest and Wildlife Management	22UPEVS2E04
5	VII/ VIII/ IX/ X/	Marine Biotechnology	22UPEVS2E05
6		Enzyme Technology	22UPEVS2E06
7		Environmental Nanotechnology	22UPEVS2E07
8		Industrial Biotechnology	22UPEVS2E08
9		Phytoremediation	22UPEVS2E09
10		Designs for Waste Management	22UPEVS2E10
11		Bioremediation and Bio economy	22UPEVS2E11
12		Sludge Management	22UPEVS2E12
13		Principles of Toxicology	22UPEVS2E13
14		Pesticide Toxicology	22UPEVS2E14
15		Applied Toxicology	22UPEVS2E15
16		Industrial Toxicology	22UPEVS2E16

S. No.	Semester	Skill Based Elective Courses	Code
1	II,III, IV,V,VI	Aquaculture	22UPEVS2K01
2		Biocomposting	22UPEVS2K02
3		Biopesticides and Crop Protection	22UPEVS2K03
4		Bioremediation Techniques	22UPEVS2K04
5		Environmental Sanitation	22UPEVS2K05
6		Horticulture	22UPEVS2K06
7		Organic Farming Practices	22UPEVS2K07
8		Phytoremediation	22UPEVS2K08

S. No.	Semester	Core Practical Courses	Code
1	I	Core Practical - I	22UPEVS2P01
2	II	Core Practical -II	22UPEVS2P02
3	III	Core Practical -III	22UPEVS2P03
4	IV	Core Practical -IV	22UPEVS2P04
5	V	Core Practical -V	22UPEVS2P05
6	V	Core Practical -VI	22UPEVS2P06
7	VII	Core Practical -VII	22UPEVS2P07
8	VIII	Core Practical -VIII	22UPEVS2P08
9	IX	Core Practical -IX	22UPEVS2P09
10	X	Core Practical -X	22UPEVS2P10

S. No.	Semester	Allied Practical Courses	Code
1	I	Chemistry - Practical - I	22UPEVS2AP1
2	II	Chemistry - Practical - II	22UPEVS2AP2
3	III	Botany - Practical	22UPEVS2AP3
4	IV	Zoology - Practical	22UPEVS2AP4

S. No.	Semester	Field Studies	Code
1	I	Field Studies I	22UPEVS2FS1
2	II	Field Studies II	22UPEVS2FS2
3	III	Field Studies III	22UPEVS2FS3
4	IV	Field Studies IV	22UPEVS2FS4
5	V	Field Studies V	22UPEVS2FS5
6	VII	Field Studies VI	22UPEVS2FS6
7	VIII	Field Studies VII	22UPEVS2FS7
8	IX	Field Studies VIII	22UPEVS2FS8

S. No.	Semester	Core Project	Code
1	VI	Core Project I	22UPEVS2PR1
2	X	Core Project II	22UPEVS2PR2

S. No.	Semester	Industrial Visits/ Study Tour	Code
1	VI	Industrial Visit/ Study Tour I	22UPEVS2IV1
2	X	Industrial Visit/ Study Tour II	22UPEVS2IV2

S. No.	Sem	Part IV – Value Added/ Self Learning Courses	Code
1	I	Value Education - Yoga	22UPEVS2VY1
2	II	Environmental Studies- UGC Mandatory Course	22UPEVS2ES1
3	VII	Online Courses (MOOC /SWAYAM) – Self Study	22UPEVS2SW1
4	VIII	Human Rights - UGC Mandatory Course	22UPEVS2HR1
5	VIII	Industry Oriented Course I - Self Study	22UPEVS2IC1
6	IX	Industry Oriented Course II - Self Study	22UPEVS2IC2

12. CBCS - Scheme of Examinations (Semester-wise structure)

S. No.	Part	Course Code	Course Title	Weekly Contact Hours	Credits	Internal Marks	External Marks	Total Marks
			Semester -I					
1	I	22UPEVS2T01/ 22UPEVS2H01/ 22UPEVS2M01	Language - I	4	3	25	75	100
2	II	22UPEVS2E01	Communicative English - I	4	3	25	75	100
3	II	22UPEVS2PE1	Professional English –I	4	-	25	75	100
4	III	22UPEVS2C01	Core – I - Earth Ecology and Environment	4	4	25	75	100
5	III	22UPEVS2P01	Core - Practical I	3	2	40	60	100
6	III	22UPEVS2A01	Allied Chemistry - I	4	4	25	75	100
7	III	22UPEVS2AP1	Allied Chemistry - Practical I	3	2	40	60	100
8	III	22UPEVS2FS1	Field Studies I	2	1	25	25	50
9	IV	22UPEVS2VY1	Value Education - Yoga	2	-	25	75	100
			Sub Total	**30**	**19**	**255**	**595**	**850**
			Semester -II					
10	I	22UPEVS2T02/ 22UPEVS2H02/ 22UPEVS2M02	Tamil II/Hindi II/Malayalam II	4	3	25	75	100
11	II	22UPEVS2E02	Communicative English - II	4	3	25	75	100
12	II	22UPEVS2PE2	Professional English –II	4	-	25	75	100
13	III	22UPEVS2C02	Core – II - Environmental Chemistry	4	4	25	75	100
14	III	22UPEVS2P02	Core - Practical II	3	2	40	60	100
15	III	22UPEVS2A02	Allied Chemistry II	4	4	25	75	100
16	III	22UPEVS2AP2	Allied Chemistry - Practical II	3	2	40	60	100
17	III	22UPEVS2FS2	Field Studies II	1	1	25	25	50
18	IV	22UPEVS2K0*	Skill Based Elective - I	2	2	25	75	100
19	IV	22UPEVS2ES1	Environmental Studies	1	-	25	75	100
			Sub Total	**30**	**21**	**280**	**670**	**950**
			Semester -III					
20	I	22UPEVS2T03/ 22UPEVS2H03/ 22UPEVS2M03	Tamil III/Hindi III/Malayalam III	4	3	25	75	100
21	II	22UPEVS2E03	Foundation English - III	4	3	25	75	100
22	III	22UPEVS2C03	Core - III - Environmental Microbiology	4	4	25	75	100
23	III	22UPEVS2P03	Core - Practical III	3	2	40	60	100
24	III	22UPEVS2A03	Allied Botany - III	4	4	25	75	100
25	III	22UPEVS2AP3	Allied Botany Practical	3	2	40	60	100

26	III	22UPEVS2FS3	Field Studies III	2	1	25	25	50
27	IV	22UPEVS2K02	Skill Based Elective II	2	2	25	75	100
28	IV	-	Non-Major Elective -I	2	2	25	75	100
			Library /Seminar	2	-	-	-	-
			Sub Total	**30**	**23**	**255**	**595**	**850**
			Semester -IV					
29	I	22UPEVS2T04/ 22UPEVS2H04/ 22UPEVS2M04	Tamil IV/Hindi IV /Malayalam IV	4	3	25	75	100
30	II	22UPEVS2E04	Foundation English - IV	4	3	25	75	100
31	III	22UPEVS2C04	Core - IV - Environmental Biochemistry and Toxicology	4	4	25	75	100
32	III	22UPEVS2P04	Core - Practical IV	3	2	40	60	100
33	III	22UPEVS2A04	Allied Zoology - IV	4	4	25	75	100
34	III	22UPEVS2AP4	Allied Zoology - Practical	3	2	40	60	100
35	III	22UPEVS2FS4	Field Studies IV	2	1	25	25	50
36	IV	22UPEVS2K0*	Skill Based Elective III	2	2	25	75	100
37	IV	-	Non-Major Elective -II	2	2	25	75	100
			Library /Seminar	2				
			Sub Total	**30**	**23**	**255**	**595**	**850**
			Semester -V					
38	III	22UPEVS2C05	Core – V Biodiversity and Conservation	4	4	25	75	100
39	III	22UPEVS2C06	Core – VI - Environmental Pollution-I	4	4	25	75	100
40	III	22UPEVS2C07	Core – VII - Waste Management	4	4	25	75	100
41	III	22UPEVS2C08	Core – VIII - Biostatistics and Environmental Modelling	4	4	25	75	100
42	III	22UPEVS2P05	Core - Practical V	3	2	40	60	100
43	III	22UPEVS2P06	Core - Practical VI	3	2	40	60	100
44	III	22UPEVS2E**	Elective –I	4	4	25	75	100
45	III	22UPEVS2FS5	Field Studies V	2	1	25	25	50
46	IV	22UPEVS2K0*	Skill Based Elective IV	2	2	25	75	100
			Sub Total	**30**	**27**	**255**	**595**	**850**
			Semester -VI					
47	III	22UPEVS2C09	Core – IX - Energy and Environment	4	4	25	75	100
48	III	22UPEVS2C10	Core - X - Environmental Pollution-II	4	4	25	75	100
49	III	22UPEVS2C11	Core – XI - Environmental Analysis and Techniques	4	4	25	75	100
50	III	22UPEVS2P07	Core - Practical VII	3	2	40	60	100
51	III	22UPEVS2PR1	Core - Project I	9	5	50	150	200
52	III	22UPEVS2E**	Elective - II	4	4	25	75	100
53	IV	22UPEVS2K0*	Skill Based Elective V	2	2	25	75	100
54	III	22UPEVS2IV1	Industrial Visits/Study Tour I	-	2	-	50	50
			Sub Total	**30**	**27**	**215**	**635**	**850**
			UG - Total	**180**	**140**	**1515**	**3685**	**5200**

			Semester -VII					
55	III	22UPEVS2C12	Core – XII - Natural Resources Management	4	4	25	75	100
56	III	22UPEVS2C13	Core – XIII - Environmental Impact Assessment	4	4	25	75	100
57	III	22UPEVS2C14	Core – XIV - Environmental Biotechnology	4	4	25	75	100
58	III	22UPEVS2C15	Core – XV - Environmental Engineering	4	4	25	75	100
59	III	22UPEVS2P08	Core - Practical VIII	6	4	40	60	100
60	III	22UPEVS2FS6	Field Studies VI	1	1	25	25	50
61	III	22UPEVS2E**	Elective - III	4	4	25	75	100
62	IV	22UPEVS2SW1	SWAYAM -MOOC	2	2	-	100	100
			Library /Seminar	2				
			Sub Total	**30**	**27**	**190**	**560**	**750**
			Semester -VIII					
63	III	22UPEVS2C16	Core – XVI - Climate Change and Current Issues	4	4	25	75	100
64	III	22UPEVS2C17	Core – XVII - Environmental Geoinformatics	4	4	25	75	100
65	III	22UPEVS2C18	Core – XVIII - Pollution Control Strategies	4	4	25	75	100
66	III	22UPEVS2P09	Core - Practical IX	6	4	40	60	100
67	III	22UPEVS2FS7	Field Studies VII	1	1	25	25	50
68	III	22UPEVS2E**	Elective - IV	4	4	25	75	100
69	IV	-	Non-Major Elective III	3	3	25	75	100
70	IV	22UPEVS2HR1	Human Rights	1	-	25	75	100
71	IV	22UPEVS2IC1	Industry Oriented Course I	1	1	25	25	50
			Library /Seminar	2				
			Sub Total	**30**	**25**	**240**	**560**	**800**
			Semester -IX					
72	III	22UPEVS2C19	Core – XIX - Environmental Safety and Health	4	4	25	75	100
73	III	22UPEVS2C20	Core – XX - Research Methodology and Instrumentation	4	4	25	75	100
74	III	22UPEVS2C21	Core – XXI - Disaster Management	4	4	25	75	100
75	III	22UPEVS2C22	Core – XXII - Environmental Laws and Policies	4	4	25	75	100
76	III	22UPEVS2P10	Core - Practical X	6	4	40	60	100
77	III	22UPEVS2FS8	Field Studies VIII	1	1	25	25	50
78	IV	22UPEVS2E**	Elective - IV	4	4	25	75	100
79	IV	-	Non-Major Elective V	3	3	25	75	100
80	IV	22UPEVS2IC2	Industry Oriented Course II	-	1	25	25	50
			Sub Total	**30**	**29**	**240**	**560**	**800**
			Semester -X					
81	III	22UPEVS2PR2	Core - Project II	26	7	50	150	200
82	III	22UPEVS2E**	Elective VI	4	4	25	75	100
83	III	22UPEVS2IV2	Industrial Visits/Study Tour II	-	2	-	50	50
			Sub Total	**30**	**11**	**75**	**275**	**350**
			PG - Total	**120**	**94**	**745**	**1955**	**2700**
			OVERALL TOTAL	**300**	**234**	**2260**	**5640**	**7900**
*/** represents the number of the course among the listed skill based elective /elective courses chosen in the respective semesters								

Examinations

- Examinations are conducted at the end of every Semester.
- The examination for the Odd Semester (I, III, V, VII and IX) will be held in November/December and the Even Semester (II, IV, VI, VIII and X) will be held in the month of April/May of every academic year.
- 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 existing syllabus structure at the time of examination.
- The practical examinations for major and allied courses will be held at the end of each semester.

Requirements for proceeding to subsequent semesters

- A candidate shall be permitted to appear for the University examinations for any semester (practical/theory) if he / she secures not less than 75% of attendance in the number of working days during the semester.
- Candidates shall register their names for the First semester examination after the admission in the PG courses.
- Candidates shall be permitted to proceed from the First Semester up to the Final Semester irrespective of their failure in any of the Semester Examination subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current semester subjects.
- Candidates shall be eligible to proceed to the subsequent semester, only if they earn sufficient attendance as prescribed therefore by the Syndicate from time to time.

  Provided in case of candidate earning less than 50% of attendance in any one of the semester due to any extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorized Medical Attendant (AMA), duly certified by the Head of the Institution, shall be permitted to proceed to the next semester and to complete the course of study. Such candidate shall have to repeat the missed semester by rejoining after completion of final semester of the course, after paying the fee for the break of study as prescribed by the University from time to time.

13. 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 theory examination with prescribed question paper pattern.

Attainment Rubrics for Theory Courses

Internal *(Max. Marks - 25)*

Attendance	Seminar	Assignment	Internal/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 K3, K4 K5, K6
B	100 to 200 words (Answer any three out of five questions)	3 x 5 = 15 (Analytical Type Questions)	
C	500 to 1000 words (Answer all five questions)	5 x 8 = 40 (Essay Type Questions)	

Attainment Rubrics for Practical 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 Project

Internal (Max. Marks - 50)

Performance/Skills/ Attendance	50 Marks

External (Max. Marks - 100)

Viva-Voce Presentation	25 Marks
Dissertation	75 Marks

14. Passing Minimum

- There shall be no passing minimum for internal marks.
  For external examination, passing minimum shall be of 50% (38 Marks out of 75 Marks) prescribed for the course.
- In the aggregate (External + Internal) the passing minimum shall be of 50% for each course / practical/ project and viva-voce.
- Grading shall be based on overall marks obtained (Internal + External) in the respective courses.

15. Classification of Successful Candidates

- Candidates who obtain 75% of the marks in the aggregate shall be declared to have passed the examination in **First Class with Distinction** provided they pass all the examinations prescribed for the course at the first appearance.

- Candidates who secure not less than 60% of the aggregate marks in the whole examination shall be declared to have passed the examination in **First Class.**

- All other successful candidates securing below 60% shall be declared to have passed in the **Second Class.**

16. Grading System

Evaluation of performance 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
EARTH ECOLOGY AND ENVIRONMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS2C01	100	4	3	1	0	4

Course Objectives

The purpose of this course is to make the students to understand the basic information about the earth and environment. They will also learn about the interactions between the components of our environment, ecology and also about environmental issues and its sustainability.

Course Outcomes

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

CO1 Understand the principles, scope and components of the earth and environment

CO2 Know the basic concepts of ecology and ecosystems, factors and its interaction along with its succession processes

CO3 Understands the interrelation between the earth environment & man and concept of biodiversity, its types, values , and its conservation methods.

CO4 Learns about various environmental issues and environmental sustainability.

CO5 Apply the knowledge of basic ecology in field studies.

Mappings of course outcomes with programme outcomes

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

CORE COURSE – I
EARTH ECOLOGY AND ENVIRONMENT

UNIT I Earth and Environment Contact Hours 8

Definition, Principles and Scope of Environmental Science. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Earth as an eco-system. Interaction between Earth, Man and Environment (K1, K2, K3)

UNIT II Ecology Contact Hours 8

Scope, basic concepts in ecology, levels of ecology. Abiotic factors-Temperature, Light, Precipitation - Topographic and Edaphic Factors. Biotic Factors – Introduction to population ecology and community ecology – Ecological Interactions – Ecological Succession. (K1, K2, K3)

UNIT III Ecosystem Contact Hours 12

Ecosystem-Introduction, kinds- structure and function. Energy flow in ecosystem, food chain and food webs, pyramids of energy, biomass and numbers. Major ecosystems - pond, grassland, forest, desert, cropland etc. productivity of different ecosystems - primary productivity in terrestrial ecosystems, secondary productivity. Biogeochemical cycles in ecosystems-carbon, nitrogen, sulfur and phosphorous. (K1, K2, K3)

UNIT IV Biodiversity Contact Hours 12

Biodiversity and its conservation: Definition, types, importance of biodiversity and threats to biodiversity. Concept and basis of identification of 'Hotspots'; hotspots in India. Measures of biodiversity. Strategies for biodiversity conservation: in situ, ex situ and in vitro conservation. (K1, K2, K3)

UNIT V Environmental Issues and Awareness Contact Hours 10

Global Environmental Issues - Biodiversity loss, Climate change, Ozone layer depletion. Sea level rise. International efforts for environmental protection. National Action Plan on Climate Change. Sustainable Development Goals - 2030. (K4, K5, K6)

Text Books

1. Sharma P.D. (2017) Ecology and Environment.13th Edition Rastogi Publications Ltd.
2. Rana S.V.S. (2009) Essentials of Ecology and Environmental Science. Prentice Hall Publishers Ltd.
3. Pratibha Singh, Anoop Singh & Piyush Malaviya (2009) Text Book of Environment & Ecology – Excel Publishers.

Reference Books

1. Singh J.S., Singh S.P. & Gupta S.R. (2014) Ecology, Environmental Science & Conservation S Chand Publishing Co
2. Sharma P.D. (2012) Environmental Biology. Deep and Deep Publications
3. Odum, E. P. & Barrett, G. W. (2005). Fundamentals of ecology. 5th ed. Belmont, CA: Thomson Brooks/Cole.
4. Pranav Kumar (2017) Fundamentals of Ecology and Environment. Second Edition Pathfinder Publications.

5 Madhab Chandra Dash (2018) Readings In Ecology And Environmental Science, Gen Next Publications.

6 Singh H.R. & Neeraj Kumar (2012). Ecology and Environmental Science, Vishal Publications

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1. http://archive.mu.ac.in/myweb_test/M.A.Part%20-%20II%20-%20Paper%20VII .pdf
2. http://dspace.vpmthane.org:8080/jspui/bitstream/123456789/4202/1/FC%20Sem%202%20THE%20CONCEPT%20OF%20ECOLOGY%20AND%20ENVIRONMENT.pdf
3. https://shodhganga.inflibnet.ac.in/bitstream/10603/68238/6/06_chapter%201.pdf
4. http://rvskvv.net/images/Environmental-Science_23.04.2020.pdf
5. https://www.environmentalscience.org/ecology
6. http://environment-ecology.com/what-is-environment/669-environment.html
7. https://www.nationalgeographic.org/topics/resource-library-human-impacts-environment/?q=&page=1&per_page=25

CORE COURSE – II

ENVIRONMENTAL CHEMISTRY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS2C02	100	4	4	0	0	4

Course Objectives

The purpose of this course is to develop an understanding the basics of chemistry in relevance to environment and such as, solutions preparation, chemical reactions and their effects on the environment, to provide students with an understanding of the fundamental chemical processes occurred on 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 To analyze chemical processes involved in air, water and soil environmental problems

CO5 Know the different types of toxic and 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 14

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 o f 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 and total suspended solids, 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) - Physicochemical 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, NPK in soil, Chemical reactions in soil (K5)

UNIT V Pollutant Chemistry Contact Hours 10

Pesticides: Classification, Degradation, Analysis - Pollution due to Pesticides – DDT and Endosulphan, Hydrocarbons: Classification, Hydrocarbon Decay (K3) - Effects on Macro and Microorganisms (K4) – Toxic effects of heavy metals - Ar, Cd, Pb & Hg

Text Books

1. De, A.K. (2017) Environmental Chemistry, Eighth Edition, New Age International Publishers.
2. Sharma, B.K. (2019) Environmental Chemistry, Goel Publishing House Ltd., Meerut, UP.

3. Balram Pani, (2017) Text Book of Environmental Chemistry, I.K. International Publishing House PVT. Ltd.
4. Girard J.E. (2015) Principles of Environmental Chemistry.
5. Rao, C.S. (2018) Environmental Pollution Control Engineering, 3rd Edition, New Age International (P) Ltd Publishers.

Reference Books

1. Manahan, S.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, V.K. (2015) Environmental Pollution and health, The Energy and Resource Institute (TERI)
4. Vanloon, G.W. and Duffy S.J. (2011) Environmental Chemistry a global perspective, 3rd Edition, Oxford University Press
5. Ibanez, J. G., Hernandez-Esparza, M., Doria-Serrano, C., Fregoso-Infante, A., and Singh, M.M. (2007). Environmental Chemistry. Springer Press

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1. https://ocw.mit.edu/courses/1-84j-atmospheric-chemistry-fall-2013/pages/lecture-notes/
2. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/04.environmental_chemistry/01.atmosphere/et/5503_et_et.pdf
3. http://www.fao.org/docrep/field/003/AC172E/AC172E04.htm
4. https://static1.squarespace.com/static/580d5051cd0f68322963dc55/t/5ec569f1b2ae022884f7338c/1589996020800/Water+Chemistry.pdf
5. http://agriinfo.in/?page=topic&superid=5&topicid=174

CORE COURSE – III

ENVIRONMENTAL MICROBIOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS2C03	100	4	4	0	0	4

Course Objectives

To learn the basic knowledge about microbes, role of microbes and microbial interactions in the various environmental components. To understand the biogeochemical cycles prevailing in the environment, to enhance the skill on microbial analysis related to environment

Course Outcomes

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

CO1 Able to understand the significance of Microbiology and Microbiologists

CO2 Able to understand about microbes in environmental field and the role of microbes in soil fertility

CO3 To enhance the skill on microbial analysis of relevance to the environment and understand the role of microbes on biogeochemical cycles

CO4 Know about the impact of microbial air and water pollutants and their diseases

CO5 Apply the microbial processes to clean the environment.

Mappings of course outcomes with programme outcomes

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

CORE COURSE – III

ENVIRONMENTAL MICROBIOLOGY

UNIT I Introduction to Microbiology Contact Hours 12

Introduction - History and Scope of Microbiology – Contributions of Antonie van Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch and Alexander Fleming - General characters of Bacteria, Fungi and Virus - Difference between Prokaryotes and Eukaryotes (K1, K2, K3)

UNIT II Geo microbiology 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: Mycorrhizae (K1, K2, K3)

UNIT III Biogeochemical Cycles Contact Hours 10

Carbon cycle - Role of microbes in Carbon cycle - Nitrogen cycle - Mechanism of biological nitrogen fixation - Ammonification, Nitrification, Denitrification - Phosphorous cycle and Sulphur cycle (K1, K2, K3, K4)

UNIT IV Air Borne and Water Borne Diseases Contact Hours 12

Microbiology of air - Microbial air pollutants - Bioaerosols, Aero allergens – Airborne diseases, Symptoms and preventive measures - Water pollution: Sources and nature of pollutants in water – waterborne diseases, Symptoms and preventive measures (Cholera and Typhoid) (K3, K4, K5, K6)

UNIT V Applied Microbiology Contact Hours 12

Microbial conversion of solid waste to food (Mushroom), fuels (Biogas), Biodegradation of Lignin – Bioremediation: Types and its application – Bio deterioration of paper - Metal Corrosion (K3, K4, K5, K6)

Text Books

1. Pelczar, Chan and Kreig, (1982) Microbiology, McGraw Hill Book Co, New York
2. Dubey and Maheshwari, (1999) A text book of Microbiology, 1/e, Chand publications, New Delhi.
3. Mohapatra, P. K. (2008) Text Book of Environmental Microbiology, I K International Publishing House Limited

Reference Books

1. Prescott, Harvey, Klein, (2013) “Microbiology”, -McGraw Hill, Ninth Edition.
2. SubbaRao, N.S. (2004) Soil Microbiology.4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. SubbaRao, N.S. (1995) Biofertilizers in Agriculture and Forestry.3rd Edition, Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
4. Brock, T.D. Madigan, M.T. Martinko, J.M. and Parker, J. (1994) Biology of Microorganisms, VII Ed., Prentice-Hall, New Jersy, USA.

5. Ronald, M. Atlas and Richard Bartha, (1997) Microbial Ecology, 4/e, Benjamin Cummings Publishing company, USA.

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

CORE COURSE - IV

ENVIRONMENTAL BIOCHEMISTRY AND TOXICOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	22UPEVS2C04	100	4	4	0	0	4

Course Objectives

The purpose of this course is to focus on understanding the role of pollutants, xenobiotics in the natural environment and to understand the basics of environmental toxicology, cell biology and biochemistry and to characterize the adverse effects of chemical substances on ecosystems 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
CO2 Understand the basic principles, target organ toxicity and the toxicity of a select group of chemical compounds.
CO3 Synthesize and apply concepts from multiple sub-disciplines in environmental cell biology, biochemistry and toxicology.
CO4 Use technical and analytical skills to quantify the level of xenobiotics in environmental compartments
CO5 Understand the effects of xenobiotics on human health.

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

A brief history of cell biology, chemistry of the cell, Prokaryotic and Eukaryotic cell structure and intracellular organelles – Cell wall, membranes, nucleolus, endosomes, peroxisomes, mitochondria, endoplasmic reticulum, plant vacuoles, plastids, microbodies and chloroplast. Cell growth and division-Meiosis and Mitosis, genotypes and phenotypes, Cancer cell, stem cells and cloning (K1, K2)

UNIT II Environmental biochemistry Contact Hours 10

Basic chemistry of macromolecules: Carbohydrates, Amino acids, Proteins, Lipids and Nucleic acids of physiological significance. Structure and function of proteins and enzymes. Bioenergetics and metabolism of carbohydrates and lipids: Role of ATP; Glycolysis, Citric acid cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis, lipid metabolism; Biosynthesis of cholesterol; Fatty acid oxidation; Electron transport chain and Oxidative phosphorylation. Metabolism of proteins and amino acids. Micronutrients: Vitamins and Minerals. Biochemistry of extracellular and intracellular communication: Membrane (K1, K2)

UNIT III Basics of Toxicology Contact Hours 10

Ecotoxicology: Biomarkers; Bioaccumulation; Biomagnification; Bioconcentration factor; Risk assessment; Effects on population and ecosystems; Toxicity of heavy metal (Pb, Cd, Hg and As). Cytotoxicity and Genotoxicity: Molecular mechanism of cell death; chromosomal aberration; sister chromatid exchanges; Micronucleus and Nuclear abnormalities; DNA damage and repair mechanism. Carcinogenesis: Classification of carcinogens; Metastasis and metabolism of chemical carcinogens; cancer risk evaluation; Brief outline of cancer therapy. Reproductive toxicology: Teratology; Reproductive toxicity; *In vitro* fertilization (K3, K4, K5)

UNIT IV Toxicity Testing and Bioassay Contact Hours 10

Toxicity assay: Acute and chronic toxicity; Dose- Response Relationship- Median lethal concentration (LD_{50} and LC_{50}); Sublethal concentration and safe concentration (NOEL, MATC); Whole Effluent Toxicity (WET) test; Bioassay - types, methodologies and application; Toxico Kinetics and toxicokinetic analysis (K5, K6)

UNIT V Xenobiotics Contact Hours 10

Concept of Xenobiotics: Toxic materials; Xenobiotic induced oxidative stress; Cell injury; Mode of action: Types of exposure, Absorption, Distribution, Metabolism and Excretion of toxicants (Phase I and Phase II reaction)

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 BB, Gruissem W and Jones RL (2002) Biochemistry and Molecular Biology of Plants, ASPB, USA.
2. Cooper GM and Hausman RE (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 April 23rd 2004 by W. H. Freeman (first published).

4. Gerald Karp (2002) Cell and Molecular Biology: Concepts and Experiments, 7th Edition.
5. Klaassen, Curtis D; Casarett, Louis J; Doull, John, (2013) Casarett and Doull's toxicology: the basic science of poisons (8th Edition) McGraw Hill Publishers.
6. Ted A. Loomis, A. Wallace Hayes. Loomis's Essentials of Toxicology (1996) 4th Edition, Academic Press Publishers.
7. Sharma PD, Rastogi and Lamporary (1994) Environmental Biology and Toxicology, Rajpal and Sons Publishing, New Delhi.
8. Ted A Simon. Environmental Risk Assessment: A Toxicological Approach (2014) CRC Press publications.
9. Loganathan, S., Murugan, T. (2017) Pesticide-Mediated Toxicity in Modern Agricultural Practices, Sustainable Agriculture towards Food Security, 359-373.

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1. https://academic.oup.com/toxsci/article/120/suppl_1/S49/1616424
2. https://www.hindawi.com/journals/bmri/2017/4627872/
3 https://iubmb.onlinelibrary.wiley.com/doi/pdf/10.1016/0307-4412(81)90131-X
4 https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/downloads/Introduction_To_Biochemistry.pdf

CORE COURSE – V

BIODIVERSITY AND CONSERVATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	22UPEVS2C05	100	4	4	0	0	4

Course Objectives

The purpose of this course is 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 main reasons for decline and threats to biodiversity worldwide and understand the need for local action to address the global loss of biodiversity

CO4 Evaluate the pros and cons of species introductions and reintroductions

CO5 Understand the various *in situ* and *ex situ* conservation measures and make critical judgments on the conflict between conservation and development

Mappings of course outcomes with programme outcomes

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

CORE COURSE – V

BIODIVERSITY AND CONSERVATION

UNIT I Introduction Contact Hours 08

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) – Endangered and endemic species of flora and fauna in India (K1 & K2) - Ecologically Sensitive Areas (ESA) in India (K4 & K5) - Values of Biodiversity (K4 & K5)

UNIT II Threats to Biodiversity Contact Hours 12

Biodiversity threats under Anthropocene era: Habitat loss, fragmentation and degradation – Pollution - Overexploitation (K2, K4 & K5) – 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) - Human-Animal conflict with special reference to elephants (K3, K4 , K5 & K6)

UNIT III Conservation Strategies Contact Hours 14

In situ conservation: Afforestation, Social Forestry, Agro-forestry, Zoos, Biosphere Reserves, National Parks, Sanctuaries, Protected Area Network, Sacred Groves and Sthalavrikshas (K1, K2 & K3) – *Ex situ conservation*: Botanical gardens, Cryopreservation, Gene Bank, Seed Bank, Pollen Bank, Sperm Bank, cDNA Bank (K1, K2 & K3) - Status and protection of species in National and International levels (K3 & K4)

UNIT IV Sustainable Management of Bioresources Contact Hours 12

Biodiversity Prospecting - Examples of biopiracy and bioprospecting (K2 & K5) - 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: Role of CITES, IUCN and Convention on Biological Diversity (CBD) in biodiversity conservation (K2, K3 & K4) – WWF-India for priority and threatened species conservation (K3, K4 & K5)

UNIT V Policies, Programmes and Acts for Conservation Contact Hours 10

Salient features of Biological Diversity Act 2002 (K2 & K3) - Policies implemented by MoEF & CC for biodiversity conservation - Monitoring the Illegal Killing of Elephants (MIKE) programme - UNESCO Man and Biosphere Programme (MAB) (K3 & K5) - Nagoya Protocol on Access and Benefit-Sharing – Cartagena Protocol on Biosafety (K3) - SAWEN Network to combat illegal wildlife trade – Ramsar Strategic Plan 2016-2024 for wetland conservation (K4 & K5)

Text Books

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

CORE COURSE – V

BIODIVERSITY AND CONSERVATION

Reference Books

1. Alonso A. Aguirre and Raman Sukumar (2017) Tropical Conservation. Perspectives on Local and Global Priorities, Oxford University Press, USA
2. Chaudhuri AB and Sarkar DD (2003) Megadiversity Conservation, Flora, Fauna and Medicinal Plants of India's Hot Spots. Daya Publishing House, New Delhi.
3. Dadhich LK and Sharma AP (2002) Biodiversity –Strategies for Conservation, APH Publishing Corporation, New Delhi.
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7. Muthuchelian K (2016) Bioinformatics, Barcoding and Benefit Sharing in Biodiversity Educationist Press, New Delhi.
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9. William V. Holt, Janine L. Brown and Pierre Comizzoli (2014) Reproductive Sciences in Animal Conservation. Progress and Prospects, Springer, New York.

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1. Ghosh-Harihar M, An R, Athreya R et al. (2019) Protected areas and biodiversity conservation in India. *Biological Conservation* 237: 114-124
2. Behera MD, Behera SK & Sharma S (2019) Recent advances in biodiversity and climate change studies in India. *Biodiversity and Conservation* 28: 1943-1951.

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8. https://www.cbd.int/gspc/strategy.shtml
9. https://www.zsl.org/sites/default/files/LPR%202020%20Full%20report.pdf
10. http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf

CORE COURSE – VI

ENVIRONMENTAL POLLUTION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	22UPEVS2C06	100	4	4	0	0	4

Course Objectives

The purpose of this course is to gain awareness of environmental pollution and its types, sources, effects & monitoring 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 types

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

CO3 To understand the type impacts on environment from each of the pollutant

CO4 To acquire skills in assessing environmental impacts through a multidisciplinary approach

CO5 Apply relevant monitoring, skills and modern engineering tools to identify the environmental pollutants

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 POLLUTION

UNIT I Air Pollution Contact Hours 10

Air pollution - Natural and anthropogenic sources of pollution (K1 & K2) – Types of Air pollutants (K3) – History of air pollution (air pollution episode, global and India) (K3) - Effects of air pollution on environment (K3) Meteorology based transport and diffusion of pollutants - Behavior of pollutants in the atmosphere (K4)– Effects on environment - Air pollution standards (K4)- Air pollution index (K5) - Methods of monitoring, sampling and control of air pollution (K4, K5 & K6).

UNIT II Water Pollution Contact Hours 10

Water pollution – Types, and sources (K2 & K3) – Toxicology of water pollutants (Trace metals and organic substances) - Eutrophication (K4), Physico-chemical and bacteriological sampling techniques (K3 & K4)- Water quality and standards. Ground water pollution & marine pollution – sources (K3 & K4) – Ecological and Economic impacts of water pollution (K3 & K4)- Control of water pollution (K5)- Water harvesting techniques (K5).

UNIT III Soil Pollution Contact Hours 10

Soil Pollution- Sources (industrial, domestic and agricultural) & types of contaminants (pesticides, heavy metals and others) (K1 to K4) –Process that contribute degradation of soil quality (erosion, physical and chemical degradation) (K4) – Detrimental effects of soil pollutants on flora, fauna and ground water (K4) - Soil minerals and its importance's (K4)– Soil quality parameters (K4)– Soil sampling methods, devices and soil pollution control methods (K5).

UNIT IV Noise Pollution Contact Hours 10

Noise Pollution: Definition (K1), sources (K2), sound pressure level (K2), decibels, intensity, duration, pitch (K3), noise-monitoring-sound level meter, noise indices (K4). Noise exposure levels and effects on humans and animals (K4). Permissible standards (CPCB standards) (K4).

UNIT V Thermal & Radioactive Pollution Contact Hours 10

Thermal pollution- Sources (K2), Effects on aquatic environment and control measures (K4). Radioactive Pollution: Definition (K1), radioactivity (K2). Biological effects of radiation and ecosystem (K4). Radiation exposure standards (K4), radiation monitoring devices (K5).

Text Books

1. Avinash Chauhan (2020) Environmental Pollution and Management. IK International Publishers Ltd
2. Mark Brusseau, Ian Pepper, Charles Gerba (2019) Environmental and Pollution Science, 3rd Edition, Academic Press
3. Shafi, S.M (2005) Environmental Pollution. Atlantic Publishers and Distributors.
4. Khopkar, S. M (2005) Environmental Pollution Monitoring and Control, New Age

International (P) Ltd Publishers**.**

5. Rao CS (2018) Environmental Pollution Control Engineering, 3rd Edition, New Age International (P) Ltd Publishers.

Reference Books

1. Jeffrey Peirce J, Aarne Vesilind P, Ruth Weiner (1997) Environmental Pollution and Control, 4th Edition, Butterworth-Heinemann
2. Roy M Harrison (2000) Pollution: Causes, Effects and Control, 4th Edition, The Royal Society of Chemistry
3. Ahluwalia, V K (2015) Environmental Pollution and health, The Energy and Resource Institute (TERI)
4. Daniel Vallero (2014) Fundamental of Air Pollution, 5th Edition, Academic Press
5. Agarwal S K (2009) Water Pollution, A P H Publishing Corporation

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2. https://www.nile-center.com/uploads/RQZG7BCW4DGXNSZ.pdf
3. https://www.researchgate.net/publication/321289637_WATER_POLLUTION-SOURCESEFFECTS_AND_CONTROL
4. http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.agro-0c6457fb-fa78-4aa1-9eca-5f4483681a90/c/ILNS-3-2014-1-6.pdf
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7. https://www.nios.ac.in/media/documents/313courseE/L36.pdf
8. https://www.conserve-energy-future.com/radioactive-pollution-causes-effects-solutions.php
9. https://www.researchgate.net/publication/319329633_Noise_Pollution_Human_Health_A_Review
10.https://ec.europa.eu/environment//europeangreencapital/wp-content/uploads/2011/05/EGCNantesUKChap7-F.pdf

CORE COURSE – VII

WASTE MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	22UPEVS2C07	100	4	4	0	0	4

Course Objectives

The purpose of this course is to understand the problems of different kinds of wastes and understand 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 Understand industrial specific wastes and their efficient management

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

CO4 Describe methods of disposal of hazardous solid waste

CO5 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 – VII

WASTE MANAGEMENT

UNIT I Municipal waste Management Contact Hours 12

Wastes – Introduction, Definition, Sources and Classification (K1 & K2); Municipal Solid Wastes – Source, Types, Per Capita Generation, Global Scenario Wastes (K3); Collection and Transportation Methods, Waste Processing and Material Recovery (TMRF), (K4) Effects of Municipal Solid Wastes on Environment. Disposal Methods (Landfill, Composting, Burning, Incineration, Pyrolysis, Anaerobic Digestion) (K5 & K6)

UNIT II Hazardous Waste Management Contact Hours 10

Hazardous waste – Introduction (K1 & K2), Characteristics (K3), Classification of Hazardous Waste (Industrial, Hospital and Domestic) – Labeling and Handling of Hazardous Solid Wastes (Segregation, Recovery of Hazardous Waste Substances) (K3 & K4) - Hazardous Wastes Disposal Techniques (K5).

UNIT III Biomedical Waste Management Contact Hours 8

Biomedical Wastes: Sources, Types of Biomedical Wastes (K1 & K2), Impacts of Biomedical Wastes on Environment (K3 & K4) – Labeling and transport (K4), Control Measures and disposal of biomedical wastes (K5).

UNIT IV Plastic, Radioactive & e-waste Management Contact Hours 12

Plastic Wastes: Sources, Types (K1 & K2), Facts & Figures of Plastic Waste Scenarios in National & International (K37 K4), Effects of Plastic Wastes on Environment, Control Measures of Plastic Wastes (K5 & K6). Radioactive Wastes: Sources, Types (K1 & K2), Effects (K3), Control and Disposal Methods (K4 & K5). E-wastes: Sources, Types of e-wastes (K2) – Impacts of e-wastes on Environment (K3) - Control and disposal methods of e-wastes (K4).

UNIT V Recovery of Waste Contact Hours 8

Vermicomposting, mushroom cultivation, fly ash bricks, biogas; Microbial fuel cell - Production of methane, ethanol, electricity; Industrial specific waste management techniques (K3, K4 & K5).

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 Delh
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

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WASTE MANAGEMENT

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1. Hieronymi, C.K, R. Kahhat, 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 MN (2019) Plastic Waste Management Processing and Disposal, 2nd Edition, Scrivener Publishing.

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4. www.cement.org/waste/wt_apps_radioactive.asp
5. www.ipma.co.in/recycle.asp
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8. https://aces.nmsu.edu/pubs/_g/G314.pdf
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10. https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/E-Learning/Moocs/Solid_Waste/W2/Solid_waste_management_UNEP_2005.pdf

CORE COURSE – VIII

BIOSTATISTICS AND ENVIRONMENTAL MODELING

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	22UPEVS2C08	100	4	4	0	0	4

Course Objectives

The purpose of this course is to equip students with basic knowledge in basic statistical and bio statistical methods. To be skilled in using various tools for statistical analyses, to introduce the concept of environmental modeling, its approaches, methods, to make them aware of the practical applications of biostatistics and environmental modeling.

Course Outcomes

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

CO1 Know the basic methods in Statistics and methods of data collection

CO2 Understand the basic principles of biostatistics and different types of tests

CO3 Enable to understand the different tools in biostatistics for various datasets

CO4 Learns the basic concept and principles of environmental modeling

CO5 Acquire the skills to apply the biostatistics and modeling methods for environmental studies.

Mappings of course outcomes with programme outcomes

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

CORE COURSE – VIII

BIOSTATISTICS AND ENVIRONMENTAL MODELING

UNIT I Basic Statistical Methods Contact Hours 8

Elementary concept of statistics – Sampling Methods - Data Collection, Computation and Presentation, Calculation of mean, mode and standard deviation from field data, laboratory data – Data representation Methods. (K1, K2, K3)

UNIT II Biostatistics Methods Contact Hours 5

Measures of dispersion: Range, Standard Deviation, Variance, Skewness and Kurtosis; Distribution - Normal, t test and chisquare test, Difference among means - ANOVA. Correlation and Regression - Linear and Multiple. (K3, K4, K5)

UNIT III Tools for Analysis Contact Hours 7

Descriptive Statistics, Data Distribution Analysis – Parametric and Non-Parametric Tests- Introduction to SPSS, MATLAB, Biio Python and R Statistics (K3, K4)

UNIT IV Environmental Modeling Contact Hours 7

Approaches to development of environmental models; linear, simple and multiple regression models, validation and forecasting. Models of population growth and interactions: Lotka-Voltera model, Leslie's matrix model. Point Source Stream Pollution Model, Box Guassian Plume Model. (K4, K5)

UNIT V Application of Environmental Modeling and Biostatistics Contact Hours 7

Experimental Design for Environmental Modeling - Case Studies - Biostatistics - Significance in Data Presentation - Data Validation through Statistical Approaches. Statistical and Modeling Softwares - Commercial Use and Applications(K5, K6)

Text Books

1. Sharma A K (2005).Text Book of Biostatistics, DPH Mathematic Series, Discovery Publishing House
2. Smith J (2012). Environmental Modeling - An Introduction, Oxford University Press, UK.
3. Gray & Gray (2016). Introduction to Environmental Modeling Cambridge University Press

CORE COURSE – VIII

BIOSTATISTICS AND ENVIRONMENTAL MODELING

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1. Jorgeson SE (1995). Handbook of Environmental and Ecological Modeling, Levis Publications, New York
2. Rosner B (2016) Fundamentals of Biostatistics, 8th Edition Cengage Learning, USA.
3. William G Gray (2018). Introduction to Environmental Modeling, Cambridge University Press UK.
4. Sundar Rao & Richard (2015) Introduction to Biostatistics and Research Methods 5th Edition, PHI Learning Publishers.
5. Chap T. Le & Lynn E. Eberly (2016) Introductory Biostatistics, 2nd Edition, John Wiley Publications
6. Mike J Barnsley, S.B. (2007) Environmental Modeling, A Practical Introduction, 1st Edition, Taylor & Francis Co., Publishers
7. Andrew Ford (2009) Modeling the Environment, 2nd Edition, Island Press Publications.

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3. http://biostatcourse.fiu.edu/
4. http://www.fao.org/3/W7295E/w7295e08.htm
5. https://www.epa.gov/measurements-modeling/environmental-modeling
6. http://www.eolss.net/sample-chapters/c07/e4-20-03-01.pdf

CORE COURSE – IX

ENERGY AND ENVIRONMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	22UPEVS2C09	100	4	4	0	0	4

Course Objectives

The purpose of this course is to understand the various forms of conventional and non-conventional energy resources and effective utilization of their resources. Further, to explore the knowledge pertaining to various biological energy resources and their feedstocks, conversion technologies and conservation practices.

Course Outcomes

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

CO1 Understand the different types of energy sources

CO2 Explore the knowledge in the interrelationship with energy-environment-sustainable development

CO3 Understand the global fossil fuels energy resources utilization and their impact on environment and economy and need for coal phase out scenario

CO4 Explore more knowledge related to various renewable energy resources in India and recent initiatives and policy framework by different organizations and MNRE, MoEF&CC and other Ministries

CO5 Understand the existing novel technologies used for energy conservation in an efficient manner and energy audit for sustainable environmental management

Mappings of course outcomes with programme outcomes

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

CORE COURSE – IX

ENERGY AND ENVIRONMENT

UNIT I Energy sources Contact Hours 10

Introduction to nexus between Energy, Environment and Sustainable Development (K1 & K2) - Potential and perspectives of various energy sources in India (K3 & K4) - Classification of energy resources - Conventional and Non-conventional, Renewable and Non- renewable energy (K1, K2, K3 & K4) – Environmental implications of energy resources (K4 & K5)

UNIT II Non-renewable Energy Sources Contact Hours 12

Fossil fuels (Coal, petroleum, LPG and natural gas) – Composition and Classification of coal, crude oil and natural gas – Consumption and demands of coal, crude oil and natural gas – Environmental and economic impacts of fossil fuel consumption (K3 & K4) – Global coal phase out scenario (K4, K5 & K6) - Nuclear energy – fission and fusion (K1 & K2)

UNIT III Renewable Energy Sources Contact Hours 14

Solar, wind, geothermal, hydel and tidal energy sources (K1 & K2) - *Ocean Thermal Energy Conversion (OTEC)*: Principle and generation (K3 & K4) – Global energy consumption pattern – Applications of solar and wind energy - Present scenario and recent initiatives of renewable energy sources in India (K4, K5 & K6)

UNIT IV Waste to Energy Contact Hours 10

Bioenergy - Biomass energy as an energy source - Characteristics of biomass (K1 & K2) - Energy plantations - Biomass conversion technologies (K3 & K4) - *Types of biofuels*: Biodiesel, bioethanol, biogas, biohydrogen - Importance, production, technologies and applications (K4, K5 & K6) - India's Bioenergy Policy (K3 & K4)

UNIT V Energy Conservation Contact Hours 08

Energy conservation – Principles and approach (K1 & K2) - Energy conservation in buildings - Green buildings - Solar passive architecture, eco-housing (K3, K4, K5 & K6) - Energy audit (K4 & K5) - National and International norms (K2)

Text Books

1. Anuja Dahiya (2015) Bioenergy - Biomass to Biofuels. Academic Press, UK.
2. Balasubramanian Viswanathan (2017) Energy Sources. Fundamentals of Chemical Conversion Processes and Applications. Elsevier, Netherlands.
3. Bansal NK (2014) Non-Conventional Energy Resources, Vikas Publishing House Pvt Ltd., New Delhi.
4. Bhatia SC and Gupta RK (2018) Textbook of Renewable Energy. Woodhead Publishing India Private Limited, New Delhi.
5. Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala (2019) Fundamentals and Applications of Renewable Energy. McGraw-Hill Education.
6. Sawhney GS (2012) Non-Conventional Energy Resources, PHI Learning Private Limited, New Delhi.

CORE COURSE – IX

ENERGY AND ENVIRONMENT

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1. David B. Rutledge (2020) Energy: Supply and Demand. Cambridge University Press, UK.
2. Ehrlich R (2013) Renewable Energy. A First Course. CRC Press, Boca Raton, USA.
3. Galanakis CM (2020) Biobased Products and Industries. Elsevier, Netherlands.
4. Jacobson MZ (2020) 100% Clean, Renewable Energy and Storage for Everything. Cambridge University Press, UK.
5. Mitra M and Nagchaudhuri A (2020) Practices and Perspectives in Sustainable Bioenergy. A Systems Thinking Approach. Springer Nature India Private Limited.
6. Nikolay Belyakov (2019) Sustainable Power Generation. Current Status, Future Challenges, and Perspectives. Academic Press, UK.
7. Pandey A, Larroche C, Dussap C-G, Gnansounou, Khanal SK and Ricke S (2019) Biofuels: Alternative Feedstocks and Conversion Processes for the Production of Liquid and Gaseous Biofuels. Academic Press, UK.
8. Simon CA (2020) Alternative Energy. Political, Economic and Social Feasibility. Second Edition, Rowman & Littlefield, USA.
9. Thomas L (2020) Coal Geology, Third Edition, Wiley.
10. Tyagi H, Chakraborty PR, Powar S and Agarwal AK (2020) Solar Energy. Systems, Challenges, and Opportunities. Springer Nature Singapore Pte Ltd.

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1. Alalwan HA, Alminshid AH and Aljaafari HA (2019). Promising evolution of biofuel generations. Subject review. *Renewable Energy Focus*, 28, 127-139.
2. Bhagea R, Bhoyroo V and Puchooa D (2019). Microalgae: the next best alternative to fossil fuels after biomass. A review. *Microbiology Research*, 10(1).
3. Gong J, Li C and Wasielewski MR (2019) Advances in solar energy conversion. *Chemical Society Reviews*, 48(7), 1862-1864.
4. Lu M and Lai JH (2019) Building energy: a review on consumptions, policies, rating schemes and standards. *Energy Procedia*, 158, 3633-3638.
5. Srivastava RK, Shetti NP, Reddy KR and Aminabhavi TM (2020). Biofuels, biodiesel and biohydrogen production using bioprocesses. A review. *Environmental Chemistry Letters*, 1-24.
6. Vargas SA, Esteves GRT, Maçaira PM, Bastos BQ, Oliveira FLC and Souza RC (2019). Wind power generation: A review and a research agenda. *Journal of Cleaner Production*, 218, 850-870.
7. Wang H, Lei Z, Zhang X, Zhou B and Peng J (2019). A review of deep learning for renewable energy forecasting. *Energy Conversion and Management*, 198, 111799.

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2. https://climateanalytics.org/media/report_coal_phase_out_2019.pdf
3. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC111438/acd_in_metis_final.pdf
4. https://www.worldgbc.org/what-green-building
5. https://beeindia.gov.in/sites/default/files/ctools/TR-EnergyAudits.pdf

CORE COURSE – X

ENVIRONMENTAL POLLUTION - II

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V	22UPEVS2C10	100	4	4	0	0	4

Course Objectives

The purpose of this course is to gain awareness of environmental pollution and its types, sources, effects & monitoring 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 types

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

CO3 To understand the type impacts on environment from each of the pollutant

CO4 To acquire skills in assessing environmental impacts through a multidisciplinary approach

CO5 Apply relevant monitoring, skills and modern engineering tools to identify the environmental pollutants

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 POLLUTION - II

UNIT I Air Pollution Contact Hours 10

Air pollution - Natural and anthropogenic sources of pollution (K1 & K2) – Types of Air pollutants (K3) – History of air pollution (air pollution episode, global and India) (K3) - Effects of air pollution on environment (K3) Meteorology based transport and diffusion of pollutants - Behavior of pollutants in the atmosphere (K4)– Effects on environment - Air pollution standards (K4)- Air pollution index (K5) - Methods of monitoring, sampling and control of air pollution (K4, K5 & K6).

UNIT II Water Pollution Contact Hours 10

Water pollution – Types, and sources (K2 & K3) – Toxicology of water pollutants (Trace metals and organic substances) - Eutrophication (K4), Physico-chemical and bacteriological sampling techniques (K3 & K4)- Water quality and standards. Ground water pollution & marine pollution – sources (K3 & K4) – Ecological and Economic impacts of water pollution (K3 & K4)- Control of water pollution (K5)- Water harvesting techniques (K5).

UNIT III Soil Pollution Contact Hours 10

Soil Pollution- Sources (industrial, domestic and agricultural) & types of contaminants (pesticides, heavy metals and others) (K1 to K4) –Process that contribute degradation of soil quality (erosion, physical and chemical degradation) (K4) – Detrimental effects of soil pollutants on flora, fauna and ground water (K4) - Soil minerals and its importance's (K4)– Soil quality parameters (K4)– Soil sampling methods, devices and soil pollution control methods (K5).

UNIT IV Noise Pollution Contact Hours 10

Noise Pollution: Definition (K1), sources (K2), sound pressure level (K2), decibels, intensity, duration, pitch (K3), noise-monitoring-sound level meter, noise indices (K4). Noise exposure levels and effects on humans and animals (K4). Permissible standards (CPCB standards) (K4).

UNIT V Thermal & Radioactive Pollution Contact Hours 10

Thermal pollution- Sources (K2), Effects on aquatic environment and control measures (K4). Radioactive Pollution: Definition (K1), radioactivity (K2). Biological effects of radiation and ecosystem (K4). Radiation exposure standards (K4), radiation monitoring devices (K5).

Text Books

1. Avinash Chauhan (2020) Environmental Pollution and Management. IK International Publishers Ltd
2. Mark Brusseau, Ian Pepper, Charles Gerba (2019) Environmental and Pollution Science, 3rd Edition, Academic Press
3. Shafi, S.M (2005) Environmental Pollution. Atlantic Publishers and Distributors.

4. Khopkar, S. M (2005) Environmental Pollution Monitoring and Control, New Age International (P) Ltd Publishers**.**
5. Rao CS (2018) Environmental Pollution Control Engineering, 3rd Edition, New Age International (P) Ltd Publishers.

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1. Jeffrey Peirce J, Aarne Vesilind P, Ruth Weiner (1997) Environmental Pollution and Control, 4th Edition, Butterworth-Heinemann
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3. https://www.researchgate.net/publication/321289637_WATER_POLLUTION-SOURCESEFFECTS_AND_CONTROL
4. http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.agro-0c6457fb-fa78-4aa1-9eca-5f4483681a90/c/ILNS-3-2014-1-6.pdf
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7. https://www.nios.ac.in/media/documents/313courseE/L36.pdf
8. https://www.conserve-energy-future.com/radioactive-pollution-causes-effects-solutions.php
9. https://www.researchgate.net/publication/319329633_Noise_Pollution_Human_Health_A_Review
10.https://ec.europa.eu/environment//europeangreencapital/wp-content/uploads/2011/05/EGCNantesUKChap7-F.pdf

CORE COURSE – XI

ENVIRONMENTAL ANALYSIS AND TECHNIQUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VI	22UPEVS2C11	100	4	4	0	0	4

Course Objectives

The purpose of this course is to introduce knowledge and skills in analysis of environmental pollutants in environmental matrices, including extraction, sample preparation and instrumentations analysis, theory and techniques in quantitative and qualitative methods.

Course Outcomes

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

CO1 Understand the basics and requirement of environmental analysis

CO2 Understand the environmental quality parameters to be monitored and determined

CO3 Know the role of sample preparation in environmental analysis

CO4 Understand the instrumental techniques and methods of analysis and Collect, analyze, validate the instrumental data and conclude the analytical data and prepare analytical reports

CO5 Use spectroscopic and chromatographic techniques to quantify various pollutants in environment.

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XI

ENVIRONMENTAL ANALYSIS AND TECHNIQUES

UNIT I Introduction to Environmental Analysis Contact Hours 8

Quality Control and Quality Assurance Program in Environmental Analysis - Qualitative and Quantitative Analysis - Internal and External Standards - Standards Data Collection - Analysis - Data Errors in Quantitative analysis, Precision and Accuracy in Measurement. Types of Samples and Analysis Methods. (K1,K2,K3)

UNIT II Water Quality Analysis Contact Hours 10

Physical Parameters - Colour - Temperature - Turbidity. Chemical Parameters - pH- Electrical Conductivity - Total Solids - Dissolved Oxygen - Total Alkalinity - Iron -Nitrate - Biochemical Oxygen Demand - Chemical Oxygen Demand. Biological Parameters - MPN (Most Probable Number) and MFT (Membrane Filter Techniques) - SPC (Standard Plate Count) - National Water and Wastewater Quality Standards. (K1,K2,K3)

UNIT III Soil Quality Analysis Contact Hours 6

Collection of Soil Samples - Physico - Chemical Analysis of Soil - Density - Specific gravity - Texture - pH - Electrical Conductivity - Chlorides - Nitrates - Phosphates - Organic Matter - Standard Soil Quality Standards. (K1,K2, K3, K4,K5)

UNIT IV Air Quality Analysis Contact Hours 8

Indoor Air Quality - Ambient Air Quality Parameters – Particulate Maters, Inorganic and Organic Air Pollutants - Air Sampling Methods - Air Quality Monitoring Equipments - Environmental Air Quality Standards. (K1,K2, K3)

UNIT V Analytical Techniques Contact Hours 12

pH meter - Electrical Conductivity Meter - Nephlometer - UV-Vis Spectrometer - High Pressure Liquid Chromatography (HPLC) - Gas Chromatography - Flame Photometer - Atomic Absorption Spectrometry - X-ray Diffraction - Sound Level Meter. (K1,K2, K3, K4,K5)

Text Books

1. Krishnan Kannan, K., 1997. Fundamentals of Environmental Pollution, S. Chand Company, New Delhi
2. Murali Krishna, K.V.S.G. (2015) Air Pollution and Control, University Science Press.
3. Dara, S.S., 2000. A Text book of Environmental Chemistry and Pollution Control. S. Chand Company, New Delhi.

Reference Books

1. Christian GD (2001), Analytical Chemistry, 5th edition, John Wiley and Sons Inc., India
2. Wilson, K, Walker, J (2010) Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University Press.
3. Goel, P.K. (2006) Water Pollution Causes, Effects and Control, New Age International Publishers.
4. Sandell, E. B., and Ōnishi, H. (1978) Photometric determination of traces of metals, Wiley

5. Welz, B., and Sperling, M. (2008) Atomic Absorption Spectrometry, John Wiley & Sons.
6. Ed Metcalfe, Atomic absorption and emission spectroscopy, J. Wiley, 1987.

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1. https://www.statisticshowto.com/accuracy-and-precision/
2. http://reference.wolframcloud.com/language/guide/ScientificDataAnalysis.html
3. https://www.epa.gov/wqs-tech/water-quality-standards-handbook
4. http://cwc.gov.in/water_quality

http://www.fao.org/3/a-i0131e.pdf

6. https://www.intechopen.com/books/air-quality/methods-for-online-monitoring-of-air-pollution-concentration
7. https://www.iedunote.com/environmental-analysis
8. http://www.cpeo.org/techtree/ttdescript/msgc.htm
9. https://www.scu.edu.au/southern-cross-geoscience/research-facilities-and-resources-group/analytical-equipment/
10. http://www.sticindia.com/saif_instruments.html#ea

CORE COURSE – XII

NATURAL RESOURCES MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII	22UPEVS2C12	100	4	4	0	0	4

Course Objectives

The purpose of this course is a view of the nature of Earth's resources, particularly the nonrenewable resources, how and where they are generated, how they are extracted and used, and how these activities impact Earth's environment. It also addresses sustainability by looking into different ways of conservation of the natural resources and their management.

Course Outcomes

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

CO1 Understand the different types of natural resources and their significance in ecosystem

CO2 Extensive knowledge pertaining to the sustainable utilization of natural resources

CO3 Develop an objective view of the nature of Earth's resources, particularly the non-renewable resources

CO4 Explain how and where the Earth's resources are generated, how they are overexploited, and how these activities impact Earth's environment

CO5 Develop perspectives on sustainability by looking into different ways of conservation of the precious natural resources and their management

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XII

NATURAL RESOURCES MANAGEMENT

UNIT I Introduction Contact Hours 08

Natural resources – Classification, Concepts and approaches of natural resource conservation (K1 & K2) – Natural resources of India – Factors influencing resource availability (K1 & K2) - Overexploitation of natural resources - Earth overshoot Day (K3 & K4)

UNIT II Land Resources Management Contact Hours 12

Land degradation due to mining, exploration, industrialization, irrigation and natural disasters - Soil erosion – Land degradation in India (K1, K2, K3 & K4) – Salient features of CoP 14 UNCCD for land restoration - Land restoration for achieving the Sustainable Development Goals (K4 & K5) - *Soil Fertility and Nutrient Management*: Role of organic matter and its significance in soil quality – Diagnosis of soil nutrient deficiencies (K3, K4 & K5) – Sustainable agricultural practices (K5 & K6) - Wasteland development strategies – Ecological significance of wetland conservation (K4 & K5)

UNIT III Mineral Resources Management Contact Hours 12

Resources and reserves – Origin, distribution and uses of economic minerals (K1 & K2) - Exploration of mineral resources from oceans - Steps in mineral exploitation - Impact of exploitation of economic minerals on environment - Conservation of economic mineral resources (K3, K4 & K5)

UNIT IV Water Resources Management Contact Hours 14

Overutilization of surface and groundwater – Integrated water resource management (K2, K3 & K4) - Watershed management – Rain water harvesting (K5 & K6) – Conflicts of major river water disputes in India - Interlinking of rivers and river basin management – Restoration of lakes and Ganga and Yamuna River Action Plans (K3, K4 & K5) - Coastal zone management strategies - Ecological significance of mangroves, Coral reefs and its conservation (K4 & K5)

UNIT V Forest Resources Management Contact Hours 12

Significance for the conservation of forest resources – Major forest types in India and their characteristics (K1 & K2) - Timber extraction, mining, dams and their impacts on forest and tribal people – Key features in India State of Forest Report 2019 (K3, K4 & K5) - *Forest management tools*: Social forestry, Agro-forestry, Urban forestry and Community forestry - Eco development committees, Ecotourism and Management of grasslands (K4 & K5)

Text Books

1. Owen OS & Chiras DD (1995) Natural Resources Conservation. Prentice-Hall India, New Delhi.
2. Sarah Fehley (2011) Natural Resource Management, Oriental Enterprises, Dehradun, India.
3. Miller TG Jr. (1989) Environmental Science, Wadsworth Publishing Co.

Reference Books

1. Dutta A (2001) Biodiversity and Ecosystem Conservation. Kalyani Publisher, Kolkata.
2. Filho WL and Sumer V (2015) Sustainable Water Use and Management, Springer International Publishing, Switzerland.
3. Grebner DL, Bettinger P and Siry JP (2013) Introduction to Forestry and Natural

Resources, Academic Press, UK.

4 Jha LK (1997) Natural Resource Management. APH Publishing Corporation, New Delhi.

5 Jhariya MK, Banerjee A, Meena RS, Yadav DK (2020) Sustainable Agriculture, Forest and Environmental Management, Springer, Singapore.

6 Kumar HD (1995) Modern Concepts of Ecology. Vikas Publishing House (P) Ltd., New Delhi.

7 Larocque GR (2020) Ecological Forest Management Handbook, Taylor & Francis.

8 MaDicken KG and Vergora NT (1990) Agroforestry: Classification & Management. John Wiley & Sons, New York.

9 Nalini KS (1993) Environmental Resources and Management, Anmol Publications (P) Ltd., New Delhi.

10 Nautiyal S and Kaul AK (1999) Forest Biodiversity & its Conservation Practices in India.

11 Negi SS (1993) Biodiversity and its Conservation in India. Indus Publications, New Delhi.

12 Obi Reddy GP, Patil NG and Arun Chaturvedi (2017) Sustainable Management of Land Resources: An Indian Perspective, Apple Academic Press, Inc., USA.

13 Ramade F (1984) Ecology of Natural Resources, John Wiley & Sons Ltd.

14 Rana SVS (2003) Essentials of Ecology & Environmental Sciences. Prentice-Hall of India, New Delhi.

15 Raymond F and Dasmann (1984) Environmental Conservation. 5th edition, John Wiley & Sons, New York.

16 Sapru RK (1987) Environmental Management in India. Vol I & II. Ashish Publishing House, New Delhi.

17 Sharma VK (1985) Water Resources Planning and Management. Himalaya Publishing House, New Delhi.

18 Tewari DN (1994) Tropical Forestry in India. Int. Book Distributor, Dehra Dun.

19 Wang Y (2014) Encyclopedia of Natural Resources – Land - Volume I, CRC Press, USA.

Journal Articles

1 Islam, M., & Managi, S. (2019). Green growth and pro-environmental behavior: Sustainable resource management using natural capital accounting in India. *Resources, Conservation and Recycling*, 145, 126-138.

2 Jain, S. K. (2019). Water resources management in India–challenges and the way forward. Current Science, 117(4), 569-576.

3 Rahaman, M. M., & Varis, O. (2005). Integrated water resources management: evolution, prospects and future challenges. *Sustainability: Science, Practice and Policy*, 1(1), 15-21.

4 Rebound effects in agricultural land and soil management: Review and analytical framework Paul, C., Techen, A. K., Robinson, J. S., & Helming, K. (2019). Rebound effects in agricultural land and soil management: Review and analytical framework. *Journal of Cleaner Production*, 227, 1054-1067.

5 Roidt, M., & Avellán, T. (2019). Learning from integrated management approaches to implement the Nexus. Journal of Environmental Management, 237, 609-616.

6 Singh, A., Saha, D., & Tyagi, A. C. (2019). Emerging issues in water resources management: Challenges and prospects. In Water governance: Challenges and Prospects (pp. 1-23). Springer, Singapore.

7 Soni, A. K. (2019). Mining of Minerals and Groundwater in India. In: Groundwater-Resource Characterisation and Management Aspects. Intech Open.

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1 http://www.icimod.org/?q=1258
2 mines.nic.in/imsector.html
3 www.rainwaterharvesting.org/happenings/wetland_conservation.htm
4 www.ecoworld.com/atmosphere/effects/organic-farming-in-india.html
5 www.agroforestry.net

CORE COURSE – XIII

ENVIRONMENTAL IMPACT ASSESSMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII	22UPEVS2C13	100	4	4	0	0	4

Course Objectives

The purpose of this course is 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 about the methods used for EIA studies

CO4 Discuss the implications of current jurisdictional and institutional arrangements in relation to EIA

CO5 Communicate both orally and in written form the key aspects of EIA

CO6 Understand how to liaise with and the importance of stakeholders in the EIA process

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XIII

ENVIRONMENTAL IMPACT ASSESSMENT

UNIT I Introduction to EIA 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 - Projects subject to EIA (Category A, B1 and B2) – Steps in EIA process – Objectives of the Standard Terms of Reference (TOR) - Stages and time frame for obtaining Environmental Clearance from MoEF & CC according to EIA notification 2006 – Merits and Demerits of EIA (K1, K2 & K3) – Overview of EIA 2020 Draft (K4 & K5)

UNIT II EIA Methodologies Contact Hours 10

Assessment of impacts: Air, water, soil, noise, biological, social, cultural, economical, and environmental factors (K5 & K6) – *EIA Methodologies*: Adhoc Method – Checklist Approach – Matrix Methods – Network Methods – Overlay Method (K2, K3 & K4)

UNIT III Public Participation, Preparation and Review of EIA Report Contact Hours 10

Objectives of People's Participation - Advantages and Disadvantages of People's Participation - People's Participation Techniques: Public Hearing - 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 08

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)

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.

Reference Books

1. Anjaneyulu Y and Valli Manickam (2007) Environmental Impact Assessment Methodologies, 2nd Edition, B.S. Publications (ISBN: 978-81-7800-144-9).
2. Bregman JI (1999) Environmental Impact Statements. Lewis Publishers, London.
3. Carroll B, Fothergill J, Murphy J & Turpin T (2019) Environmental Impact Assessment Handbook: A practical guide for planners, developers and communities. ICE Publishing.
4. Christopher S and Mark Y (2007) Environmental Management Systems, (third edition), Earthscan Publications, First South Asian Edition.
5. David LG and Stanley BD (2001) ISO 14000Environmental Management, Prentice Hall.

6. Eccleston CH (2000) Environmental Impact Assessment - A Comprehensive Guide to Project and Strategic Planning, John Wiley and Sons, NY.
7. Hart SL (2019) Improving impact assessment: Increasing the relevance and utilization of scientific and technical information. Routledge.
8. Peter Wathern (2015) Environmental Impact Assessment: Theory and Practice, Taylor & Francis, London
9. Singleton R, Castle, P and Sort, D (1999) Environmental Assessment, Thomas Telford Publishing, London.
10. 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. Singh, G. G., Lerner, J., Mach, M., Murray, C. C., Ranieri, B., St-Laurent, G. P.... & Chan, K. M. (2020). Scientific shortcomings in environmental impact statements internationally. People and Nature, 2(2), 369-379.

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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 – XIV

ENVIRONMENTAL BIOTECHNOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII	22UPEVS2C14	100	4	4	0	0	4

Course Objectives

The purpose of this course is to acquaint students with knowledge in environmental biotechnology for gene cloning, to acquire skills in bioremediation of environmental pollutants, to apply the skills in developing innovative biotechnological processes for waste conversion, resource recovery, and production of bioproducts bioresources.

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 degradation of environmental pollutants

CO4 Acquire skills in manipulating the microbes for biodegradation of pollutants

CO5 Develop processes for waste bioconversion to value-added products.

CO6 Apply the process for recovery of resources from different wastes.

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XIV

ENVIRONMENTAL BIOTECHNOLOGY

UNIT I Structure and DNA Modifying Enzymes Contact Hours 12

Introduction to Biotechnology - Organization of Bacterial Genome - Structure of DNA – Restriction Enzymes: Nomenclature - Classification - Restriction and Methylation - Type II Restriction Endonuclease - Use of Restriction Endonucleases - Restriction Mapping and its Applications - DNA Modifying Enzymes - Nucleases - Polymerases - DNA Ligases. (K1, K2, K3)

UNIT II Gene Cloning and PCR Techniques Contact Hours 10

Gene Cloning - Over view, Cloning vectors - Plasmids, phages and cosmids, phagemids, Ti plasmids and viral vectors M13 - Cloning strategies, cloning and selection of individual genes – PCR - Working principle, types and applications. Environmental genome. (K1, K2, K3)

UNIT III Environmental Applications Microbes Contact Hours 10

Use of microbes in environmental decontamination - Biodegradation - Biosorption - Biotransformation - Bioaugmentation - Biostimulation - Rhyzoremediation, Mycoremediation - Phycoremediation - Bioleaching and Biomining - MEOR - Bioremediation pollutants: Heavy metals, PAHs, VOCs - Bioindicators and biosensors for detection of pollution. (K1, K2, K3)

UNIT IV Biotechnology for Waste Treatment Contact Hours 10

Biotechnology for Waste Management - Sewage treatment - Activated Sludge Process - Anaerobic Treatment - Sludge stabilization - Aerobic Composting, Anaerobic Digestion, Biogas Production, Algal Cultivation: Nutrient Removal. Solid Waste Treatment - Biocomposting - Vermicomposting - Air Pollution Control - Bioscrubber, Biofilters. (K3, K4, K5, K6)

UNIT V Microbial Bioproducts Contact Hours 10

Microbial bioproducts for environmental cleanup - Microbial biomass - Biosorbents - Biosurfactants - Microbial enzymes: lignocellulases, lipases, dioxygenases - Bioflocculants - Bioplastics - Biofertilizers - Biopesticides - Microbial fuels: Bioethanol, Biobutanol, and Biohydrogen. (K4, K5, K6)

Text Books

1. Mohapatra, P.K. (2008) Text Book of Environmental Biotechnology. IK International Publishers Ltd
2. Thakur, I.K. (2013) Environmental Biotechnology: Basic Concepts and Applications. 2nd Edition.
3. Brown TA (1995) Gene cloning - A introduction - Chapman & Hall, London.

CORE COURSE – XIV

ENVIRONMENTAL BIOTECHNOLOGY

Reference Books

1. Alexander N. Glazer Hiroshi Nikaido (1995) Microbial Biotechnology, WH Freeman and Company, NY, USA.
2. Bernaral R. Glick and Jack J. Pastemak (1994) Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press. Washington, DC USA.
3. Brown, T.A. (1995) Gene cloning - A introduction - Chapman & Hall, London.
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7. Primrose SB (1994) Molecular Biotechnology, 2nd edition, Blackwell Scientific Publications, UK.
8. Singh, D.P. and Dwivedi, S.K. (2005) Environmental Microbiology and Biotechnology. 1st Edition, New Age International (P) Ltd., Publishers, New Delhi.
9. Fulekar, M.H. (2010) Environmental Biotechnology, CRC Press.
10. Cheremisinoff, N.P. (1997) Biotechnology for Waste and Wastewater Treatment. Science direct.

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1. www.microbialfuelcell.org
2. www.pollutionissues.com/A-Bo/Bioremediation.html
3. www.bioreactors.net
4. http://enhs.umn.edu/current/5103/gm/harmful.html
5. www.wastewatertreatment.co.in/index.php
6. http://archive.industry.gov.au/Biotechnologyonline.gov.au/enviro/environment.html
7. https://preventioncdnndg.org/eco-quartier/biomethanization-2/
8. https://www.nrel.gov/workingwithus/learning.html
9. https://www.epa.gov/recycle/composting-home

CORE COURSE – XV

ENVIRONMENTAL ENGINEERING

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII	22UPEVS2C15	100	4	4	0	0	4

Course Objectives

The purpose of this course is to teach the students about the background of engineering principles, designs and methods to solve the environmental problems like wastewater treatment, sludge stabilization and biogas production, and to monitor environmental pollutants.

Course Outcomes

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

CO1 Understand the complex environmental issues use of various engineering strategies to apply to solve environmental issues

CO2 Understand the basic principles and methods of environmental engineering

CO3 Identify the suitable treatment methods for wastewater treatment and sludge stabilization

CO4 Understand the process of biogas production from sewage sludge and design the reactors for sewage and sludge treatment..

CO5 Monitor the environmental pollutants and control the treatment process

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XV

ENVIRONMENTAL ENGINEERING

UNIT I An Overview of Wastewater Treatment and Disposal Contact Hours 10

Environmental sanitation, wastewater - wastewater quantity and quality-characteristics - treatment required - preliminary, primary, secondary, and tertiary treatments - sedimentation - effluent disposal - chlorination - sludge stabilization - biosolids. (K1, K2) Sewer system - design of sewers, estimation of sewage flow, sewage collection, and odour control. (K3, K4)

UNIT II Pre and Primary Wastewater Treatment Plant Contact Hours 8

Principle and design of screening, equalization tank, grit chambers, rectangular and circular coagulation and flocculation tank, sedimentation tank. Chemically Enhanced Primary Treatment (CEPT) - Design for a Small Community level. (K2, K3, K5, K6)

UNIT III Aerobic Treatment of Wastewater Contact Hours 8

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. (K2, K3, K5, K6)

UNIT IV Anaerobic Treatment of Wastewater and Sludge Contact Hours 10

Design of facilities for anaerobic treatment of wastewater and sludge (K5) - Anaerobic digesters and septic tanks, Anaerobic filters, Upflow anaerobic sludge blanket reactor - Sludge thickening and digestion -Biogas production - Sludge dewatering process, Biosolids - drying and disposal. (K5, K6)

UNIT V Air Pollution and Control Equipments Contact Hours 8

Principle and design of minimum stack height - Settling chamber - Cyclone collector - Fabric filter and Electrostatic Precipitators (ESP) - Bioscrubbers. (K4, K5, K6)

Text Books

1. Venugopala Rao, P (2002) Textbook of Environmental Engineering PHI Learning Pvt. Ltd
2. Basak, N N (2017) Environmental Engineering Tata McGraw Hill Publishing Company
3. Weiner R F, Matthews R A (2003) Environmental Engineering 4th edition, Butterworth and Heinemann press

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1. Air Pollution Control Technology Manual (1998) Overseas Environmental Cooperation Center, Japan
2. Anne Maczulak (2010) Environmental Engineering: Designing a Sustainable Future, Infobase Publishing, NY, USA
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4. 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
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6. Mackenzie L. Davis, David A. Cornwell, (2014) Introduction to Environmental Engineering 5th edition, McGraw Hill.
7. Nelson DL (2016) Textbook of Environmental Engineering, CBS publishers
8. Dugal KN (2008) Element of Environmental Engineering, S Chand Publishing

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2. www.pollutionissues.com/A-Bo/Bioremediation.html
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4. http://enhs.umn.edu/current/5103/gm/harmful.html
5. www.wastewatertreatment.co.in/index.php
6. http://archive.industry.gov.au/Biotechnologyonline.gov.au/enviro/environment.html
7. https://preventioncdnndg.org/eco-quartier/biomethanization-2/
8. https://www.nrel.gov/workingwithus/learning.html
9. https://www.epa.gov/recycle/composting-home
10. https://www.epa.gov/remedytech/green-remediation-best-management-practices-bioremediation

CORE COURSE – XVI

CLIMATE CHANGE AND CURRENT ISSUES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VIII	22UPEVS2C16	100	4	4	0	0	4

Course Objectives

The purpose of this course is to focus on improving understanding of the climate system and climate science and the 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 Empower the students to think critically about climate science

CO3 Sources and impacts of climate change due to anthropogenic activities especially energy utilization

CO4 Understand the existing novel technologies used for measurement of climate change and weather forecasting

CO5 Understand the recent initiatives and policy framework by UNFCCC, IPCC, CoP, MoEF&CC and other Ministries

CO6 Evaluate the successes and failures 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	*	*			*	*	*	*
CO6	*				*	*	*	*

CORE COURSE – XVI

CLIMATE CHANGE AND CURRENT ISSUES

UNIT I Meteorological Elements for Climate Change Contact Hours 10

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: Hadley 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 - Role of air pollutants in climate change – 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) – Recent extreme events in the world – Global consequences of El Niño – Impacts of climate change: 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 08

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 08

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 hydrofluorocarbons (HFC) – Green climate funds – Clean Development Mechanism (CDM) – 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)

Text Books

1 Donald Ahrens C and Robert Henson (2016) Meteorology Today: An Introduction to Weather, Climate, and the Environment. Eleventh 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 Cowie J (2007) Climate Change: Biological and Human Aspects, Cambridge University Press, UK. 32

3 Dogra N and Srivastava S (2012) Climate Change and Disease Dynamics in India, TERI, New Delhi.

4 Filho WL (2012) Climate Change and the Sustainable Use of Water Resources, Springer-Verlag, Berlin, Heidelberg.

5 Friel S (2019) Climate Change and the People's Health (Vol. 2). Small Books Big Ideas in Popul.

6 John Turner and Gareth J Marshall (2011) Climate Change in the Polar Regions. Cambridge University Press, UK.

7 Kala CP and Silori CS (2013) Biodiversity Communities and Climate Change, TERI, New Delhi.

8 Lawrence A. Palinkas (2020) Global Climate Change, Population Displacement, and Public Health. The Next Wave of Migration. Springer Nature Switzerland.

9 Newman J, Anand M, Henry H, Hunt S and Gedalof Z (2011) Climate Change Biology, CAB International, Cambridge, MA, USA.

10 Marselle MR, Stadler J, Korn H, Irvine KN & Bonn A (2019) Biodiversity and health in the face of climate change (p. 481). Springer Nature.

11 Parry M L (2019). Climate Change and World Agriculture. Routledge.

12 Quaschning VV (2019) Renewable Energy and Climate Change. John Wiley & Sons.

13 Ramesh Chandrappa, Sushil Gupta and Umesh Chandra Kulshrestha (2011) Coping with Climate Change. Principles and Asian Context. Springer-Verlag, Berlin.

Journal Articles

1 Figueres C. (2020). Paris taught me how to do what is necessary to combat climate change.

2 Solomon, C. G., & LaRocque, R. C. (2019). Climate change—a health emergency. *New England Journal of Medicine*, 380(3): 209-211.

3 Walsh, B. S., Parratt, S. R., Hoffmann, A. A., Atkinson, D., Snook, R. R., Bretman, A., & Price, T. A. (2019). The impact of climate change on fertility. *Trends in Ecology & Evolution* 34(3): 249-259.

Web References

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 – XVII

ENVIRONMENTAL GEOINFORMATICS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VIII	22UPEVS2C17	100	4	4	0	0	4

Course Objectives

The purpose of this course is to introduce the principles, processes 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 Acquaint adequate knowledge on principles and basic concepts of environmental geoinformatics.

CO2 Understand the basic concepts of GIS and its mechanisms

CO3 Know the various types of GPS systems and its environmental applications

CO4 Learns to interpret satellite images and apply the tools of remote sensing and GIS for environmental disaster management and conservation

CO5 Understand Image Classification Techniques, Image enhancement and interpretation methods

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XVII

ENVIRONMENTAL GEOINFORMATICS

UNIT I Remote Sensing Contact Hours 8

Intoduction to Remote Sensing Principles of Remote Sensing and GIS – Components of Remote Sensing Electromagnetic Radiation, EMR Spectrum- Properties –Historical Perspectives of Remote Sensing in India (K1, K2)

UNIT II GIS Concepts Contact Hours 10

Introduction to Geographical Information Systems Components of GIS -: Data structures - vector and raster data. Conversion of Vector and Raster Data – Geo referencing, Digitization and data attributes -map data representation. (K5, K6)

UNIT III GPS Concepts Contact Hours 10

Introduction to GPS, 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 of aerial photos and satellite imagery Recognition Elements and Interpretation keys. Image Enhancement Techniques-Linear Non- linear Contrast Enhancement Filtering - Principles of Image Classification - Supervised Classification - Unsupervised Classification (K2, K5, K6)

UNIT V Application of Remote Sensing and GIS Contact Hours 10

Applications of remote sensing for land use/land cover, landscape mapping, vegetation analysis, climate change studies, flood, drought assessment desertification and water shed management. Application of GIS for environmental studies- surveying and mapping. Emerging new softwares for RS and GIS.(K4, K5, K6)

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. P. & 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 & 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, Mc. Graw 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 – XVIII

POLLUTION CONTROL STRATEGIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VIII	22UPEVS2C18	100	4	4	0	0	4

Course Objectives

The purpose of this course is to gain awareness of environmental pollution, control and treatment technologies to understand the fundamental principles governing the treatment of pollutants in the environment.

Course Outcomes

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

CO1 To develop environmental scientists and engineers and sensitize them towards environmental issues

CO2 Get exposed good practice of technologies and options used to remediate reduce/eliminate pollution of the environment

CO3 Select methods for control, and prevention of pollution to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

CO4 Apply relevant techniques, skills and modern engineering tools to solve the environmental problems

CO5 Evaluate process design criteria for different air treatment technologies and perform basic calculations

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XVIII

POLLUTION CONTROL STRATEGIES

UNIT I Air Pollution Control & Treatment Contact Hours 12

Air Pollution Control Methods: Particulate matter (Settling Chamber, Cyclones, Fabric Filter, Electrostatic Precipitator and Wet Scrubbers) - Gaseous Pollutants (NOx, SO2, CO, CO2 and Hydrocarbons).

UNIT II Water Pollution Control & Treatment Contact Hours 12

Drinking Water – Filtration, Chlorination, Reverse Osmosis, Ozonation. Wastewater Treatment Methods: Primary Treatment (Screening, Grit Removal, Neutralization, Coagulation, Skimming, Sedimentation) - Secondary Treatment (Aerobic – Aeration, Activated Sludge Process, Trickling Filters, Biological Contact Filters, Rotating Filters, Oxidation Ponds; Anaerobic – Anaerobic Digestion, Septic Tanks, Lagoons) - Tertiary Treatments (Ozonation, Chlorination, Activated Carbon filtration, UV, Reverse Osmosis) -

UNIT III Soil Pollution Control & Treatment Contact Hours 10

Soil Pollution Control - Soil Remediation Techniques: In situ and Ex situ - Physical (Soil Covering, Excavation, Electrokinetic Remediation, Air Sparging, Encapsulation) - Chemical (Soil Washing, Solidification, Vitrification) - Biological (Bioremediation and Phytoremediation).

UNIT IV Radiation Pollution Control & Treatment Contact Hours 8

Radioactivity and Radiation – Radiation Units - Radiation sources – Radiation Protection – Time – Distance - Shielding – Exposure and Contamination - Controlled area – Collection, storage and disposal.

UNIT V Noise, Thermal Pollution Control & Treatment Contact Hours 8

Noise Control Measures -Greenbelt and Protective Instruments – Elimination – Substitution – Engineering Control – Administrative Controls – Personal Protective Equipment's – Selection of hearing protection device. Thermal Pollution –Cooling ponds – Cooling Towers – Beneficial use of waste heat.

Text Books

1. Khopkar, S. M (2005) Environmental Pollution Monitoring and Control, New Age International (P) Ltd Publishers**.**
2. Rao CS (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 Pub house
5. J. Jeffrey Peirce Ruth F. Weiner P. Aarne Vesilind (1997) Environmental Pollution Control, 4th Edition, Elsevier Science

CORE COURSE – XVIII

POLLUTION CONTROL STRATEGIES

Reference Books

1. Yung –Tse Hung, Lawrence K Wang and Nazih K Shammas (Eds.) (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 (Eds.) (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 (Eds.) (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.

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
10. https://www.researchgate.net/publication/300713847_Treatment_Methods_for_Radioactive _Wastes_and_Its_Electrochemical_Applications

CORE COURSE - XIX

ENVIRONMENTAL HEALTH AND SAFETY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IX	22UPEVS2C19	100	4	4	0	0	4

Course Objectives

Introduction to basic principles of environmental health and safety practices and creating awareness of public and occupational health and safety requirements associated with the environment. The purpose of this course is 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 Knowledge in the concepts and scope, basic requirements for healthy environment, environmental quality, human exposure and health impact.

CO2 Knowledge of the Industrial pollution and chemical safety in public exposure from industrial sources, Hazards by industry major chemical contaminants at workplace. Industrial environmental accidents.

CO3 Knowledge of understand the Environmental Disease present study in Fluorosis and Allergies; Epidemiological issues.

CO4 Knowledge of understand course will equip student with basic knowledge on safety issue related with explosion, pollutant release in water and air, and to implement measure during outbreak of flu epidemic at work place.

CO5 Knowledge of understand of occupational Safety and Health. Principles and methods of occupational health, Health problem due to industrial dust, heat, chemicals, noise, toxic gases and metals, Health hazard in agriculture - Pesticides and environment, Pesticides and human health.

Mappings of course outcomes with programme outcomes

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

CORE COURSE - XIX

ENVIRONMENTAL HEALTH AND SAFETY

UNIT I **Environmental Health** Contact Hours 12

Environmental health criteria, Scope of International Programme on Chemical Safety (IPCS). Effects of mercury, lead, chromium, cadmium, arsenic and nitrate on human health. Water borne diseases; Prevention and protection of community health from water borne diseases. Air borne bio-allergens; present in the ambient air, seasonal changes, mode of dispersal, disease intensity and control (K1, K2)

UNIT II **Industrial Pollution and Chemical Safety** Contact Hours 10

Extent of industrial pollution, Public exposure from industrial sources, Hazards by industry, Major chemical contaminants at workplace, Industrial environmental accidents (K2, K3, K4)

UNIT III **Occupational hazards** Contact Hours 10

Health consequences of different occupations- Anthracosis, Silicosis, Asbestosis; Concept of stress, Stress related diseases, Stress management, Stress, strain and general adaptive syndrome; Industrial Environmental Psychology; Cardio-respiratory response during high altitude acclimatization; Effect of climate on performance, Pandemics. (K4, K5)

UNIT IV **Occupational Safety and Health** Contact Hours 10

Effects of Physical Environment on Accidents, Crime, Suicide and Diseases of Man: Effects of temperature, humidity, ionization, ultra violet radiation and acidity of air on skin, lungs, throat, nose, eye, nervous system. Effects of weather and climate on diseases, mental processes, working efficiency, traffic and industrial accidents, behaviour, suicide and suicide attempts, effect of thermal stress and altitude on the action of drug. (K4, K5, K6)

UNIT V **Environmental Health Management** Contact Hours 10

Occupational health practice: investigation, monitoring, control, characteristics and hazards of radioactive materials, dispersion of radioactive materials, risk assessment techniques for accidental release of toxic and inflammable materials, hazard analysis, potential risk, conceivable release mechanisms and release rates, fire and explosion hazards and simplified models for their assessment, examples of occupational health hazards: nasal cancer, asbestosis, bronchitis, heart disease, occupational health services. (K4, K5, K6)

Text 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. Standard Methods for Examination of Water and Waste Water, American Public Health Association (APHA).
4. A comprehensive laboratory manual for Environmental Sciences and Engineering By P.R. Sreemahadevan Pillai. New Age International Publishers.
5. Chemical and biological methods for water pollution studies By R.K. Trivedi
6. Handbook of water and waste water analysis By S.K. Maiti. Soil and air analysis by S.K. Maiti.

CORE COURSE - XIX

ENVIRONMENTAL HEALTH AND SAFETY

Reference Books

1. Environmental Health - Monroe T. Morgan (2003).
2. Handbook of Environmental Health and Safety - Koren, H. (2002).
3. Institution of Occupational Safety and Health, United Kingdom- A Practical Guide, 1993.

Web References

1. www.ehs.ucsb.edu/
2. www.ifc.org/ehsguidelines
3. www.slintec.lk/wp-content/uploads/2011/08/HealthSafetyManual.pdf
4. https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines
5. https://www.ncbi.nlm.nih.gov/books/NBK55873/

CORE COURSE – XX

RESEARCH METHODOLOGY AND INSTRUMENTATION

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IX	20UPEVS2C20	100	4	4	0	0	4

Course Objectives

The purpose of this course is to acquaint students about various types of research methods, instruments and their working principles, 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 Chose the research that they want to carryout.

CO3 Identify and design their research problems.

CO4 Understand the principles of research methods and instruments required for their research experiments.

CO5 Apply their knowledge on instrumentation for environmental analysis, and field works, data collection, and Statistical analysis methods and Data interpretation.

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XX

RESEARCH METHODOLOGY AND INSTRUMENTATION

UNIT I Research Methods Contact Hours 8

Basics of Fundamental and Applied Research, Types, scope, hypothesis. (K1, K2) Concept of research articles, research papers, reviews, scientific popular articles; Components of a Research Article (title, author-line, address, abstract, summary, hypothesis, keywords, introduction, methodology, observations, discussion, conclusion, citing relevant work of others); Reference protocols; Copyright Act (in brief), Plagiarism, Cheating / academic frauds; process of reviewing; Concept of Impact factor; H-Index, i-10 index and SCI Impact factor for journals. (K1, K2, K3)

UNIT II Basic Analytical Equipments Contact Hours 8

Principle, Working mechanism and environmental applications of pH Meter, Conductivity meter, Nephlometer. (K1, K2, K3) Basic principles and applications of light and electron microscopes. Types, function and applications of centrifuges. (K4, K5) Principle, types and environmental application of elctrophoretic techniques and radio immune assay techniques. (K4,K5)

UNIT III Spectroscopy Methods Contact Hours 12

Principle and concept of chromatography- stationary phase, mobile phase, partition and adsorption, coefficients. (K1,K2,K3) Working principle, instrumentation and environmental applications of Thin layer and Ion exchange chromatography, HPLC, HPTLC, LC-MS, and GC-MS 9 (K4, K5, K6)

UNIT IV Chromatography & Mass Spectrometry Contact Hours 12

Principle and concept of chromatography- stationary phase, mobile phase, partition and adsorption, coefficients. (K1,K2,K3) Working principle, instrumentation and environmental applications of Thin layer and Ion exchange chromatography, HPLC, HPTLC, LC-MS, and GC-MS 9 (K4, K5, K6)

UNIT V Statistical Analyses Contact Hours 10

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, Variance, Skewness and Kurtosis; Distribution- Normal, *t* test and *chisquare* test, Difference among means - ANOVA. (K3, K4, K5) Correlation and Regression - Linear and Multiple. Introduction to statistical Softwares (SPSS, R, MATLAB) (K3, K4, K5, K6)

Text Books

1. Rt Kumar, (2010.) Research Methodology: A Step-by-Step Guide for Beginners, SAGE Pub.
2. Gurumani, N. (2006).Research Methodology for Biological Science. MJP Publishers.

CORE COURSE – XX

RESEARCH METHODOLOGY AND INSTRUMENTATION

Reference Books

1. Christian GD (2001), Analytical Chemistry, 5th edition, John Wiley and Sons Inc., India
2. Khopkar SM (1993) Environmental Pollution analysis, Wiley Eastern Ltd.
3. Manahan SE (2007) Environmental Chemistry, 7th edition, Lewis Publications, Florida, USA.
4. Banerjee PK (2004) *Introduction to Biostatistics*. S. Chand and Co., New Delhi.
5. Manly, Bryan FJ (2001) Statistics for Environmental Science and Management, Chapman and Hall / CRC Press, Boca Raton, FL, USA.
6. Skoog DA, Holler FJ and Nieman TA (1980) Principles of Instrumental Analysis – 5th edition, Thomson Asia Pvt., Singapore.
7. Vogel AI (1998) Quantitative Analysis, 6th edition, Prentice Hall Inc., Willard HH, Merrit LL and Dean JA (1976) Instrumental Methods of Analysis, 5th edition, Van Nostrand Reinhold.
8. Rastogi VB (2007) Fundamentals of Biostatistics. Ane Books India, New Delhi.
9. Wilson, K, 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
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/

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 – XXI

DISASTER MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IX	22UPEVS2C21	100	4	4	0	0	4

Course Objectives

The purpose of this course is 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.
CO2 Understand the different disaster prone zones.
CO3 Develop a basic under understanding of prevention, mitigation, preparedness, response and recovery.
CO4 Understand the technological advancements for early warning system.
CO5 Develop the disaster assistance tools and disaster preparedness.
CO6 Understand the disaster relief and recovery measures.

Mappings of course outcomes with programme outcomes

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

CORE COURSE – XXI

DISASTER MANAGEMENT

UNIT I Types of Disasters Contact Hours 08

Geological Disasters - Hydro-Meteorological Disasters - Biological Disasters - Technological Disasters - Intentional, Civil, and Political Hazards - Global Outlook on Disaster Science

UNIT II Geological Hazards Contact Hours 10

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

UNIT III Hydrological and Meteorological Hazards Contact Hours 12

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

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. During Disaster: Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Response System – Relief and Rehabilitation. Post-disaster: Damage and Needs Assessment - Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment

UNIT V Disaster Management in India Contact Hours 10

Disaster Management Act 2005 - National Guidelines and Plans on Disaster Management - 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

Text Books

1. Donald Hyndman and David (2005) Hyndman Natural Hazards & Disasters, Cengage Learning.
2. Palanivel K, Saravanavel K and Gunasekaran S (2015) Disaster Management, Allied Publishers Pvt Ltd., New Delhi.

Reference Books

1. BimalKanti Paul (2011) Environmental Hazards and Disasters - Contexts, Perspectives and Management, John Wiley & Sons, UK.
2. Bryant Edwards (2005) Natural Hazards, Cambridge University Press, UK.
3. Carter Nick W (1991) Disaster Management: A Disaster Manager's Handbook, ADB Manila

4 Collins Larry R and Schneid Thomas D (2000) Disaster Management and Preparedness, Taylor and Francis.

5 Coppola DP (2011) Introduction to International Disaster Management, 2nd Edition, Elsevier Science (B/H), London.

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7 Jack Pinkowski (2008) Disaster Management Handbook, CRC Press -Taylor & Francis Group.

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9 Joseph F. Gustin (2010) Disaster & Recovery Planning: A Guide for Facility Managers, 5th Edition, Taylor &Francis.

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11 Pandey RK (2020) Disaster Management in India. SAGE Publications.

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13 Sharma RK and Sharma G (2005) Natural Disaster, APH Publishing Corporation, New Delhi.

14 Srivastava PK, Singh SK, Mohanty UC and Murty T (2020) Techniques for Disaster Risk Management and Mitigation. John Wiley & Sons Inc., USA

15 Tomaszewski B (2020) Geographic Information Systems for Disaster Management. Taylor & Francis Limited.

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.

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7 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.

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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

CORE COURSE - XXII

ENVIRONMENTAL LAWS AND POLICIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IX	12UPEVS2C22	100	4	4	0	0	4

Course Objectives

The purpose of this course is to introduce the students to the vast field of Laws and Policies both at the national and international level relating to 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.
CO6 Get knowledge of the legal system operating in India.

Mappings of course outcomes with programme outcomes

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

CORE COURSE - XXII

ENVIRONMENTAL LAWS AND POLICIES

UNIT I **Environmental Legislation** Contact Hours 12

Definition of environment and pollutants, central and state boards for the prevention and control of environmental pollution, powers and functions of pollution control boards, penalties and procedure, duties and responsibilities of citizens for environmental protection. (K1, K2)

UNIT II **Laws and Acts guarding** Contact Hours 10

Wildlife Protection Act 1972, The Water (Prevention and Control of Pollution) Act 1974. Prevention and Control of Air Pollution Act 1981, Forest Conservation Act 1981, Environment (protection) Act 1986, Hazardous waste (Management and Handling) Rules, 1989, Bio-Medical Waste (Management and Handling) Rules, 1998. Issues involved in enforcement of environmental legislation, public awareness, public interest litigations (PILs) and its role in control of environmental pollution in India. (K1, K2, K3)

UNIT III **Environmental Movement In India** Contact Hours 10

Movements related to Environment Sacredgroves, Bishnoi tradition, Chipko movement, Tehridam, Sardar Sarovar, Narmada dam, Almatti dam, Silent Valley. Supreme Court Cases – Ratlam Municipality, Ganga Action Plan, Taj Trapezium, Delhi CNG, Tamil Nadu Tanneries, Doon Valley, Span motels private limited case, Oleum gas case (K1, K2, K3)

UNIT IV **International Environmental Treaties and Conventions** Contact Hours 10

StockholmConferenceonHumanEnvironment,1972, Ramsar Convention on Wetlands 1971, Montreal Protocol, 1987, Basel Convention (1989,1992), Earth Summit at Rio de Janeiro 1992, Kyoto Protocol 1997, Earth Summit at Johannesburg 2002. Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade 21, Convention on Desertification 1996, Convention on Biodiversity & Cartagena Protocol on Bio safety (K1, K2, K5, K6)

UNIT V **Major Initiatives/Policies** Contact Hours 10

Issues involved in enforcement of environmental legislation, public awareness, public interest litigations (PILs) and its role in control of environmental pollution in India. (K4, K5, K6)

Text Books

1. Environmental Law in India (2000) P. Leelakrishnan Butterworths India Publishers.
2. Textbook on Environmental Law (2010) N. Maheshwara Swamy, 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, 2005.
6 Leelakrishnan. P, 2008, Environmental Law Case Book, Lexis Nexis, Butterworths.
7 Mohanty. S. K., 2011, Environment and Pollution Law, Universal Law Publishing Co.Pvt. Ltd.
8 Shastri S C, 2008, Environmental Law, (2nd Edn.), Eastern Book Company, Lucknow.
9 Singh Gurdip, 2004, Environmental Law in India, Mcmillan & Co.
10 Shantakumar S, 2005 Introduction to Environmental Law, (2nd Edn.), Wadhwa&

Company, Nagpur.

11 Sahasranaman P B, 2008 Handbook of Environmental Law in India, Oxford University Press (India).

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, Textbook on Environmental Law, (2nd Edn.), Asia Law House, Hyderabad, 2008.
6. I.A. Khan, Environmental Law, **(**2nd Edn.), Central Law Agency, Allahabad, 2002.
7. D.K. Asthana and Meera Asthana, Environment Problems and Solutions, (2nd Edn.), S. Chand & Co. Ltd., New Delhi, 2001.
8. S. Shantakumar, Introduction to Environmental Law, (2nd Edn.), Wadhwa & Company, Nagpur, 2005.
9. S.C. Shastri, Environmental Law, (3rd Edn.), Eastern Book Company, Lucknow, 2008.

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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/
9. www.ngosindia.com/resources/pil.php

ELECTIVE COURSE - I

CANCER BIOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V / VI	22UPEVS2E01	100	4	4	0	0	4

Course Objectives

The purpose of this course is to introduce the students to the vast field of Laws and Policies both at the national and international level relating to environment.

Course Outcomes

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

CO1 The course is mainly focus on understanding the role of chemicals in the natural environment and to characterize the adverse effects of chemical substances on the ecosystem and humans.

CO2 To understand the basic processes underlying the transformation of a normal cell to its malignant counterpart, and the consequences of malignant transformation on the cellular and organism level.

CO3 To Understand how the biological knowledge of cancer development is used in modern cancer treatment.

CO4 To Show knowledge and skills in laboratory techniques used in experimental cancer research, and demonstrate knowledge in cancer epidemiology, use basic epidemiological research methods and describe their importance.

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				*		*		
CO2				*				
CO3						*		*
CO4				*		*		
CO5						*		
CO6							*	
CO7				*				*
C08						*		*

ELECTIVE COURSE - I

CANCER BIOLOGY

UNIT I **Fundamentals of Cancer Biology** Contact Hours 12

Cancer cell: Introduction, cancer as a group of diseases, Overview of gene expression &chromosome structure. Tobacco carcinogens, their biomarkers and tobacco induced cancer. Overview of cell division, differentiation and death. Tumor heterogeneity and cancer cell plasticity. Oncogenes and tumor suppressors. Conversion of normal cells into cancer cells (K1, K2).

UNIT II **Classification of cancer** Contact Hours 10

Classification of cancer types: solid tumors, histopathological and immunohistochemical diagnosis. Molecular diagnosis. Molecular classification of cancer. Cancer treatment-laser, chemo and other Approaches (K1, K2, K3).

UNIT III **Carcinogenesis** Contact Hours 10

Historical developments, Classification of mutational changes at the chromosomal level and gene mutations, Chemical mutagens – Alkylating agents and others, Molecular mechanism of mutations. Effects on DNA, Induction and analysis of gene mutations in mammalian cell culture. Chemical carcinogens– Reaction and mechanism of action. Environmental hazards induced carcinogenesis and preventive measures (K3, K4).

UNIT IV **Cell and Molecular Basis of Cancer** Contact Hours 10

Molecular basis of carcinogenesis: cancer genes, oncogenes and their mutations, signal transduction pathways, ligands and receptors. Cell cycle and Apoptosis: Growth and proliferation, angiogenesis, invasion and metastasis, epigenetics, stem cells, apoptotic pathways, cell immortalization and tumorigenesis, genetic instability. Cancer genomics and proteomics (K4, K5, K6).

UNIT V **Cancer epidemiology, etiology and drug discovery** Contact Hours 10

Risk factors, prevention of cancer, cancer screening and treatment modalities. Cancer drug discovery and its applications in various types. Fundamentals of bioinformatics. Basis of anti-cancer drugs and pharmacokinetics (K4, K5, K6).

Text Books

1. Acton QA (2013) Issues in Radiation Biology and Toxicology Research, Scholarly Editions, Atlanta, GA, USA.
2. Baker D, Karalliedde L, Murray V, Maynard RL and Parkinson NHT (2012) Essentials of Toxicology for Health Protection – A handbook for field professionals, 2nd edition, Oxford University Press, UK.
3. Camacho C (2012) Molecular Oncology–Principles and Recent Advances, Bentham Books, USA.
4. Dietert RR (2010) Immunotoxicity Testing: Methods and Protocols, Humana Press, USA.
5. Dietert RR and Luebke RW (2012) Immunotoxicity, Immune Dysfunction, and Chronic Disease, Humana Press, USA.

6 Fowler B A (2013) Computational Toxicology – Methods and Applications for Risk Assessment, Academic Press, UK.
7 Gupta R S (2006) Toxicology of Organophosphate and Carbamate Compounds, Academic Press, UK.
8 Krieger RI and Hayes WJ (2010) Hayes' Hand book of Pesticide Toxicology, Elsevier, UK.
9 Lynch JJ (2012) Lippincott's Manual of Toxicology, Lippincott Williams & Wilkins, USA.
10 Manahan SE (2013) Fundamentals of Environmental Toxicology and Toxicological Chemistry –Sustainable Science, 4th edition, CRC Press, Boca Raton, FL, USA.
11 Matthiessen P (2013) Endocrine Disrupters–Hazard Testing and Assessment Methods, John Wiley & Sons, Inc.., NJ, USA.
12 Schober O and Riemann B (2013) Molecular Imaging in Oncology, Springer-Verlag, Berlin.
13 Siddiqui SS, Loganathan S, Krishnaswamy S, Faoro L, Jagadeeswaran R, Salgia R (2008) *C. elegans* as a model organism for in vivo screening in cancer: effects of human Met in lung cancer affect *C. elegans* vulva phenotypes. Cancer Biol. Ther.7 (6):856-863.
14 WexlerP,HakkinenPJ,KennedyJr.G,StossFW(2000)InformationResourcesin Toxicology, 3rd edition, Academic Press, UK.

Reference Books

1. Singh DK (2012) Pesticide Chemistry and Toxicology, Bentham Books, USA.
2. Mullen PW (2011) Immunotoxicology: A Current Perspective of Principles and Practice, Springer, London.
3. Spellman FR and Stoudt ML (2013) The Handbook of Environmental Health, Scarecrow Press Inc., MA, USA.

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1. http://www.sanger.ac.uk/
2. http://www.wormbase.org/#01-23-6
3. http://www.reprotox.org
4. http://www.unomaha.edu/envirotox/
5. http://www.clintox.org/radsig.cfm
6. http://informahealthcare.com/doi/book/10.3109/9781420093100
7. www.tox.si/novice/zadnja-novice/103-toxicity-of-ionizing-radiaton
8. http://www.nccr-oncology.ch
9. ntp.niehs.nih.gov/ntp/Factsheets/WormToxFS06.pdf
10. ansc.umd.edu/labs/hamza/pub/Nass_Hamza%20CPTox_2007.pdf
11. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2580824/pdf/nihms-75488.pdf
12. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3428303/pdf/pone.0043577.pdf

ELECTIVE COURSE –II

ECOTOURISM

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V / VI	22UPEVS2E02	100	4	4	0	0	4

Course Objectives

To understand the principles and importance of ecotourism, to learn the impacts and management practices of ecotourism, to know about the concept of ecotourism, development of ecotourism places.

Course Outcomes

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

CO1 Know the principles and concept of ecotourism
CO2 Able to understand the types and benefits of ecotourism
CO3 Know interesting places of ecotourism
CO4 Evaluate the impacts of ecotourism on the environment
CO5 To understand the different parts of ecotourism in India

Mappings of course outcomes with programme outcomes

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

ELECTIVE COURSE –II

ECOTOURISM

UNIT I **Introduction to Ecotourism** Contact Hours 12

Scope and definitions; Objectives of tourism; Significance of Tourism – Classification – Religious tourism – Cultural tourism – Heritage tourism – Monumental tourism – Adventure tourism – Mass tourism – Sustainable tourism – Consumptive & non consumptive tourism; implications of tourism (K1, K2, K3)

UNIT II **Biodiversity of Ecotourism** Contact Hours 12

Ecotourism – definition and characteristics features - Ecosystem & biodiversity support to local economy, conservation of biosphere, learning experience; Goals - social, economical and environmental (K1, K2,K3)

UNIT III **Types of Ecotourism** Contact Hours 10

Principles of Ecotourism: Types of Ecotourism – Objectives of Ecotourism – benefits of Ecotourism – trends affecting ecotourism (K1, K2, K3)

UNIT IV **Impact of Ecotourism** Contact Hours 10

Impact of Ecotourism: Economic impacts (fiscal impacts) – Types and degree of impacts from Ecotourism activities – Socio cultural impacts – Environmental impact (K3, K4, K5, K6)

UNIT V **Different parts of Ecotourism** Contact Hours 10

Ecotourism in India – India a land of pluralism: land, people, flora and fauna and climatic variations – Ecotourism in India – Different ecotourism spots - contrast from tropics to snow – ocean to mountain – desert to forest – Critical analysis of ecotourism in India with a case study (K3, K4, K5, K6)

Text Books

1. Dasman, R.F. (1968) Environmental Conservation: John Wiley and Sons, New York.
2. Mukherjee, N. (2008) Ecotourism and sustainable Development. Cybetech Publications, New Delhi.

Reference Books

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

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1. www.incredibleindia.org/newsite/cms_page.asp?pageid=994

2. www.nativescience.org/html/eco-tourism.html

3. www.wcsindia.org/

4. envfor.nic.in/divisions/9-10.pdf

5. http://www.ceeraindia.org/documents/lib_tabofcon_160300.htm

ELECTIVE COURSE – III

ENVIRONMENTAL MANAGEMENT SYSTEM

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V / VI	22UPEVS2E03	100	4	4	0	0	4

Course Objectives

The aim of this course is to provide students with a broad understanding about Environmental Auditing (EA) and sustainable innovative strategies in Environmental Science.

Course Outcomes

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

CO1 Understand the major principles and components of EA processes

CO2 Describe the benefits of environmental auditing and how it fits with the wider environmental management responsibilities of an organization

CO3 Outline the role of an environmental audit within an organizations Environmental Management System (EMS)

CO4 Acquire basic skills to take up environmental auditing and lifecycle analysis at specific industries

CO5 Understand how to liaise with and the importance of stakeholders in the EA process

CO6 Access different case studies/examples of EA in practice

CO7 Summarize the EA report with suitable environmental management plan

CO8 Acquire various approaches for Environmentally Sustainable Product Innovation

Mappings of course outcomes with programme outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	*		*		*	*	*	*
CO2	*		*		*	*	*	*
CO3	*		*		*	*	*	*
CO4	*		*		*	*	*	*
CO5	*		*		*	*	*	*
CO6	*		*		*	*	*	*
CO7	*		*		*	*	*	*
CO8	*		*		*	*	*	*

ELECTIVE COURSE – III

ENVIRONMENTAL MANAGEMENT SYSTEM

UNIT I Environmental Auditing Contact Hours 08

Environmental Auditing (EA) – Definition, Key concepts of EA - Objectives and Scope of EA - Types of EA: Liabilities Audit, Management Audit and Activities Audit - Principle elements of an Environmental Audit – Components of auditing – Advantages and disadvantages of internal and external environmental audit

UNIT II Audit Process Contact Hours 12

Major steps involved in auditing process: Pre-audit activities, Onsite audit process (material balance, waste flow, monitoring, field observations, draft report) and Post-audit activities – Environmental audit report and follow-up – Problems encountered during the audit – Environmental auditor competence

UNIT III Environmental Management System (EMS) Contact Hours 08

Core Elements of Environmental Management System: Plan, Do, Check, Act – PCDA Loops – Key features of ISO 14001 in EMS – Benefits of implementing an EMS

UNIT IV Life Cycle Assessment (LCA) Contact Hours 12

Stages in Life Cycle Assessment – Life Cycle Assessment: Cradle-to-Grave, Cradle-to-Gate, Cradle-to-Cradle, Life Cycle Energy Analysis – Life Cycle of Industrial Products – Phases of LCA Framework: Goal and Scope definitions, Life Cycle Inventory (LCI), Life Cycle Impact Assessment (LCIA) and Life Cycle Interpretation – Applications of LCA – Limitations of LCA

UNIT V Environmentally Sustainable Product Innovation Contact Hours 10

Sustainable Innovative Strategies in Environmental Science: Ecodesign or Design for Environment (DfE) – Product Design – Materials Management – Production Design: Cleaner Production Strategies - Eco-design Approaches for Developing Eco-friendly Products - Eco-labeling in India and other countries – Barriers to Cleaner Production Implementation

Text Books

1 Shrivastava AK (2003) Environment Auditing. APH Publisher, New Delhi.

2 Sarkar D, Datta R, Mukherjee A and Hannigan R (2016) An Integrated Approach to Environmental Management. John Wiley & Sons Inc., USA.

Reference Books

1 Buckley R (1991) Perspectives in Environmental management. Springer-Verlag Berlin Heidelberg.

2 Christopher S and Mark Y (2007) Environmental Management Systems, (third edition), Earthscan Publications, First South Asian Edition.

3 David LG and Stanley BD (2001) ISO 14000 Environmental Management, Prentice Hall.

4 Galanakis CM (2020) Innovation Strategies in Environmental Science. Elsevier, Netherlands.

5 Jain RK, Cui Z and Domen JK (2016) Environmental Impact of Mining and Mineral Processing. Management, Monitoring, and Auditing Strategies. Elsevier, UK.

6 Murali Krishna IV and Manickam V (2017) Environmental Management: Science and Engineering for Industry. Elsevier, UK.

7 Shanker K, Shankar R and Sindhwani R (2019) Advances in Industrial and Production Engineering. Springer Nature Singapore Pte Ltd.

8 Shen TT (1995) Industrial Pollution Prevention. Springer-Verlag Berlin Heidelberg.

9 Whitelaw K and Butterworth (1997) ISO 14001: Environmental System Handbook.

Journal articles

1 Aich A and Ghosh SK (2020). Framework for Auditing of Municipal Solid Waste Management System in India. In: Solid Waste Policies and Strategies: Issues, Challenges and Case Studies (pp. 85-99). Springer, Singapore.

2 Gupta S, Saksena S and Baris OF (2019). Environmental enforcement and compliance in developing countries: Evidence from India. *World Development*, 117, 313-327.

3 Wanyonyi, A. (2020). An Insight into the Emerging Issues, Challenges and Future Prospects in Environmental Audit. Challenges and Future Prospects in Environmental Audit (June 16, 2020).

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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/

ELECTIVE COURSE –IV
FOREST AND WILDLIFE MANAGEMENT

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
V / VI	22UPEVS2E04	100	4	4	0	0	4

Course Objectives

Introduce to the principles and concepts of conservation, to provide scientific knowledge on sustainable Management

Course Outcomes

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

CO1 The student completed this course can expect to have an adequate knowledge on importance of forest ecosystem
CO2 Students understand the different properties of soil
CO3 The students learn sound knowledge on impact of deforestation in ecosystems
CO4 Students can understand the laws of forest
CO5 Students learn the different wild life conservation and management

Mappings of course outcomes with programme outcomes

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

ELECTIVE COURSE –IV
FOREST AND WILDLIFE MANAGEMENT

UNIT I **Introduction to Forests Ecosystem** Contact Hours 12

Definition -- Forest Ecosystem - Forest community concepts - Succession - Primary productivity - Composition of forest types in India -Classification of India's Forests - Species composition association and diversity. Extent of forests in India and other countries - Role of forests - Factors of locality - climatic - edaphic - topographic - biotic - Interaction of Forests with the Environment. Recent trends in forestry development in the world. Exotics - Role of Exotic forest trees in India - Application of bio-technological methods in forestry (K1, K2, K3)

UNIT II **Forest Soils** Contact Hours 11

Classification - Factors affecting soil formation - Podzolization and laterization - Physical, Chemical and biological properties of Forest soils - Problem soils. Soil and water conservation measures. Watershed management - Concepts and methods - Forest treatments - Streamflow - Impact on water yield and quality Use of remote sensing techniques in forest survey (K1, K2, K3)

UNIT III **Definition and objectives of forest mensuration** Contact Hours 11

Measurement of diameter, girth, height and volume of Trees-Role of Forest Protection in Indian Forest-r Forest fire - Fire protection methods- Forest Policy - Necessity - Formulation of National Forest Policy - History of Forest development in India - Indian Forest Policy of 1894, 1952 and 1988- Role of ICFRE in Forest Research and Education - Forest laws - Necessity - General Principles - Indian Forest Act 1927, Forest Conservation Act 1980 (K1, K2, K3)

UNIT IV **Introduction to Wildlife management** Contact Hours 10

Ecology and biology of wildlife - Principles and techniques of management - Wildlife habitats - Census - Land tenure system - Major wildlife species in India and their broad study – Wild life health and management- Human and wild animal Conflict and Management-Wildlife Forensics - Overview, various forensic protocols for species Identification- Wildlife crime case studies (K3, K4, K5, K6)

UNIT V **Wildlife conservation and management** Contact Hours 10

Habitat management and conservation in India- Policy and legal measures – Sanctuaries, National parks and Biosphere reserves - Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Wildlife corridors. MAB, Red Data Book, Category of threat, CITES Wildlife census, Purpose, techniques. Direct and indirect methods of population estimation. Role of scientific institution and NGOs in Wild Life Conservation - Wildlife (Protection) Act, 1972-Ecotourism (K3, K4, K5, K6)

Text Books

1. Avery, T.E. and Barkhart, H.E. (1983) Forest measurements. McGraw Hill Book Company, New York. 331 p.
2. Chaturvedi, A.N. and Khanna, L.S. (1994) Forest mensuration. International Book Distributor, Dehradun. 403 p.

3. FAO. (1981) Manual of forest inventory with special reference to mixed tropical forests, FAO. Forestry Paper 27.
4. Jerram, M.R.K. and Bourne, R. (1980) Elementary forest mensuration. Natraj Publication, Dehradun. 126 p.
5. Philip, M.S. (1998) Measuring trees and forests. CAB Publication, New York.
6. Dhyani, S.N. (1994) Wildlife management. Rawat Publication, Jaipur. 258 p.
7. Hosetti, B.B. (1997) Concepts in wildlife management. Daya Publishing House, Delhi.

Reference Books

1. Khan, T.I. and Al-Ajmi, D.N. (1999) Global biodiversity conservation measures, Pointer Publishers, Jaipur. 468 p.
2. Nautiyal, S. and Kaul, A.K. (1999) Forest biodiversity and its conservation practices in India. Oriental enterprise Dehradun, 337 p.
3. Ramakrishnan, P.S. (1992) Shifting agriculture and sustainable development. Man and Biosphere series. The Parthenon Publishing Group. 424 p.
4. Saharia, V.B. (1989) Wildlife law in India. Natraj Publication, Dehradun.
5. Sinha, P.C. (1998) Wildlife and forest conservation. Anmol Publishing Pvt.Ltd., New Delhi.
6. The World Resources Institute, 1990-91. Possible effects on global wanning on forests and range Iands World Resources; 1990-91. Oxford University Press, 1990. New York.

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1. www.gfc.state.ga.us/resources/publications/ForestsAndWildlife.pdf
2. woodlandstewardship.org/?page_id=1154
3. https://www.forestasyst.org/wildlife.html
4. gradestack.com/.../Management.../Forests-and-Wildlife/15038-2998-4773-study-wtw
5. https://www.bookstore.ksre.ksu.edu/pubs/MF2899.pdf

ELECTIVE COURSE – V

Marine Biotechnology

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E05	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			*					

Unit I Introduction to Marine Biotechnology Contact Hours: 10

ELECTIVE COURSE – V

Marine Biotechnology

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: 10

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: 10

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)

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Text Books

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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.
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2. Ravi Shankar, P. "Fish Biology and Ecology", University College of Science, Osmania University, Hyderabad, 2006.

ELECTIVE COURSE - VI

Enzyme Technology

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E06	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 - VI

Enzyme Technology

Course Code: 22UPEVS1E02

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.
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6. Shanmugam S. and Sathishkumar T. (2009) Enzyme Technology. I K International Publishing House Pvt. Ltd. ISBN: 9789380026053

ELECTIVE COURSE - VI

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
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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 – VII

Environmental Nanotechnology

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E07	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 – VII

Environmental Nanotechnology

Unit I: Introduction to Nanotechnology **Contact Hours: 10**

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: 10**

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: 10**

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: Synthesis, Properties and Applications.

ELECTIVE COURSE – VII

Environmental Nanotechnology

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.
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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.
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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.

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4. https://www.sciencedirect.com/topics/engineering/ecodesign
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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 –VIII

Industrial Biotechnology

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/ X	22UPEVS2E08	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 –VIII

Industrial Biotechnology

Unit I Introduction **Contact Hours: 10**

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: 10**

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: 10**

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)

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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.

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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.
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5. Glazer A N and Nikaido H, (2007) Microbial Biotechnology. Second edition. Cambridge University Press.

ELECTIVE COURSE – IX

Phytoremediation

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E09	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 – IX

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: 08

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

Unit III Phytoextraction Contact Hours: 10

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: 10

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.
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4. Khalid Hakeem, Muhammad Sabir, Munir Ozturk and Ahmet Mermut, (2015) Soil Remediation and Plants Prospects and Challenges, Academic Press.

ELECTIVE COURSE – IX

Phytoremediation

5. Kuldeep Bauddh, John Korstad, and Pallavi Sharma, (2020) Phytorestoration of Abandoned Mining and Oil Drilling Sites, Elsevier Science.
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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
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6. https://grist.org/science/phytomining-nickel-kinabalu-park-malaysia/
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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 X

Designs for Waste Management

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E10	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 X

Designs for Waste Management

Subject Code: 22UPEVS1E01

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: 10

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.

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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
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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

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ELECTIVE COURSE - XI

Bioremediation and Bio economy

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E11	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 - XI

Bioremediation and Bio economy

Unit I Bioremediation: Principles and Applications Contact Hours: 08

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: 10

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: 10

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.

ELECTIVE COURSE - XI

Bioremediation and Bio economy

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 – XII

Sludge Management

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E12	100	4	4	-	-	4

Unit-I

Sludge – An Overview

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

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

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

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

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

ELECTIVE COURSE – XII

Sludge Management

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.

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 - XIII

Principles of Toxicology

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E13	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 - XIII

Principles of Toxicology

Unit I Toxicology **Contact Hours: 6**

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: 8**

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: 8**

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: 6**

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: 6**

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 – XIV

Pesticide Toxicology

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E14	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 – XIV

Pesticide Toxicology

Unit I Pesticides **Contact Hours: 6**

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: 8**

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: 8**

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: 6**

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: 6**

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 - XV

Applied Toxicology

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E15	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 - XV

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 - XV

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 – XVI

Industrial Toxicology

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VII/VIII/IX/X	22UPEVS2E16	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 – XVI

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.

ELECTIVE COURSE – XVI

Industrial Toxicology

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.

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2. https://journals.sagepub.com/doi/pdf/10.3109/10915818309140666
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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

ALLIED COURSE – I

CHEMISTRY I

Chemistry - I (Inorganic, Organic, Phy-I)

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS2A01	100	4	4	0	0	4

UNIT-IChemical Bonding

1.1 Types of Bonding- Ionic Bond, covalent Bond and coordinate bond Molecular Orbital Theory-bonding, antibonding and nonbonding orbitals. M.O. diagrams of Hydrogen, Helium, Nitrogen, discussion of bond order and magnetic properties.

1.2. Hydrides-classification and characteristics - preparation, properties and uses of Borazole, $NaBH_4$ and $LiAlH_4$.

UNIT-II Nuclear Chemistry

2.1 Natural radioactivity-radioactive series including Neptunium series-Group displacement law.

2.2 Nuclear Binding energy, mass defect-Calculations.

2.3 Nuclear Fission and Nuclear Fusion-differences – Stellar energy.

2.4 Nuclear reactors, Applications of radioistopes-C-14 dating, rock dating.

UNIT-III Basic Concepts of Organic Chemistry

3.1 Covalent Bond-Orbital Overlap-Hybridisation – Geometry of Organic molecules-Methane,

3.2 Ethylene and Acetylene Electron displacement Effects: Inductive, Resonance, Hyper conjugative & steric effects. Their effect on the properties of compounds.

3.3 Stereoisomerism: Symmetry-elements of symmetry- cause of optical activity, Tartaric acid. Racemisation. Resolution. Geometrical isomerism of Maleic and Fumaric acids.

UNIT-IVAromatic compounds

4.1 Aromatic compounds-Aromaticity-Huckel's rule

4.2 Electrophilic substitution in Benzene-Mechanism of Nitration, Halogenation-Alkylation, Acylation.

4.3 Isolation, preparation,properties and structure of Naphthalene Haworth_s synthesis.

4.4 Heterocyclic compounds:- Preparation, properties and uses of Furan, Thiophene,Pyrrole.

UNIT-V

Polymer Chemistry

5.1 Basic concepts: Monomer, polymerization, degree of polymerization, repeat units. Classification of Polymers-addition and condensation polymers, natural and synthetic, based on structure, inorganic and organic, thermoplastic and thermosettingresin.

5.2.Preparation, properties and uses of Poly olefins-polythene, PTFE, Freons, PVC, polypropylene andpolystyrene.

5.3 Natural and synthetic rubbers-Constitution of natural rubber, Buna-N ,Buna -S, Neoprene, Polyurethane and silicone rubbers

ALLIED COURSE – I

CHEMISTRY I

Chemistry - I (Inorganic, Organic, Phy-I)

. **Reference books :**

1. Soni.P.L, Text Book of Inorganic Chemistry,Sultan Chand&Sons.
2. Bhal.B.S. and Arun Bhal ,A Text Book of OrganicChemistry
3. PuriB.R , L.R. Sharma and Pathania,PhysicalChemistry
4. V.R Gowrikar,N.V.Viswanathan :PolymerScience

ALLIED COURSE – II

CHEMISTRY II

Chemistry - II (Inorganic, Organic, Phy-II)

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS2A02	100	4	4	0	0	4

UNIT-I

Co-ordination chemistry

1.1 Definition of terms- classification of ligands-NomenclatureChelation- Examples. Chelate effect- explanation.Werner's theory-conductivity and precipitation studies. Sidgwick's theory-Effective Atomic Number concept.

1.2 Pauling's theory-postulates-Application to octahedral, square planar and tetrahedral complexes. Pauling's theory and magnetic properties of complexes. Merits and demerits of Pauling's theory

1.3 Biological role of Haemoglobin and Chlorophyll (Elementary idea of structure and functions).

UNIT-II

Carbohydrates & Aminoacids

2.1 Carbohydrates: Classification, preparation and properties of Glucose and Fructose-Properties of Starch, Cellulose and derivatives of Cellulose. Inter conversion of Glucose to Fructose and vice versa.

2.2 Amino Acids-classification, preparation and properties of Glycine and Alanine.

UNIT-III

Pharmaceutical chemistry

3.1 Chemotherapy: Preparation, uses and mode of action of sulpha drugs-prontosil, sulphadiazine and sulphafurazole. Uses of penicillin, chloramphenicol and streptomycin, Definition and one example each for-analgesics, antipyretics, tranquilizers, sedatives, hypnotics, local anaesthetics and general anaesthetics . Cause and treatment of diabetes, cancer andAIDS.

UNIT-IV

4.1 Photochemistry: Grotthus-Draper law and Stark-Einstien's law of photochemical equivalence. Quantum yield. Example for photochemical reactions- Hydrogen-Chlorine reaction (elementary idea only) Photosynthesis. Phosphorescence and Fluorescence.

4.2 Phase Rule: Phase rule and the definition of terms in it. Application of phase rule to water system. Reduced phase rule and its application to a simple eutetic system (Pb-Ag) Freezing mixtures.

ALLIED COURSE – II

CHEMISTRY II

Chemistry - II (Inorganic, Organic, Phy-II)

UNIT-V

5.1 Electro Chemistry- Kohlrausch law -measurement of conductance, pH determination. Conductometic titrations. Galvanic cells-EMF-standard electrode potentials, reference electrodes.

5.2 Corrosion: Methods of prevention.

Reference books :

1. Soni.P.L, Text Book of Inorganic Chemistry, Sultan Chand & Sons.
2. Puri and Sharma, Text book of Inorganic Chemistry-Vishalpublishing
3. Soni.P.L. Text Book of Organic Chemistry, Sultan Chand andSons.
4. Jain.M.K, Principles of Organic Chemistry-Vishal publishing Co.
5. Kundu and Jain, Physical Chemistry, S. Chand.
6. Puri, Sharma and Pathania, Text-book of Physical Chemistry, Vishal Publishingco

ALLIED COURSE – III

BOTANY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS2A03	100	4	4	0	0	4

Unit - I: Plant Kingdom and Diversity

Plant Kingdom - Introduction to Plant Kingdom concepts - Natural Classification - Plant Diversity - Structure, reproduction and life cycle of Algae - Chlorella, Spirulina, Sargassum, Gracilaria; Fungi - Saccharomyces, Penicillium, and Agaricus; Bryophytes - Sphagnum, Pteridophytes - Marsilea, Gymnosperm - Pinus.

Unit - II: Plant Taxonomy

Plant Taxonomy- Definition, History, Classification - Types - Artificial, Natural, Mechanical Phylogenetic and Phenetic- Systematic study and economic importance of the families: Annonaceae, Asteraceae, Brassicaceae, Curcurbitaceae, Ephorbiaceae, Lamiaceae, Malvaceae, Rutaceae, Arecaceae and Poaceae.

Unit - III: Plant Morphology and Ecological Adaptations

Plant Morphology - General Morphological Features of Monocots and Dicots - Root, Stem, Leaf - Reproductive Morphology - Inflorescence - Flower, Fruit - Seed. Plant Adaptations - Water soil and Substratum based- Hydrpophytes - Xerophytes - Psychrophytes - Mesophytes - Oxylophytes - Halophytes - Psammophytes - Lithophytes - Chasmophytes - Plant Movements.

Unit - IV: Plant Anatomy and Physiology

Plant Anatomy - Internal Structure of Monocot and Dicot Room Stem and Leaf - Plant Physiology - Water absorption, macro and micro nutrients uptake, Photosynthesis - C3 Cycle, C4 Cycle, CAM Cycle, Respiration, Transpiration, and Plant growth regulators.

Unit – V: Economic Botany

Single Cell Proteins - Chlorella, Yeast; Mushroom cultivation; Biofertilizers - Rhizobium, Azotobacter, Azospirilium and blue green algae; Coir production; Plant products of Commercial Importance - Dried Products - Fibre - Timber - Plant Value added Products.

References:

1. Singh V. Pande P.C. and Jain D.K. (2014). A Text book of Botany.Rastogi publications. Meerut.
2. Sharma O. P. (2009) Plant Taxonomy, Tata Mc Grow Hill, New Delhi
3. Pandey, B.P. (1978) Plant Anatomy, S.Chand and Co., New Delhi.
4. Salisbury,P.B. & Ross,C.W.(1992).Plant Physiology.Wadsworth Publishing,California
5. Pandey, B.P(2017) Economic Botany. S. Chand Publication, New Delhi
6. Bendre, A.M. & Kumar, A.(2017).A Text Book of Practical Botany-1, Rastogi Publications, Meerut.
7. Pandey, B.P. (2017).Modern Practical Botany-Vol. I, S. Chand & Co, Ltd., New Delhi

ALLIED COURSE – IV

ZOOLOGY

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	22UPEVS2A04	100	4	4	0	0	4

GENERAL PRINCIPLES OF ZOOLOGY

Course Objective

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

- Understand the structure of the cell and its functions
- Study the development of animals
- Analyse the physiology and functions of different organs
- Know environmental problems
- Deploy the concepts of evolution

Unit -I: Cell Biology:

Structure of Animal Cell, Structure and functions of Plasma Membrane, Golgi Body & Mitochondria

Genetics: Mendelian laws - Sex linked inheritance - Turner's, Klinefelter's and Down syndrome - ABO Blood group and Rh factor – Phenylketonuria and Sickle cell anemia.

Unit –II: Developmental Biology:

Types of Eggs - Fertilization - Cleavage and Gastrulation in Frog –fetal membranes in chick - Placentation in mammals.

Unit –III Physiology:

Osmotic and ionic regulation in fishes – Digestion and Excretion in Man - Respiration - Types of Respiratory organs – Respiratory pigment - Hb - Transport of respiratory gases – types of Muscles.

Unit-IV Ecology

Environmental factors – Temperature and Light - Pond Ecosystem – Water Pollution – Air Pollution – Animal Associations

Unit-V Evolution:

Evidences – Morphological, Anatomical, Biochemical and Paleontological - Lamarckism – Neo Lamarckism, Darwinism – Neo-Darwinism, cultural evolution of Man.

Course Outcomes:

After the completion of the course, students should be able to

- Realisethe various cell structure, organelles,
- Gain Knowledge regarding genetic disorders, developmental process, physiological functions, Environmental aspects and evolutionary process.
- Applied knowledge for higher learning and occupational needs.

ALLIED COURSE – IV

ZOOLOGY

REFERENCE BOOKS

1. Verma.P.S.&.Agarwal V.K (2006) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology– S.Chand& Company LTD. Ram Nagar, New Delhi -110055
2. Verma.P.S.&.Agarwal V.K. Chordate Embryology. S.Chand& Company Ltd. Ram Nagar, New Delhi - 110055
3. Verma P.S. & Tyagi B.S. Animal Physiology. VI Edition, S. Shand & Company Ltd, Ram Nagar, New Delhi -110055

ALLIED PRACTICAL COURSE – I

CHEMISTRY PRACTICAL - I

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS2AP1	100	3	0	0	3	2

I. TITRIMETRY

a) Estimation of Sodium hydroxide - Standard sodiumcarbonate.
b) Estimation of Hydrochloric acid-Standard Oxalicacid.
c) Estimation of Ferrous sulphate –Standard Mohr'sSalt.
d) Estimation of Oxalic Acid – Standard FerrousSulphate.
e) Estimation of Ferrous iron using diphenylamine as internalindicator.

TEXT BOOKS AND REFERENCE BOOKS

1. V. Venkateswaran, R. Veerasamy and A. R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, ISBN: 9788180547768, 8180547760, Edition: 2012
2. A O. Thomas, Practical Chemistry
3. Raj K Bansal, Laboratorary Manual Of Organic Chemistry

ALLIED PRACTICAL COURSE – II

CHEMISTRY PRACTICAL - II

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS2AP2	100	3	0	0	3	2

II. OrganicAnalysis:

a) Detection of elements- nitrogen, sulphur andhalogens.

b) Detection of aliphatic oraromatic.

c) Detection of whether saturated or unsaturatedcompounds.

Preliminary tests and detection of functional groups, phenols, aromaticamines, aromatic acids, Urea , benzamide &carbohydrate.

TEXT BOOKS AND REFERENCE BOOKS

1. V. Venkateswaran, R. Veerasamy and A. R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, ISBN: 9788180547768, 8180547760, Edition: 2012
2. A O. Thomas, Practical Chemistry
3. Raj K Bansal, Laboratorary Manual Of Organic Chemistry

ALLIED PRACTICAL COURSE – III

BOTANY PRACTICAL

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS2AP3	100	3	0	0	3	2

Experiments:

1. Plant Diversity - Preparation and Demonstration of Slides
2. Plant Cell Division – Mitosis in Onoin Root Tip
3. Plant anatomical structures- T.S of Dicot-Root, Stem and Leaf, Monocot- Root, Stem and Leaf
4. Plant Cell Functions - Plasmolysis and Deplasmolysis
5. Plant Cell Functions - Stomatal Distribution
6. Plant Taxonomy – Flower Dissection
7. Plant Physiology – Potato Osmoscope Experiment
8. Plant Physiology –Paper chromatography experiment

ALLIED PRACTICAL COURSE – IV

ZOOLOGY PRACTICAL

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	22UPEVS2AP4	100	3	0	0	3	2

Experiments:

1. Museum Specimen Study – Protozoa, porifera, Nematodes
2. Study of Living Cells
3. Minor Dissections/Permanent Slide Preparations
4. Cytological Study – Pathological Slides, IHC
5. Mouth parts of Cockroach and other Insects

REFERENCE BOOKS

- M. Ekambaranatha Ayyar & T. N. Ananthakrishnan. Outlines of Zoology.
- M. Ekambaranatha Ayyar & T. N. Ananthakrishnan. Manual of Zoology, Vol I & II.

LANGUAGE COURSE – I

TAMIL I

இக்கால இலக்கியங்களும் உரைநடையும்

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS2T01	100	4	4	0	0	3

பாடநோக்கம்:

தற்கால இலக்கியப் போக்குகளையும் இலக்கணங்களையும் மாணவர் அறியுமாறு செய்து அவர்களின் படைப்பாற்றலைத் தூண்டுதல்.

பயன்கள்:

1. பாரதியார் காலந்தொட்டு தற்காலப் புதுக்கவிதைகள் வரை கவிதை இலக்கியம் அறிமுகப்படுத்தப்படுவதால் படைப்பாற்றல் திறன் பெறுதல்.
2. மொழியறிவோடு சிந்தனைத்திறன் அதிகரித்தல்.
3. தமிழ்மொழியைப் பிழையின்றி எழுதவும், புதிய கலைச்சொற்களை உருவாக்கவும் அறிந்து கொள்ளுதல்.

அலகு–1: மரபுக்கவிதைகள்

அ) பாரதியார் – போகின்ற பாரதமும், வருகின்ற பாரதமும்
ஆ) பாரதிதாசன் – எழுச்சியுற்ற பெண்கள்
இ) கவிமணி – ஒற்றுமையே உயிர்நிலை
ஈ) நாமக்கல் கவிஞர் – அமிழ்தத் தமிழ்மொழி
உ) கண்ணதாசன் – அனுபவம்
ஊ) கு.கணேசன் – கவிதையென்ப.....!

அலகு–2: புதுக்கவிதைகள்

அ) நா.காமராசன் –'புழுதி' (கறுப்பு மலர்கள்)
ஆ) மு.மேத்தா – கண்ணீர்ப் பூக்கள்
இ) சிற்பி பாலசுப்பிரமணியம் – ஒரு கிராமத்து நதி
ஈ) ஈரோடு தமிழன்பன் – பாரதி கண்ட மானுடம்
உ) அப்துல் ரகுமான் – முதுமை (நேயர் விருப்பம்)
ஊ) அறிவுமதி – நட்புக்காலம் (1, 2, 7, 10, 22)

அலகு–3 : உரைநடை

எம்.எஸ்.உதயமூர்த்தி – 'எண்ணங்கள்' கங்கை புத்தக நிலையம்
13, தீனதயாளு தெரு
தி. நகர், சென்னை–600 017.

LANGUAGE COURSE – I

TAMIL I

இக்கால இலக்கியங்களும் உரைநடையும்

அலகு–4:இலக்கிய வரலாறு

அ) கவிதையின் வகையும், வளர்ச்சியும்
ஆ) தமிழ் உரைநடையின் தோற்றமும் வளர்ச்சியும்
இ) தமிழ்ச் சிறுகதையின் தோற்றமும் வளர்ச்சியும்
ஈ) தமிழ்ப் புதினங்களின் தோற்றமும் வளர்ச்சியும்
உ) தமிழ் நாடகத்தின் தோற்றமும் வளர்ச்சியும்
ஊ) நாட்டுப்புறவியல் ஓர் அறிமுகம்
எ) தமிழில் தகவல் தொடர்பு வளர்ச்சி

பாடநூல்:

1. தமிழ் இலக்கிய வரலாறு – முனைவர் மு.வரதராசன்
   சாகித்திய அகாதெமி டெல்லி.
2. தமிழ் இலக்கிய வரலாறு – சிற்பி பாலசுப்பிரமணியம்
   முனைவர் சொ.சேதுபதி
   கவிதா பப்ளிகேஷன்ஸ் சென்னை.

பார்வை நூல்கள்

1. தமிழ் இலக்கிய வரலாறு – தெ.பொ.மீ
2. தமிழ் இலக்கிய வரலாறு – முனைவர் மது.ச.விமலானந்தம்
   அபிராமி பதிப்பகம்
   78, கொடிமரத்தெரு, இராயபுரம், சென்னை–13
3. புதிய தமிழ் இலக்கிய வரலாறு– பதிப்பாசிரியர்கள்
   சிற்பி, நீலபத்மநாபன் (தொகுதி–3)

அலகு–5: மொழித்திறன்

அ) எழுத்துப்பிழை நீக்கம்
ஆ) மொழி முதலெழுத்துக்கள், இறுதி எழுத்துக்கள், மெய்ம் மயக்கம் இவற்றினடிப்படையில் தனித்தமிழ்ச் சொற்களைக் கண்டறிதல்
இ) அறிவியல் கலைச் சொல்லாக்கம்
ஈ) வல்லினம் மிகும், மிகா இடங்கள்
உ) இலக்கணக் குறிப்பு
ஊ) பிறமொழி சொற்களுக்கான தமிழாக்கம்

பார்வை நூல்கள்:

1. அ.கி.பரந்தாமனார் – நல்ல தமிழ் எழுத வேண்டுமா?
   பாரிநிலையம், 184–இ, பிரகாசம் சாலை
   சென்னை–108.
2. பூவண்ணன் – மொழித்திறன்
   வர்த்தமான் பதிப்பகம்
   141–இ, உஸ்மான் சாலை, தி.நகர், சென்னை–17.
3. புலவர் அ.ச.குருசாமி – தமிழில் பிழைகள் தவிர்ப்போம்
   நர்மதா பதிப்பகம், 10 நானாதெரு, தி.நகர்
   சென்னை–17.

LANGUAGE COURSE – II

TAMIL II

இடைக்கால இலக்கியமும் சிறுகதையும்

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS2T02	100	4	4	0	0	3

பாடநோக்கம்:

சமய இலக்கியங்களையும் சிற்றிலக்கியங்களையும் மாணவர்களுக்கு அறிமுகப்படுத்துதல் மொழித்திறனையும் சிறு கதை இலக்கிய வடிவத்தையும் மாணவர்க்கு உணர்த்துதல்.

பயன்கள்:

1. தமிழ் மொழியின் வளத்தையும் சிறப்பையும் அறிந்து கொள்ளுதல்.
2. சிறுகதை இலக்கியம் அறிமுகப்படுத்தப் படுவதன் மூலம் படைப்பாற்றல் திறன் வளர்தல்.
3. இலக்கணங்களைக் கற்பதன் மூலம் போட்டித் தேர்வுகளில் பங்கேற்று வேலை வாய்ப்பினைப் பெறுதல்.

அலகு–1: சமய இலக்கியங்கள்

அ) திருஞானசம்பந்தர் – தேவாரம்– இரண்டாம் திருமுறை
பொது – 'வேயுறு தோளிபங்கன்' எனத் தொடங்கும் பதிகம்

ஆ) ஆண்டாள் – திருப்பாவை (11–20 பாடல்கள்)

இ) திருமூலர் – திருமந்திரம் (இளமை நிலையாமை) 10 பாடல்கள்

ஈ) இராமலிங்க அடிகள் – திருவருட்பா முதல் திருமுறை சென்னைக் கந்த கோட்டம் (1, 6, 7, 8, 9) (5 பாடல்கள்)

உ) குணங்குடி மஸ்தான் சாகிபு – பராபரக்கண்ணி (1–10 பாடல்கள்)

ஊ) கண்ணதாசன் – இயேசு காவியம்– பாரச்சிலுவை (8 பாடல்கள்)

அலகு–2: சிற்றிலக்கியங்கள்

அ) முத்தொள்ளாயிரம் – சேரன் 10, 11, 12 பாடல்கள்
சோழன்–25, 26, 27 பாடல்கள்
பாண்டியன்–51, 52, 53 பாடல்கள்

ஆ) நந்திக்கலம்பகம் – 23, 61, 64,68 (4 பாடல்கள்)

இ) முத்துக்குமாரசாமிப்பிள்ளைத் தமிழ்– அம்புலிப் பருவம் (1–5 பாடல்கள்)

ஈ) அழகர்கிள்ளை விடு தூது – (1–15 கண்ணிகள்)

உ) கலிங்கத்துப்பரணி –பேய் முறைப்பாடு (213–232)

ஊ) அபிராமி அந்தாதி – 1–5 பாடல்கள்

LANGUAGE COURSE – II

TAMIL II

இடைக்கால இலக்கியமும் சிறுகதையும்

அலகு–3: சிறுகதை

சிறுகதைத் தொகுப்பு (தேர்ந்தெடுக்கப்பட்ட சிறுகதைகள்)

1. புதுமைப்பித்தன் – செல்லம்மாள்
2. கு.அழகிரிசாமி – அன்பளிப்பு
3. ஜெயகாந்தன் – குருபீடம்
4. ராஜம்கிருஷ்ணன் – வேலி
5. பாவண்ணன் – நெருப்புத்திருவிழா
6. அசோகமித்திரன் – கணவன், மகள், மகன்
7. பிரபஞ்சன் – அப்பாவு கணக்கில் 35 ரூபாய்
8. பூமணி – ஆழம்
9. பெருமாள் முருகன் – நீர் விளையாட்டு
10. சந்தியூர் கோவிந்தன் – தாத்தாவின் ஞாபகங்கள்

அலகு–4: இலக்கிய வரலாறு

அ) பன்னிரு திருமுறைகள்
ஆ) நாலாயிரத் திவ்வியப் பிரபந்தம்
இ) திருமடங்களின் தமிழ்ப்பணி
ஈ) இலக்கண நூல்கள்
உ) உரையாசிரியர்கள்
ஊ) சிற்றிலக்கியங்கள்
எ) பதினெண் சித்தர்கள்

பார்வை நூல்கள்

1. தமிழ் இலக்கிய வரலாறு – தெ.பொ.மீ
2. தமிழ் இலக்கிய வரலாறு – முனைவர் மது.ச.விமலானந்தம்
   அபிராமி பதிப்பகம்
   78, கொடிமரத் தெரு, இராயபுரம்
   சென்னை–600 013.
3. புதிய தமிழ் இலக்கிய வரலாறு– பதிப்பாசிரியர்கள்
   சிற்பி, நீலபத்மநாபன் (தொகுதி–2)

அலகு–5: மொழித்திறன்

அ) பகுபத உறுப்பிலக்கணம்
ஆ) ஆகுபெயர்
இ) தன்வினை, பிறவினை, செய்வினை, செயப்பாட்டு வினை, நேர்கூற்று, அயற்கூற்று
ஈ) உடம்படுமெய்
உ) மயங்கொலிச் சொற்கள்
ஊ) நேர்காணல்
எ) விண்ணப்பம், அலுவலகக் கடிதம் எழுதுதல்

பார்வை நூல்கள்:

1. அ.கி.பரந்தாமனார் – 'நல்லதமிழ் எழுத வேண்டுமா ?'
2. புலவர் கே. இளைய பெருமாள். – 'தமிழில் பிழையின்றி எழுதுவது எப்படி ?'
   வானதி பதிப்பகம், 23–இ, தீனதயாளு தெரு
   தி.நகர், சென்னை–17.
3. டாக்டர். பொற்கோ – 'தமிழில் நாமும் தவறில்லாமல் எழுதலாம்'
   பூம்பொழில் வெளியீடு
   6 வது குறுக்குத் தெரு,
   அடையாறு, சென்னை–20.
4. வெ.இறையன்பு – I.A.S. வழிகாட்டி

LANGUAGE COURSE – II

TAMIL II

இடைக்கால இலக்கியமும் சிறுகதையும்

LANGUAGE COURSE – III

TAMIL III

காப்பியங்களும் புதினமும்

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS2T03	100	4	4	0	0	3

பாடநோக்கம்:

காலந்தோறும் எழுந்த காப்பியங்களின் போக்கையும், புதினத்தின் இலக்கிய வடிவத்தையும் யாப்பு, அணி போன்ற இலக்கிய வகைகளையும் மொழி பெயர்ப்புத் திறனையும் மாணவர்கள் உணருமாறு செய்தல்.

பயன்கள்:

1. காப்பியங்கள் அறிமுகப்படுத்தப் படுவதால் தமிழ் மொழியின் உயர்வையும் சிறப்பையும் உணர்தல்.
2. நாவல் இலக்கியம் அறிமுகப்படுத்தப் படுவதால் சிந்தனை ஆற்றல், படைப்பாற்றல், கற்பனைத்திறன் வளர்தல்.
3. யாப்பு, அணி இலக்கணங்கள், மொழிபெயர்ப்புத்திறன் ஆகியவற்றைக் கற்பதன் மூலம் போட்டித் தேர்வுகளை எதிர் கொள்ளுதல்.

அலகு–1: சமணம்–பௌத்தம்

அ) சிலப்பதிகாரம் – ஊர்சூழ் வரி

ஆ) மணிமேலை – பாத்திர மரபு கூறியகாதை

இ) சீவகசிந்தாமணி – நாமகள் இலம்பகம்– நாட்டுவளம் (பாடல் எண் 1 முதல் 48 வரை)

ஈ) குண்டலகேசி – முதல் 10 பாடல்கள்

அலகு–2 : சைவம், வைணவம், இசுலாம், கிறித்துவம்

அ) பெரிய புராணம் – மெய்ப்பொருள் நாயனார் புராணம்

ஆ) கம்பராமாயணம் – கங்கை காண் படலம் (72 பாடல்கள்)

இ) சீறாப்புராணம் – கல்வரை நதி மறித்த படலம்

ஈ) தேம்பாவணி – வளன் சனித்த படலம்

அலகு–3: புதினம்

சாயத்திரை – சுப்ரபாரதிமணியன்– காவ்யா பதிப்பம்

அலகு–4: இலக்கிய வரலாறு

அ) ஐம்பெருங்காப்பியங்கள்

ஆ) ஐஞ்சிறு காப்பியங்கள்

இ) கம்பராமாயணம்

LANGUAGE COURSE – III

TAMIL III

காப்பியங்களும் புதினமும்

ஈ) பெரியபுராணம்

உ) சமணர்களின் தமிழ்தொண்டு

ஊ பௌத்தர்களின் தமிழ்த்தொண்டு

எ) சைவ சித்தாந்த சாத்திரங்கள்

பாட நூல்:

தமிழ் இலக்கியவரலாறு – முனைவர் மு.வரதராசன்
சாகித்திய அகாதெமி, டெல்லி

தமிழ் இலக்கிய வரலாறு – சிற்பி பாலசுப்பிரமணியம்
முனைவர் சொ.சேதுபதி
கவிதா பப்ளிகேஷன், சென்னை.

பார்வை நூல்கள்

1. தமிழ் இலக்கிய வரலாறு – தெ.பொ.மீ
2. தமிழ் இலக்கிய வரலாறு – முனைவர் மது.ச.விமலானந்தம்
3. புதிய தமிழ் இலக்கிய வரலாறு– பதிப்பாசிரியர்கள்
சிற்பி, நீலபத்மநாபன் (தொகுதி–2)

அலகு–5 : மொழித்திறன்

அ) யாப்பிலக்கணம் – (அசை, சீர், தளை, அடி வகைகள் மட்டும்) நான்கு வகை பாக்களுக்குரிய அடியின் சிறுமையும் பெருமையும்

ஆ) அணியிலக்கணம் – (உவமை, உருவகம், சிலேடை, வாழ்த்து, தற்குறிப்பேற்றம்)

இ) மொழிபெயர்ப்பு – (அலுவலகக் கடிதங்கள், அரசாணைகள்)

பார்வை நூல்:

க. பட்டாபிராமன் – மொழிபெயர்ப்பியல்
உலகத்தமிழாராய்ச்சி நிறுவனம்
தரமணி, சென்னை.

LANGUAGE COURSE – IV

TAMIL IV

பண்டைய இலக்கியங்களும் நாடகமும்

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	22UPEVS2T04	100	4	4	0	0	3

பாடநோக்கம்

சங்க இலக்கியத்தின் சிறப்பையும், நாடகம் என்னும் இலக்கிய வகையின் தன்மையையும் அகத்திணை, புறத்திணை இலக்கணங்களையும் மாணவர்களுக்கு அறிமுகப்படுத்துதல்.

பயன்கள்:

1. தமிழின் தொன்மையையும், செம்மொழித் தகுதியையும் அறிந்து கொள்ளுதல்.
2. நாடக இலக்கியம் மூலம் நடிப்பாற்றலையும், கலைத்தன்மையையும், படைப்பாற்றலையும் வளர்த்தல்.
3. பண்டைத் தமிழ் இலக்கியங்களைக் கற்றல்.
4. மொழியறிவோடு வேலை வாய்ப்பினைப் பெறுதல்.

அலகு–1: சங்க இலக்கியம்

அ) முல்லைப்பாட்டு –முழுவதும்

ஆ) குறுந்தொகை –27, 40, 58, 69, 242 (5 பாடல்கள்)

இ) அகநானூறு – 12, 15, 130 (3 பாடல்கள்)

ஈ) கலித்தொகை – 115, 133 (2 பாடல்கள்)

உ) புறநானூறு – 49, 51, 66, 74, 121 (5 பாடல்கள்)

ஊ) பதிற்றுப்பத்து – ததைந்த காஞ்சி (23)
உரைசால் வேள்வி (64)

அலகு–2 : பதினெண் கீழ்க்கணக்கு

அ) திருக்குறள் – பொறையுடைமை, நலம்புனைந்துரைத்தல்

ஆ) நாலடியார் – சினம் இன்மை (1–10 பாடல்கள்)

இ) பழமொழி – இன்னாசெய்யாமை முதல் 5 பாடல்கள்

ஈ) நான்மணிக்கடிகை –45, 49, 57, 64, 71 (5 பாடல்கள்)

உ) சிறுபஞ்ச மூலம் – 7, 9, 27, 31, 43 (5 பாடல்கள்)

ஊ) இன்னா நாற்பது – 6, 7, 13, 19, 24 (5 பாடல்கள்)

LANGUAGE COURSE – IV

TAMIL IV

பண்டைய இலக்கியங்களும் நாடகமும்

அலகு–3: நாடகம்

இன்குலாப் – ஔவை – அகரம் பதிப்பகம்
15-B1, சரவணா காம்ப்ளெக்ஸ்
வெள்ளப்பண்டாரத்தெரு
கும்பகோணம் 612 001.

அலகு–4: இலக்கிய வரலாறு

அ) தமிழின் தொன்மையும் சிறப்பும்

ஆ) முச்சங்க வரலாறு

இ) சங்க இலக்கியத்தின் சிறப்பியல்புகள்

ஈ) எட்டுத்தொகை

உ) பத்துப்பாட்டு

ஊ) பதினெண் கீழ்க்கணக்கு

பாட நூல்:

தமிழ் இலக்கியவரலாறு – முனைவர் மு.வரதராசன்
சாகித்திய அகாதெமி, டெல்லி

தமிழ் இலக்கிய வரலாறு – சிற்பி பாலசுப்பிரமணியம்
முனைவர் சொ.சேதுபதி
கவிதா பப்ளிகேஷன், சென்னை.

பார்வை நூல்கள்

1. தமிழ் இலக்கிய வரலாறு – தெ.பொ.மீ
2. தமிழ் இலக்கிய வரலாறு – முனைவர் மது.ச.விமலானந்தம்
3. புதிய தமிழ் இலக்கிய வரலாறு – பதிப்பாசிரியர்கள்
   சிற்பி, நீலபத்மநாபன் (தொகுதி–1)

அலகு–5: இலக்கணம்

அ) அகத்திணை – குறிஞ்சி, முல்லை, மருதம், நெய்தல், பாலைத் திணைகள் மட்டும்

ஆ) புறத்திணை – வெட்சி, வஞ்சி, காஞ்சி, நொச்சி, உழிஞை, தும்பை, வாகை, பாடாண், பொதுவியல் திணை விளக்கங்கள்.

LANGUAGE COURSE – I

HINDI I

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS2H01	100	4	4	0	0	3

SEMESTER-I

PROSE, GRAMMAR, BOLCHAL HINDI

OBJECTIVES:

- **To improve the language and communicative skills**
- **To improve the writing skill.**

UNIT-I

Topic:PROSE

2.appne marry rachana padi by: Hasharik prasat divedhi

3.Esshariya thon a kaie mare mansay by: Ram Dharisingh Dinakar

4.yahku shadhak bolthi hin by: Kanagaiyalal Meshra Prabhakar

UNIT-II

5.rakh-brakh by: Hari Shankar parsaiye

10.absar by : Sharat Joshi

11 jaga akhash dhegaie nai dhetha by: Vishnu Prabhakar

UNIT-III GRAMMAR

1) NOUN 2) PRONOUN 3) NUMBER 4) GENDER 5) ADJECTIVE

UNIT-IV GRAMMAR

6) VERB 7) KAL 8) VACHIYA 9) NE KA PRAYOG

UNIT-V BOLCHAL HINDI

1.Garmae 2. Paryatenmae 3. Railyatramae 4. Bangmae 5.Ashpathalmae
6.Policestationmae 7.Datkal phonepar

REFERENCE BOOK:

1. **VIVITHA written by** : PARAMANAND GUPTA,
publisher- sanjay book center golhar Varanasi 1
Editon 1997.

2. **GRAMMAR: SUGAM HINDI VYAKARNA**
Written By Prof :Vanshi Dhar And Dharmapal Shastri, Publisher- Shiksha Bharathi, Delhi,
Editon 1998.

3. **BOLCHAL KI HINDI AUR SANCHAR**
Written by:DR.Madhu dhawn
Publisher: Vani Prakashan
New Delhi -110002
Edition.2001.

LANGUAGE COURSE – II

HINDI II

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS2H02	100	4	4	0	0	3

SEMESTER-II

POETRY, SHORT STORY AND LETTER WRITING

OBJECTIVES:

- **To improve the language and communicative skills**
- **To improve the writing skill.**

UNIT-I

1.**Meradesh By** : Mythili Saran Gupta
3.**Kiran By** : Jayasankar prasath
4.**Badalrak By** : Surikhant thribathi nirala

UNIT-II

5.babukaeprathi by sumithiranathbandh
7.namangkhan by ramdharik sing dinakar
9. Nadhikadiveb By sanchithanath kiranath vadhsyan akaeya
12.tootabkiyha by darmaveer barathi

UNIT-III

SHORT STORY

TOPIC:

1. purshkar by Jai Sankar Prashath
2. Narankiya by akhaien
3. malveka malikhby mohan rakesh

UNIT-IV

4. upar woodhakuva makhan by kamaleshwar
5. akaeli by monnu bandari

LETTER WRITING

Commercial letters scope and principles
1. Letters of enquiry 2.Letters Regarding to offers and orders 3. Letters of Reference

UNIT V

4.Letters of complaint 5. Letters of collection and payment 6.Letters of credit
7.Circular letters 8.Letters Related to agency 9.Letters to bank 10.Letters Regarding Employment.

REFERENCE BOOK:

1. POETRY: Rasmaye modern hindi poetry collection ,publisher: Dakshana bharat hindi prachar sabha t.nagar, Chennai 17
2. SHORT STORY: hindi ki prathinidhi kahaniya Edited by: Dr.Krishna Raina, Publisher: Vani Prakashan New Delhi -110002 Edition.2002.
3. LETTER WRITING: Vivakarik Hindi By: Ram kishore Sharma Publisher: Lok Bharathi Prakashan 15A, Mahathma Gandhi Marga Allahabad-1

LANGUAGE COURSE – III

HINDI III

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS2H03	100	4	4	0	0	3

SEMESTER-III

NOVEL, HISTORY OF HINDI LITERATURE AND LETTER WRITING

Objective:

With modern context for improving the language and aware the reality life

UNIT-I **NOVEL:-Pather upar pan**

UNIT-II **NOVEL:-Pather upar pani,**

UNIT-III **HISTORY OF HINDI LITERATURE, 1. Aadikaal**

UNIT-IV **HISTORY OF HINDI LITERATURE, 2. Bakthikaal**

UNIT V **LETTER WRITING:**

TOPIC: OFFICIAL LETTER-WRITING

1. Ordinary official letter
2. Circular
3. Office Memorandam
4. Memorandam
5. Semi-Official letter
6. Unofficial note or References
7. Office order
8. Notification
9. Endorsement
10. Resolution

REFERENCE BOOK:

1. NOVEL: Pather upar pani, By Ravindra verma Publisher : Vani prakashan, 21 A dhariyan ganch, New Delhi 110002. **Edition 2000**

2. HISTORY OF HINDI LITERATURE: "Hindi sahiya ka saral ithihas" By **Rajnath Sharma, M.A., Vinoth Pustak Mandir,** Agra.

3. LETTER WRITING: Vivakarik Hindi By: **Ram kishore Sharma** Publisher: Lok Bharathi Prakashan 15A, Mahathma Gandhi Marga Allahabad 1

LANGUAGE COURSE – IV

HINDI IV

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	22UPEVS2H04	100	4	4	0	0	3

SEMESTER IV
KHANDA KAVYA, DRAMA AND COMPOSITION

Objective:

- **To Develop the Language and Skills**
- **To Develop the Colloquial Language**

UNIT I **KANDHA KAVYA: Sabari**
UNIT II **KANDHA KAVYA Sabari**
UNIT III **DRAMA: Yuge –Yuge Kranti**
UNIT IV **DRAMA: Yuge –Yuge Kranti**
UNIT V **COMPOSITION**
TOPICS:

1) Jana- Jhakaran Mein Samachar- Patharo ka Yokdhan
2) Barathiya jamaj mein nari ka sthan
3) Barath mein Lakhu aavam kuttir udhyok
4) Barath mein berojhkari ke samasya
5) Parivar neyojan
6) Rastra bhasha hindi ka mahathuva

REFERENCE BOOK:

1. KANDHA KAVYA: Sabari
By **Sri Naresh Mahatha,**
Publisher Lok Bharathi, Prakashan, 15-A, Mahatma Gandhi Marga, Allahabad-I , **Edition 2008.**

DRAMA: Yuge –Yuge Kranti
ByVishnu Prabhakar, Publisher : Raj Pal and Sons, Kasmiri Gate, New Delhi 110006.
Edition 1992

COMPOSITION: Vivakarik Hindi By: Ram kishore Sharma
Publisher: Lok Bharathi Prakashan 15A, Mahathma Gandhi Marga Allahabad 1

LANGUAGE COURSE – I

MALAYALAM I

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS2M01	100	4	4	0	0	3

Objectives

1. To improve the language and communication skill in Malayalam
2. To improve the writing skill.

Course out comes

1. To Acquire the knowledge of the new aspects of the modern literature
2. To gain creative skill in writing and reading
3. To improve the knowledge about the historical development in the educational field of India
4. To improve the power of discriminating

Unit 1 - (13hours).

Prose- Ajayyamaaya aatma chaithanyam

Chapter - 1, 2, 3. (Page no.7-44).

Composition- Orachan makalkkayacha kathukal

Letters - 1, 2, 3, 4 & 5.(Page no.9-25,five letters).

Translation- Oration -Martin Luther king (J r).

Unit 2.- (13hours).

Prose –Ajayyamaaya aathma chaithanyam

Chapter - 4, 5, 6. (Page no.45-92).

Composition – Orachan makalkkayacha kathukal

Letters – 6,7,8,9,10,11&12. (Page no.26-50. Seven letters).

Translation –Oration- Martin Luther king. (j r).

LANGUAGE COURSE – I

MALAYALAM I

Unit 3 (17hours)

Prose – Ajayyamaaya aathma chaithanym

Chapter 7, 8, 9,10. (Page no 93-132)

Composition– Orachan makalkkayacha kathukal

Letters – 13 ,14, 15, 16, 17, 18, 19& 20. (Page no. 51-75. Nine Letters).

Feature writing – Article 1-Vidyabhyasam thozhil.

Unit 4. (17 hours).

Prose –Ajayyamaaya aathma chaithanyam

Chapter - 11,12, 13, 14.(Page no.133-161)

Composition – Orachanmakalkkayacha kathukal

Letters -22,23,24,25,26,27,28,29,30,31,(page no,76-102. Tenletters)

Feature writing – Article 2-Prayapoorthiyaakaathavar prathyeka vibhagam.

BIBLIOGRAPHY

1. Culture - RaymondWilliams (D.C.Books)
2. Maattavum valarchayum - K.M.Prabhakaravaaryar (Mathru bhoomi Books).
3. Samskaaram,patanam,charithram,sidhantham,prayogam-
   Malayala bhasha patanasangham (D.C.Books).

LANGUAGE COURSE – II

MALAYALAM II

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS2M02	100	4	4	0	0	3

SEMESTER – II (60 HOURS)

Objectives

1. To improve the reading and writing skill
2. To introduce modern aspects of the literature
3. To introduce changes in the style of poetry and short stories in the modern literature

Course Outcomes

1. Able to develop creative writing skill
2. Acquire the knowledge about modern literature
3. Develop the habit of rational thinking
4. Develop the habit of general writing

Unit – I (15 Hours)

1. KavyaNarthaki – ChangambuzhaKrishnapillai
2. Janmadinam – Vaikkam Mohammad bazheer
3. Romantic Nirakkuttu – M.K. Sanu
4. Malayala Cherukadhyudekadha – S. Guptan Nair

Unit – II (15 Hours)

1. MruthyuPooja - AyyappaPanikkar
2. Adayalangal – Sethu
3. Kaavyabhaashayude Punarjani – Sachithanandhan
4. KadhikantePanippura – M. T. Vasudevan Nair

Chapter : 1, 2 Page No.: 9-27

LANGUAGE COURSE – II

MALAYALAM II

Unit – III (15 Hours)

1. Kannikkoyithu – VailoppalliSreedharaminon
2. Panthi bhojanam- Santhosh Echikkaanam
3. EnteKavitha - VaoloppalliSreeedharamenon
4. KadhikantePapippura - M. T. Vasudevan Nair

Chapter : 3, 4 Page No.: 28-43

Unit – IV (15 Hours

1. Ujjayiniyile rappakalukal - Vishnu Narayanan Namboothiri
2. Ormayude njarambu - K.R. Meera
3. Kavithayude Bhaavi – M. Leelavathi
4. Kadhikante Panippura – M. T. Vasudevan Nair

Chapter : 5, 6 Page No. 44 - 63

BIBLIOGRAPHY

1. Kavitha dhwani. - M. Leelavathi
2. Saahithyam prasthanangaliloode - Dr. K.M. George
3. Cherukadha innale innu .- M .Achuthan
4. Cheru kadha sahithyam M.P. Paul.

LANGUAGE COURSE – III

MALAYALAM III

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS2M03	100	4	4	0	0	3

SEMESTER– III . (60 Hours).

Title of the paper

AUTOBIOGRAPHY,TRAVALOGUE, CONVERSATION.

Prescribed books for detailed study

1.ORTHAL VISMSYAM. Kalamandalam hyderali.

(Autobiography, - PranathaBooksChochin)

2.SWISS SKETCHUKAL Raveendran. (Travalogue, -MathruBhoomi Books)

3.SARGA SRUSHTIYILE RASAVIDHYAKAL –Shabu kilithattil

(Conversation. D.C.Books)

Objectives

1. To introduce different branches of Malayalam literature in the modern period
2. To develop reading and writing skill.
3. To introduce some of the eminent writers in the Malayalam literature.
4. To develop creative thinking

Course outcomes

1. Acquire the knowledge in the different aspects of Malayalam literature
2. Gaining interest to read autobiography and service stories of famous personalities
3. Trying to realize the people who are in distance and the reality of their life.
4. Acquire the knowledge of the historical development in the Malayalam literature.

LANGUAGE COURSE – III

MALAYALAM III

Unit I. (15hours)

1. .Orthal vismayam-Kalamamdalam hyderali
   Chapter-1,2,3,4.(Page no, 9-33)
2. Swiss sketchukal-Raveendran
   Chapter 1,2,3,4.(page no 9-36)
3. Sarga srushtiyile raasavidyakal-Shabu kilithattil
   Chapter 1,2,3.(page no 11-55)

Unit – II (15 Hours)

1. OrthalVismayam - Kalamandalamhideraly
2. Chapter – 5, 6, 7, 8, 9(Page No.34-79).
3. Swiss Sketchukal – Raveendran
   Chapter – 5, 6, 7, 8, 9 (Page No,37 – 62).
4. Sargasrushtiyile raasavidyakal- Shabu kilithathil
   Chapter – 5, 6, 7 (Page No.: 65-107).

Unit – III(15hours)

1. Orthalvismayam – Kalamandalamhyderali
   Chapter : 10, 11, 12 (Page No.80 – 100)
2. Swiss sketchukal – Raveendran
3. Chapter – 10, 11, 12(Page No. 63 – 83)
4. Sargasrushtiyile raasavidyakal – Shabu kiluthathil
   Chapter - 8, 9, 10, 11 (Page No, 102 – 147).

Unit – IV(15hours)

1. Orthalvismayam – Kalamandalamhyderali
2. Chapter – 14, 15, 16, 17(Page No. 101 – 128)
3. Swiss sketchukkal – Raveendran)
   Chapter – 13, 14, 15 (Page No.: 84 – 108)
4. Sargasrushtiyile raasavidyakal – Shabu kilithathil
   Chapter – 12, 13, 14 (Page No.: 148 – 199)

Bibliography

1. SahithyaPrathanangaliloode – K. M. Gorge
2. KairaliyudeKudha – N. Krishnapillai
3. Travelogue – S. K. Pottakadu

LANGUAGE COURSE – IV

MALAYALAM IV

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	22UPEVS2M04	100	4	4	0	0	3

SEMESTER – IV (60hours)

Title of the paper

NOVEL, SCREEN PLAY, CINEMA.

Prescribed books for detailed study

1. NRUTHAM (NOVEL) - M.Mukundhan
2. AKALE (SCREEN PLA) - Syamaprasad
3. MALAYALA CINEMAYUDE KADHA-Vjayakrishnan

Objectives

1. To develop the habit of book reading
2. To dive the ability of discriminating through creative thinking
3. To introduce the cinema field as a media and trying to understand difference between Screenplay and Cinema

Course outcomes

1. Acquire the knowledge of creative thinking about the Malayalam Literature, Language, Culture and Social Life.
2. Able to write Screenplay and develop the creative skill for media
3. Able to analysis the role of cinema in the social life
4. Acquire the common knowledge about the direction, Editing, Background sound and light used for cinema
5. Acquire the knowledge to criticizing and make a comparative study about different language cinemas

LANGUAGE COURSE – IV

MALAYALAM IV

Unit – I (15 Hours)

1. Nrutham (Novel) – M. Mukundhan.
   Chapter – 1, 2, 3, 4, 5, 6, 7 Page No.: 1 – 30
2. Akale (Screenplay) – Syamaprasad.
   Scene – 1- 9 Page No.: 9 – 26
3. Malayala Cinemayude Kadha (History of Malayalam cinema) – Vijayakrishnan.
   Chapter - 1, 2, 3, 4 Page No.: 11 – 50

Unit – II (15hours)

1. Nrutham – M. Mukundhan
   Chapter – 8, 9, 10, 11 , 13, 14 Page No.: 31 – 57
2. Akale – Syamaprasad
   Scene – 10- 20 Page No.: 27 – 54
3. Malayala CinemayudeKadha – Vijayakrishnan
   Chapter - 5, 6, 7, 8 Page No.: 51 – 91

Unit – III (15hours)

1. Nrutham – M. Mukundhan
   Chapter – 15, 16, 17, 18, 19, 20, 21 Page No.: 58 - 82
2. Akale – Syamaprasad
   Scene – 21- 30 Page No.: 55 - 75
3. Malayala CinemayudeKadha – Vijayakrishnan
   Chapter - 9, 10, 11, 12, 13 Page No.: 92 - 173

Unit – IV (15hours)

1. Nrutham – M. Mukundhan
   Chapter – 22 –26 Page No.: 83 - 102
2. Akale – Syamaprasad
   Anubandham Page No. 76 - 88
3. Malayala CinemayudeKadha – Vijayakrishnan
   Chapter - 14, 15, 16, 17, 18 Page No.174 – 208

Bibliography

1. Cinimayudeidangal - C. V. Balakrishnan
2. Indian Cinema – Sathyajith Ray
3. Marunnaa malayala Novel – K. P. Appan
4. Malayala Cinema Directory - Chithrabhoomi

ENGLISH COURSE – I

COMMUNICATIVE ENGLISH- I

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS2E01	100	4	4	0	0	3

Unit I (20 hours)

1. Listening and Speaking

a. Introducing self and others

b. Listening for specific information

c. Pronunciation (without phoneticsymbols)

i. Essentials of pronunciation

ii. American and Britishpronunciation

2. Reading and Writing

a. Reading short articles – newspaperreports / fact based articles

i. Skimming and scanning

ii. Diction and tone

iii. Identifying topic sentences

b. Reading aloud: Reading anarticle/report

c. Journal (Diary) Writing

3. Study Skills - 1

a. Using dictionaries, encyclopaedias,thesaurus

4. Grammar in Context:

Naming and Describing

- Nouns & Pronouns
- Adjectives

Unit II (20 hours)

1. Listening and Speaking

a. Listening with a Purpose

b. Effective Listening

c. Tonal Variation

d. Listening for Information

e. Asking for Information

f. Giving Information

2. Reading and Writing

1. a. Strategies of Reading:

Skimming and Scanning

b. Types of Reading :

2

Extensive and Intensive Reading

c. Reading a prose passage

d. Reading a poem

e. Reading a short story

2. Paragraphs: Structure and Types

ENGLISH COURSE – I

COMMUNICATIVE ENGLISH- I

a. What is a Paragraph?
b. Paragraph structure
c. Topic Sentence
d. Unity
e. Coherence
f. Connections between Ideas: UsingTransitional words and expressions
g. Types of Paragraphs

3. Study Skills II:

Using the Internet as a Resource
a. Online search
b. Know the keyword
c. Refine your search
d. Guidelines for using the Resources
e. e-learning resources of Government
of India
f. Terms to know

4. Grammar in Context

Involving Action-I
a. Verbs
b. Concord

Unit III	**(16 hours)**
1. Listening and Speaking	

a. Giving and following instructions
b. Asking for and giving directions
c. Continuing discussions with connecting ideas
2. Reading and writing
a. Reading feature articles (fromnewspapers and magazines)
b. Reading to identify point of view and perspective (opinion pieces, editorialsetc.)
c. Descriptive writing – writing a short descriptive essay of two to three paragraphs.
3. Grammar in Context:

Involving Action – II

3

- Verbals - Gerund, Participle,Infinitive
- Modals

Unit IV	**(16 hours)**
1. Listening and Speaking	

a. Giving and responding to opinions
2. Reading and writing
a. Note taking
b. Narrative writing – writing narrativeessays of two to three paragraphs

ENGLISH COURSE – I

COMMUNICATIVE ENGLISH- I

3. Grammar in Context:

Tense

- Present
- Past
- Future

Unit V (18 hours)

1. Listening and Speaking

a. Participating in a Group Discussion

2. Reading and writing

a. Reading diagrammatic information

– interpretations maps, graphs andpie charts

b. Writing short essays using thelanguage of comparison and contrast

3. Grammar in Context: Voice (showing therelationship between Tense and Voice)

Prescribed Textbook: Communicative English - Semester – I by TANSCHE

ENGLISH COURSE – I

COMMUNICATIVE ENGLISH- II

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS2E02	100	4	4	0	0	3

Unit I	(18 hours)
1.	Listening and Speaking
a.	Listening and responding to complaints (formal situation)

b. Listening to problems and offering solutions (informal)
2. Reading and writing
a. Reading aloud (brief motivational anecdotes)
b. Writing a paragraph on a proverbial expression/motivational idea.
3. Word Power/Vocabulary
a. Synonyms & Antonyms
4. Grammar in Context

a.	Adverbs
b.	Prepositions
Unit II	(20 hours)

1. Listening and Speaking
a. Listening to famous speeches and poems
b. Making short speeches- Formal: welcome speech and vote of thanks.
Informal occasions- Farewell party, graduation speech
2. Reading and Writing
a. Writing opinion pieces (could be on travel, food, film / book reviews or on any contemporary topic)
b. Reading poetry
b.i. Reading aloud: (Intonation and Voice Modulation)
b.ii. Identifying and using figures of speech - simile, metaphor, personification etc.
3. Word Power
a. Idioms & Phrases
4. Grammar in Context

a.	Conjunctions and Interjections
Unit III	(18 hours)
1.	Listening and Speaking
a.	Listening to Ted talks

b. Making short presentations – Formal presentation with PPT, analytical presentation of graphs and reports of multiple kinds
c. Interactions during and after the presentations
2. Reading and writing

ENGLISH COURSE – I

COMMUNICATIVE ENGLISH- II

a. Writing emails of complaint
b. Reading aloud famous speeches
3. Word Power
a. One Word Substitution
4. Grammar in Context
a. Sentence Patterns
5

Unit IV	(16 hours)
1.	Listening and Speaking
a.	Participating in a meeting: face to face and online

b. Listening with courtesy and adding ideas and giving opinions during the meeting and making concluding remarks.
2. Reading and Writing
a. Reading visual texts – advertisements
b. Preparing first drafts of short assignments
3. Word Power
a. Denotation and Connotation
4. Grammar in Context:

a.	Sentence Types
Unit V	(18 hours)
1.	Listening and Speaking
a.	Informal interview for feature writing
b.	Listening and responding to questions at a formal interview
2.	Reading and Writing
a.	Writing letters of application
b.	Readers‟ Theatre (Script Reading)
c.	Dramatizing everyday situations/social issues through skits. (writing scripts and performing)
3.	Word Power
a.	Collocation
4.	Grammar in Context
a.	Working With Clauses

Prescribed Textbook: Communicative English - Semester – II by TANSCHE

ENGLISH COURSE – III

FOUNDATION ENGLISH- III

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
III	22UPEVS2E03	100	4	4	0	0	3

OBJECTIVES:

- To give a holistic approach in teaching and learning of English
- To adopt Content Based Language Teaching
- To follow student-centered learning providing autonomy of learning
- To help the learners acquire a great deal of progress through exposure to comprehensible input

OUTCOME:

- With the required language and communication skills, the learners‟ proficiency level is increased
- Through continuous practice, they get „Procedural Knowledge‟
- The learners are exposed to literary explorations
- Combined study of grammar, vocabulary and composition helps learners achieve a high degree of proficiency in English

UNIT – I – POETRY

1. A Poison Tree – William Blake
2. Leisure – W.H. Davies
3. Stopping by woods on a snowy evening – Robert Frost

UNIT-II - PROSE

1. My Early Days- APJ Abdul Kalam
2. Six Thinking Hats – Edward
3. Kindly Adjust to our English – Shashi Tharoor

UNIT – III – ONE- ACT PLAYS

1. A Mother‟s day – J.B, Priestley
2. The Trick – Erisa Kironde

UNIT – IV – SHORT STORIES

1. Subha – Tagore
2. The Doll‟s House – Katherine Mansfield
3. The Widow and the Parrot – Virginia Woolf

UNIT – V – GRAMMAR AND COMPOSITION

GRAMMAR:

1. Prefixes and Suffixes
2. Phrasal Verbs
3. Conversion of Nouns into Adjectives and Adjectives into Nouns
4. Frame sentences
5. Short forms of Positives and Negatives

COMPOSITON:

1. E-mail writing
2. Comprehension
3. Advertisement

Prescribed Textbook:

ENGLISH COURSE – III

FOUNDATION ENGLISH- III

***Symphony*: Published by Cambridge University Press & Assessment India, 2022**

ENGLISH COURSE – IV

FOUNDATION ENGLISH- IV

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
IV	22UPEVS2E04	100	4	4	0	0	3

OBJECTIVES:

- To enable the learners to get deep insight into various literary genres with the help of texts provided.
- To help acquire second language naturally in the learners‟ environment
- To train the learners to learn by practice
- To teach avoiding rote learning

OUTCOME:

- The learners acquire the basic linguistic skills, LSRW
- Comprehensible input promotes easy acquisition
- Student of any programme becomes interested in the language competence by their consistent practice and performance
- In nutshell, the study of Foundation English would make the learners to face the present day job market confidently and courageously

UNIT – I - POETRY

1. Hope is the thing with feathers – Emily Dickinson
2. Time – Allen Curnow
3. Indian Women – Shiv K. Kumar

UNIT – II - PROSE

1. My Struggle for an Education – Booker T. Washington
2. Positive Thinking – Francie Baltazar
3. A Little Bit of What you Fancy – Desmond Morris

UNIT – III – SPEECHES FROM SHAKESPEARE

1. “Tomorrow, and tomorrow, and tomorrow” (Macbeth, Act V, scene v, by Macbeth)
2. “ Friends, Romans, countrymen, lend me your ears” (Julius Caesar, Act III, scene ii, by Marc Antony)
3. The Quality of Mercy is not strained” (The Merchant of Venice, Act IV, scene i, by Portia)

UNIT – IV- SHORT STORIES

1. The Luncheon – Somerset Maugham
2. After Twenty Years – O‟Henry
3. Valiant Vicky, the Brave Weaver – Flora Annie Steel

UNIT – V- GRAMMAR AND COMPOSITION

GRAMMAR:

1. Tenses
2. Infinitives and Gerunds
3. Degrees of Comparison
4. Question Tags
5. Homonyms

COMPOSITION:

ENGLISH COURSE – IV

FOUNDATION ENGLISH- IV

1. Travel Vlog
2. Blog writing
3. Minutes of a meeting

Prescribed Textbook:

***Symphony*: Published by Cambridge University Press & Assessment India, 2022**

PROFESSIONAL ENGLISH -I

PROFESSIONAL ENGLISH FOR LIFE SCIENCES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS2PE1	100	4	4	0	0	-

OBJECTIVES:

- To develop the language skills of students by offering adequate practice in professional contexts.
- To enhance the lexical, grammatical and socio-linguistic and communicative competence of first year physical sciences students
- To focus on developing students' knowledge of domain specific registers and the required language skills.
- To develop strategic competence that will help in efficient communication
- To sharpen students' critical thinking skills and make students culturally aware of the target situation.

LEARNING OUTCOMES:

- Recognise their own ability to improve their own competence in using the language
- Use language for speaking with confidence in an intelligible and acceptable manner
- Understand the importance of reading for life
- Read independently unfamiliar texts with comprehension
- Understand the importance of writing in academic life
- Write simple sentences without committing error of spelling or grammar

(Outcomes based on guidelines in UGC LOCF – Generic Elective)

NB: All four skills are taught based on texts/passages.

UNIT 1: COMMUNICATION

Listening: Listening to audio text and answering questions

- Listening to Instructions

Speaking: Pair work and small group work.

Reading: Comprehension passages –Differentiate between facts and opinion

Writing: Developing a story with pictures.

Vocabulary: Register specific - Incorporated into the LSRW tasks

UNIT 2: DESCRIPTION

Listening: Listening to process description.-Drawing a flow chart.

Speaking: Role play (formal context)

Reading: Skimming/ScanningReading passages on products, equipment and gadgets.

Writing: Process Description –Compare and Contrast

PROFESSIONAL ENGLISH -I

PROFESSIONAL ENGLISH FOR LIFE SCIENCES

Paragraph-Sentence Definition and Extended definition-3

Free Writing.

Vocabulary: Register specific -Incorporated into the LSRW tasks.

UNIT 3: NEGOTIATION STRATEGIES

Listening: Listening to interviews of specialists / Inventors in fields

(Subject specific)

Speaking: Brainstorming. (Mind mapping).

Small group discussions (Subject- Specific)

Reading: Longer Reading text.

Writing: Essay Writing (250 words)

Vocabulary: Register specific - Incorporated into the LSRW tasks

UNIT 4: PRESENTATION SKILLS

Listening: Listening to lectures.

Speaking: Short talks.

Reading: Reading Comprehension passages

Writing: Writing Recommendations

Interpreting Visuals inputs

Vocabulary: Register specific - Incorporated into the LSRW tasks

UNIT 5: CRITICAL THINKING SKILLS

Listening: Listening comprehension- Listening for information.

Speaking: Making presentations (with PPT- practice).

Reading : Comprehension passages –Note making.

Comprehension: Motivational article on Professional Competence,

Professional Ethics and Life Skills)

Writing: Problem and Solution essay– Creative writing –Summary writing

Vocabulary: Register specific - Incorporated into the LSRW tasks

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PROFESSIONAL ENGLISH -II

PROFESSIONAL ENGLISH FOR LIFE SCIENCES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS2PE2	100	4	4	0	0	-

Objectives:

The Professional Communication Skills Course is intended to help Learners in Arts and Science colleges

• Develop their competence in the use of English with particular reference to the workplace situation.

• Enhance the creativity of the students, which will enable them to think of innovative ways to solve issues in the workplace.

• Develop their competence and competitiveness and thereby improve their employability skills.

• Help students with a research bent of mind develop their skills in writing reports and research proposals.

Unit 1- Communicative Competence (18 hours)

Listening – Listening to two talks/lectures by specialists on selected subject specific topics - (TED Talks) and answering comprehension exercises (inferential questions)

Speaking: Small group discussions (the discussions could be based on the listening and reading passages- open ended questions

Reading: Two subject-based reading texts followed by comprehension activities/exercises

Writing: Summary writing based on the reading passages.

Unit 2 - Persuasive Communication (18 hours)

Listening: listening to a product launch- sensitizing learners to the nuances of persuasive communication

Speaking: debates – Just-A Minute Activities

Reading: reading texts on advertisements (on products relevant to the subject areas) and answering inferential questions3

Writing: dialogue writing- writing an argumentative /persuasive essay.

Unit 3- Digital Competence (18 hours)

Listening to interviews (subject related)

Speaking: Interviews with subject specialists (using video conferencing skills)

PROFESSIONAL ENGLISH -II

PROFESSIONAL ENGLISH FOR LIFE SCIENCES

Creating Vlogs (How to become a vlogger and use vlogging to nurture interests – subject related)

Reading: Selected sample of Web Page (subject area)

Writing: Creating Web Pages

Reading Comprehension: Essay on Digital Competence for Academic and Professional Life.

The essay will address all aspects of digital competence in relation to MS Office and how they can be utilized in relation to work in the subject area

Unit 4 - Creativity and Imagination (18 hours)

Listening to short (2 to 5 minutes) academic videos (prepared by EMRC/ other MOOC videos on Indian academic sites – E.g. https://www.youtube.com/watch?v=tpvicScuDy0)

Speaking: Making oral presentations through short films – subject based

Reading : Essay on Creativity and Imagination (subject based)

Writing – Basic Script Writing for short films (subject based)

- Creating blogs, flyers and brochures (subject based)
- Poster making – writing slogans/captions (subject based)

Unit 5- Workplace Communication & Basics of Academic Writing (18 hours)

Speaking: Short academic presentation using PowerPoint

Reading & Writing: Product Profiles, Circulars, Minutes of Meeting.

Writing an introduction, paraphrasing

Punctuation (period, question mark, exclamation point, comma, semicolon, colon, dash, hyphen, parentheses, brackets, braces, apostrophe, quotation marks, and ellipsis)

Capitalization (use of upper case)4

Outcome of the Course:

At the end of the course, learners will be able to,

- Attend interviews with boldness and confidence.
- Adapt easily into the workplace context, having become communicatively competent.
- Apply to the Research & Development organisations/ sections in companies and offices with winning proposals.

Value Education
YOGA

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
I	22UPEVS2VY1	100	2	1		1	-

Objectives:

Providing the Value Education to improve the Students' Good character -understanding physical health - maintaining youthfulness - Moderation in five aspects of life - Personality Development - Learning of Introspection - Understanding Cultural Values - Learning Exercises and Yogaasanas.

நோக்கம் :

மாணவர்கள் குணநல மேம்பாட்டிற்கான மதிப்புக் கல்வி அளித்தல் - உடல்நலம் பற்றித் தெளிதல் - இளமை காத்தல் - ஐந்தில் அளவுமுறை கைகொள்ளல் - நற்குணங்களை வளர்த்தல் - அகத்தாய்வுப் பயிற்சிகளைக் கற்றுக் கொள்ளுதல் - பண்பாடு மதிப்புணர்தல் - உடற்பயிற்சி, யோகாசனங்கள் கற்றுக் கொள்ளல்.

Unit : 1 Yoga and Physical Health

Health - Meaning and Definition - Physical Structure - Three bodies - Five limitations - Simplified Physical Exercises - Hand, Leg, Breathing, Eye exercises - Kapalabathi, Makarasana 1,2 , Massage, Acu pressure, Relaxation exercises - Yogasanas - Pranamasana - Hastha Uttanasana - Pada Hasthasana - Aswa Sanjalana Asana - Thuvipatha asva Sanjalana asana - Astanga Namaskara - Bhujangasana - Atha Muktha Savasana - Aswa Sanjalana Asana - Pada Hasthasana - Hastha Uttanasana - Pranamasana -

Padmasana - Vajrasana - Ardha katti Chakrasana - Viruchasana - Yogamudra - Patchimothasana - Ustrasana - Vakkarasana - Salabasana

அலகு 1 : யோகமும் உடல்நலமும்

வாழ்க்கை நலம் - உடலமைப்பு - மூன்று உடல்கள் - ஐந்தில் அளவுமுறை - எளியமுறை உடற்பயிற்சி - கை, கால், மூச்சு, கண் பயிற்சிகள் - கபாலபதி, மகராசனம், உடல் வருடுதல், அக்கு பிரஸ், உடல் தளர்த்தல் பயிற்சி முறை - ஆசனம் - பிராணமாசனம் - ஹஸ்த உட்டானாசனம் - பாத ஹஸ்தாசனம் - அஸ்வ சஞ்சலான ஆசனம் - தனி பாத அஸ்வ சஞ்சலான ஆசனம் - அஷ்டாங்க நமஸ்காரம் - புஜங்காசனம்

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- அதோ முக ஸ்வானாசனம் - அஸ்வ சஞ்சலனா ஆசனம் - பாத ஹஸ்தாசனம் - ஹஸ்த உட்டானாசனம் - பிரானாயாசனம் - பத்மாசனம் - வஜ்ராசனம் - அர்த்த கட்டி சக்ராசனம் - விருச்சாசனம் (ஏகபாதாசனம்) - யோகமுத்ரா - பச்சி மோத்தாசனம் - உஸ்ட்ராசனம் - வக்ராசனம் - சலபாசனம்

Unit - 2 : Greatness of Life Force and Mind

Maintaining youthfulness - Postponing the ageing process - Sex and spirituality - Significance of sexual vital fluid - Married life - Chastity - Development of mind in stages - Mental Frequencies - Methods for Concentration - Meditation and its Benefits

அலகு 2 : உயிர்வளமும் மனவளமும்

இளமை காத்தல் - முதுமையைத் தள்ளிப் போடுதல் - பால் உணர்வும் ஆன்மிகமும் - வித்தின் மகிமை - இல்லறவாழ்வு - கற்புநெறி - மனம் அறிவாக இயங்கும் பத்துப் படி நிலைகள் - மன அலைச்சுழல் - தவ நிலைகள் - தவத்தின் பயன்கள்

Unit - 3 : Personality Development - Sublimation

Purpose and Philosophy of Life - Introspection - Analysis of Thought - Practice of Analysis of Thoughts - Moralization of Desire - Practice for Moralization of Desires - Neutralization of Anger - Practice - Strengthening of will-power.

அலகு 3 : குணநலப்பேறு

வாழ்வின் நோக்கமும், வாழ்க்கைத் தத்துவமும் - அகத்தாய்வு - எண்ணம் ஆராய்தல் - எண்ணம் ஆராய்தல் பயிற்சி முறை - ஆசை சீரமைத்தல் - ஆசை சீரமைத்தல் பயிற்சி முறை - சினம் தவிர்த்தல் - சினத்தை வெல்லல் பயிற்சி முறை.

Unit - 4 : Human Resources Development

Eradication of Worries - Analysis and Eradication practice - Benefits of Blessings - Effect of good vibrations - Greatness of Friendship - Guidance for good Friendship - Individual Peace and world peace - Good cultural behavioral patterns

அலகு 4 : மனிதவள மேம்பாடு

கவலை ஒழித்தல் - கவலை ஒழித்தல் பயிற்சி முறை - வாழ்த்தும் பயனும் - அலை இயக்கம் - நட்பு நலம் - நல்ல நட்பு - தனிமனித அமைதி - உலக அமைதி - நல்லொழுக்க பண்பாட்டு முறைகள்

Unit - 5 : Law of Nature

Value Education
YOGA

Unified force - Cause and effect system – Purity of thought deed and Genetic Centre – Love and Compassion - Gratitude - Cultural Education - Fivefold culture.

அலகு 5 : இயற்கை நியதி

ஒருங்கிணைப்பு ஆற்றல் - செயல்வினைத் தத்துவம் - கருமையத்தூய்மைக்கும் வளத்துக்கும் ஏற்ற செயல்கள் - அன்பும் கருணையும் - நன்றியுணர்வு - பண்பாட்டுக்கல்வி - ஐந்தொழுக்கப் பண்பாடு

Note: Practical orientation be introduced to the learners

Text Books:

Manavalakalai Yoga — World Community Service centre
Vethathiri Pathippagam - Erode

Reference Books:

1. Vethathiri Maharishi, 2011, Journey of Consciousness, Erode, Vethathiri Publications.
2. Vethathiri Maharishi, 2014, Simplified Physical Exercises, Erode, Vethathiri Publications,
3. Vethathiri Maharishi, 2004, Unified force, Erode, Vethathiri Publications
4. Yoga for modern age - Thathuvagnani Vethathiri Maharishi
5. Sound Health through yoga – Dr. K. Chandrasekaran, November 1999 Prem Kalyan Publications, Madurai
6. Light on yoga - BKS.Iyenger
7. எளிய உடற்பயிற்சி - உடற்பயிற்சி - வேதாத்திரி மகரிஷி, முதல் பதிப்பு 1984, 91ஆம் பதிப்பு 2016, உலகு வேதாத்திரி பதிப்பகம்.
8. Thathuvagnani Vethathiri Maharishi – Kayakalpa yoga – First Edition 2009 - Vethathiri Publications, Erode.
9. Environmental Studies - Bharathidasan University Publication Division
10. மனவளக்கலை தொகுப்பு - 1, 2 - தத்துவஞானி வேதாத்திரி மகரிஷி
11. Religion, Science and Culture - Dr. S. Radhakrishnan
12. ஜீவகாந்தம் - தத்துவஞானி வேதாத்திரி மகரிஷி
13. Social Yoga System - Dr. K. Satyamurty, Vedadri Centre for Brahmajnana, Guntur, AP
14. இல்லந்தோறும் இயற்கை உணவுகள் (Nature Dietes) - Dr. மதுரம் சேகர்.
15. Genetic centre - Thathuvagnani Vethathiri maharishi

UGC – Mandatory Course
ENVIRONMENTAL STUDIES

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
II	22UPEVS2ES1	100	1	1	0	0	-

Ability Enhancement Compulsory Courses (AECC – Environmental Studies)

Unit 1: Introduction to environmental studies

- Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere.
- Scope and importance; Concept of sustainability and sustainable development.

Unit 2: Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems:

a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3: Natural Resources: Renewable and Non-renewable Resources

- Land Resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Heating of earth and circulation of air; air mass formation and precipitation.
- Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit 4: Biodiversity and Conservation

- Levels of biological diversity :genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India

- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5: Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil, chemical and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste..
- Pollution case studies.

Unit 6: Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.
- Environment Laws : Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC).
- Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context

Unit 7: Human Communities and the Environment

- Human population and growth: Impacts on environment, human health and welfares.
- Carbon foot-print.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management: floods, earthquakes, cyclones and landslides.
- Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Unit 8: Field work

- Visit to an area to document environmental assets; river/forest/flora/fauna, etc.
- Visit to a local polluted site – Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc.

Suggested Readings:

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Gleeson,B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P.H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. Principles of Conservation Biology.
Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
7. McCully, P.1996. Rivers no more: the environmental effects of dams(pp. 29-64). Zed Books.
8. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.

9. Odum, E.P., Odum, h.T. & Andrews, J.1971. Fundamentals of Ecology. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. Waste Water Treatement. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M.L. 2001. Environmental law and policy in India. Tripathi 1992.
14. Sengupta, R. 2003.Ecology and economics: An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
17. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
18. Warren, C.E. 1971. Biology and Water Pollution Control. WB Saunders.
19. Wilson, E.O. 2006. The Creation: An appeal to save life on earth. New York: Norton.

20. World Commission on environment and Development. 1987. Our Common Future. Oxford University Press.
21. www.nacwc.nic.in
22. www.opcw.org

UGC – Mandatory Course
HUMAN RIGHTS

Semester	Paper Code	Marks	Hours/Week	L	T	P	Credit
VIII	22UPEVS2HR1	100	1	1	0	0	-

Objective

To impart the basic ideas about Human Rights at post graduations level. This paper provides different aspects of human rights which includes children and women. Students can learn not only their basic rights bus also can understand the duties to be carried out in the days to come.

Unit I: Introduction to Human Rights

Human Rights: Meaning Definitions – Origin and Growth of Human Rights in World – Need and types of Human Rights – Constitutional Provision for Protection of Human Rights – UNHRC (United Nations Human Rights Commission).

Unit II: Classification of Human Rights

Right to Liberty – Right to life – Right to Equality – Rights to Dignity – Right against Exploitation – Right to work – Right to Personal Freedom – Right to Freedom of Expression – Right to Education – Right to information – Right to Clean Environment.

Unit III: Rights of Women and Children

Rights of Women – Gender Equity – Female Feticide and Infanticide and Sex Selective Abortion – Physical Assault and Sexual Harassment – Domestic Violence – Violence at Work Place – Right for Equal Pay – Remedial Measures.

Rights to Children – Protection of Rights – Survival Rights – Participation Rights – Development Rights – Role of UN Convention on Rights of Children.

Unit: IV: Multi – Dimensional aspects of Human Rights

Labour Rights – Bonded Labour – Chid Labour – Contract Labour – Migrant Labour – Domestic Women Labour – Rights of Ethnic Refugees – Problems and Remedies – Role of Trade Union in protecting the Rights of Labourers.

Unit V: Grievance and Redressal Mechanism

Redressal Mechanisms at National and International Levels – Structure and Functions of National and State level Human Rights Commission – Rights to Information Act, 2005 – Formation of UNO,

UGC – Mandatory Course
HUMAN RIGHTS

Universal Declaration of Human Rights, 1948 – Human Rights Act,1993 – Constitutional Remedies and Directives Principles of State Policy.

References:

1. Baradat Sergio and Swaronjali Ghosh. Teaching of Human Rights : Dominant Publishers and distributors, New Delhi,2009.
2. Roy A.N. Human Rights Achievements and challenges : Vista international Publishing house, Delhi, 2005.
3. Asish Kumar das and Prasant Kumar Mohanty. Human Rights in India: Sarup and Sons. New Delhi. 2007.
4. Bani Borgohain. Human Rights Social Justice and Political Challenge. Kaniska Publishers and distributors New Delhi,2007
5. Velan, G.Human Rights and Development Issues: The associated publishers, Ambala cantt.2008.
6. Meena, P.K.Human Rights theory and practice: Murali Lal and Sons, New Delhi, 2008.
7. Bhavani Prasad Panda. Human Rights Development and environmental law: Academic excellence, Delhi,2007.
8. Vishwanathan. V.N.Human Rights – Twenty First Century Challenges: Kalpaz Publications, New Delhi,2008.
9. Ansari, M.R. Protecting Human Rights: Max Ford Books, New Delhi, 2006.
10. Rao, M.S.A. Social Movements in India – Social Movements and Social Transformation in India Vol.1 & 2: Manohar publications, New Delhi.1978.