UNIVERSITY OF KERALA

OUTCOME BASED REVISED SYLLABUS FOR BSc PROGRAMME IN

ENVIRONMENTAL SCIENCE AND ENVIRONMENT AND WATER MANAGEMENT

WITH EFFECT FROM 2021

Table 1. Scheme of Instruction and Evaluation

Seme-ster	Course Code	Study component	Instructional hours / week		Credits	Evaluation		Total Credits
			Theory	Practical		CE	ESE	
I	EN 1111.3	English I	4	-	3	20%	80%	18
	1111.3	Additional Language I	3	-	3	20%	80%	
	EE 1121	Foundation Course I	3	-	3	20%	80%	
	EE 1131	Complementary Course I	3	-	3	20%	80%	
	EE 1132	Complementary Course Practical	-	2	-	20%	80%	
	EE 1141	Core Course I	3	-	3	20%	80%	
	EE 1142	Core Course Practical		2		20%	80%	
	EE 1171	Vocational Course I	3	-	3	20%	80%	
	EE 1172	Vocational Course Practical	-	2	-	20%	80%	
II	EN 1211.3	English II	4	-	3	20%	80%	24
	1211.3	Additional Language II	3	-	3	20%	80%	
	EE 1221	Foundation Course II	2	-	2	20%	80%	
	EE 1231	Complementary Course II	3	-	3	20%	80%	
	EE 1232	Complementary Course Practical		2	2	20%	80%	
	EE 1241	Core Course II	4	-	4	20%	80%	
	EE 1242	Core Course practical		2	2	20%	80%	
	EE 1271	Vocational Course II	3	-	3	20%	80%	
	EE 1272	Vocational Course Practical	-	2	2	20%	80%	
III	EN 1311.3	English III	5	-	3	20%	80%	19
	EE 1331	Complementary Course III	3	-	3	20%	80%	
	EE 1332	Complementary Course Practical	-	2	-	20%	80%	
	EE 1341	Core Course III	3	-	3	20%	80%	
	EE 1342	Core Course IV	3	-	3	20%	80%	
	EE 1343	Core Course Practical	-	2	-	20%	80%	
	EE 1371	Vocational Course III	4	-	4	20%	80%	
	EE 1372	Vocational Course IV	3	-	3	20%	80%	
	EE 1372	Vocational Course Practical	-	2	-	20%	80%	
IV	EN 1411.3	English IV	5	-	3	20%	80%	22
	EE 1431	Complementary Course IV	3	-	3	20%	80%	
	EE 1432	Complementary Course Practical		2	2	20%	80%	
	EE 1441	Core Course V	5	-	4	20%	80%	
	EE 1442	Core Course VI	2	-	2	20%	80%	
	EE 1443	Core Course Practical	-	2	2	20%	80%	
	EE 1471	Vocational Course V	4	-	4	20%	80%	
	EE 1472	Vocational Course Practical	-	2	2	20%	80%	

Seme-ster	Course Code	Study component	Instructional hours / week		Credits	Evaluation		Total Credits
			Theory	Practical		CE	ESE	
V	EE 1541	Core Course VII	4	-	4	20%	80%	16
	EE 1542	Core Course VIII	4	-	4	20%	80%	
	EE 1543	*Core Course Practical*	-	5	-	20%	80%	
	EE 1551	*Open Course I*	2	-	2	20%	80%	
	EE 1571	*Vocational Course VI*	3	-	3	20%	80%	
	EE 1572	Vocational Course VII	3	-	3	20%	80%	
	EE 1572	Vocational Course Practical	-	4	-	20%	80%	
VI	EE 1641	Core Course IX	3	-	3	20%	80%	21
	EE 1642	Core Course III	2	-	2	20%	80%	
	EE 1643	Core Course Practical	-	4	2	20%	80%	
	EE 1661.1 EE 1661.2 EE 1661.3 EE 1661.4	Elective Course I	2	-	2	20%	80%	
	EE 1671	Vocational Course VIII	3	-	3	20%	80%	
	EE 1671	Vocational Course IX	3	-	3	20%	80%	
	EE 1673	Vocational Course Practical	-	4	2	20%	80%	
	EE 1644	Project and Factory Visit	4	-	4	20%	80%	

Table showing the credits for the programme

First language-English

Semester	Working hours/week	No of Courses	No of Credits
Sem 1	4	1	3
Sem 2	4	1	3
Sem 3	5	1	3
Sem 4	5	1	3

Total No. of credits = 12

Additional language (Hindi/Malayalam)

Semester	Working/ hours	No of Courses	No of Credits
Sem 1	3	1	3
Sem2	3	1	3

Total No. of credits = 6

Complementary course (Chemistry)

Semester	Working hours/week Theory Practicals	Total Hours	No of Courses	No of credits
Sem 1	3 2+2#	7	1	3
Sem 2	3 2+2#	7	1	3
Sem 3	3 2+2#	7	1	3
Sem 4	3 2+2#	7	1+1*	3 + 4 *

 # The additional 2 hrs as per university regulation of work load for practicals if number of students exceeds 15 in a batch

**Practical Examinations will be conducted only on even semester by the*

university Total No of Credits 12+4=16

Semester	Working hours/week Theory Practicals	Total Hours	No of Courses	No of credits
Sem 1	3	3	1	3
Sem 2	2 + 2 # *	6	1+1	2

2 hrs as per university regulation of work load for practicals; Total No of Credits = 5

*Practical examination for foundation course

Core Course (Environmental science)

Semester	Theory Hrs/ Week	Practical Hrs/week	Total Hrs	No of course	No of credits
Sem1	3	2 + 2#	7	1	3
Sem 2	4		4	1	4
Sem 3	6	2+2#	10	2	6
Sem 4	7	2+2#	11	2+1**	6+4**
Sem 5	8	4+4#	15	2	8
Open	3		3	1	2
Sem 6	5	4+4#	13	2+1***	5+4***
Elective	3		3	1	2

#2 hrs as per university regulation of work load for practicals

* Practical examination for foundation course and core course are conducted together as part I & II and the credit is included with core course of 2 credits

At the end of 4th semester; * At the end of 6th

semester *<u>*Practical Exam will be conducted by the*</u>

<u>*university;*</u> Total No of credits 32+6=38

Vocational Course (Water Management)

Semester	Theory Hrs/ Week	Practical Hrs/week	Total Hrs	No of course	No of credits
Sem1	3	2+2#	7	1	3
Sem2	3	2+2#	7	1+1	3+2=5*
Sem3	7	2+2#	11	2	4+3=7
Sem4	4	2+2#	8	1+1*	4+2=6*
Sem5	6	4+4#+4+4#	22	2	3+3=6
Sem6	6	4+4#	14	2+1 *	3+3+2=8*
Project		4+4#	8	1	4

#2 hrs as per university regulation of work load for practicals

Practical Exam will beconducted by the university;

Total No of Credits 27+8=35

B.Sc Environmental Sciences & Environment and Water Management

Six semesters; One semester-18 weeks

Total No of Courses : 43

Sl.No	Study component	No. of courses	Total credit
1	Language English	4	12
2	Additional Lan (Hin/Mal)	2	6
3	Foundation course	2	5
4	Complementary course	6	16
5	Core course	13	38
6	Vocational course	12	35
7	Open Course	1	2
8	Elective courses	1	2
9	Dissertation	1	4
10	Total	43	120

Total No of Credits = 12+6+16+5+38+35+2+2+4=120

Semester 1

Semester	Study component	Title of course	Instructional Hrs
EN1111.3	English I	-	4x18=72
1111.3	Additional Language (Hin/Mal) I	-	3x18=54
EE1121	Foundation Course I	1. Computer Basics and Informatics	3x18=54
EE1141	Core Course I	1. Research Methodology and Perspectives of Science	3x18=54
EE1142	Core Course Practical	2. Environmental Science lab	2x18=36
EE1171	Vocational Course I	1.Water Resources and Fluid Mechanics	3x18= 54
EE1172	Vocational course Practical	2.Water Management Lab	2x18=36
EE1131	Complementary Course I	1.Theoretical Inorganic chemistry	3x18=54
EE1132	Complimentary Course Practical	2.Chemistry lab	2x18=36

Eng-4; SL-3; FC-3; CoreC-5; Vo C-5; Comp C-5; Total=25 Instructional Hrs/week

Semester II

Semester	Study component	Title of course	Instructional Hrs
EE1211.3	English II	-	4x18=72
EE1211.3	Additional Language (Hin/Mal) II	-	3x18=54
EE1221	Foundation Course	1.ComputerApplication for Biostatistics	2x18=36
EE1241	Core Course II	1. Environmental studies	4 x 18=72
EE 1242	Core Course practical	Environmental Science lab	2 x 18 = 36
EE1271	Vocational Course II	1.Water Resources management	3x18=54
EE1272	Vocational Course Practical	2.Water Management lab	2x18=36
EE1231	Complementary course II	1. Organic and Environmental Chemistry	3x18=54
EE1232	Complementary course Practical	2.Chemistry lab	2x18=36

Eng-4; SL-3; FC-2; Core C- 6; Vo C-5; Comp C- 5; Total=25 Instructional Hrs/week

Semester 1II

Semester	Study component	Title of course	Instructional Hrs
EE1311.1	English III	-	3x18=54
EE1341	Core Course III	1. Fundamentals of Ecology and Current Environmental Issues	3x18=54
EE1342	Core Course IV	2 Environmental Management	3x18=54
EE1343	Core Course Practical	3.Environmental Science lab	2x18=36
EE1371	Vocational III	1.Hydrology	4x18=72

EE1372	Vocational IV	2.Water Quality Parameters and Assessment	3x18=54
EE1373	Vocational Practical	3.Water Management lab	2x18=36
EE1331	Complementary III	1.Analytical Chemistry and Biomolecules	3x18=54
EE1332	Complementary Practical	2.Chemistry lab	2x18=36

Eng-3; CoreC-8; Vo C-9; Comp C-5; Total =25 Instructional Hrs/week

Semester 1V

Semester	Study component	Title of course	Instructional Hrs
EE1411.3	1.English IV	-	5x18=90
EE1441	Core Course V	1.Environmental Biotechnology& Microbiology	5x18=90
EE1442	Core Course VI	2.Biophysics, Biostatistics and Computer Application	2x18=36
EE1443	Core Course Practical	3. Environmental Science lab	2x18=36
EE1471	Vocational V	1.Water Quality Management	4x18=72
EE1473	Vocational Practical	3.Water Management lab	2x18=36
EE1431	Complementary IV	1.Physical chemistry	3x18=54
EE1432	Complementary Practical	2.Chemistry lab	2x18=36

Eng-5; Core C- 9; Vo C- 6; Comp C-5; Total =25 Instructional Hrs/week

Semester V

Semester	Study component	Title of course	Instructional Hrs
EE1541	Core Course VII	1.Environmental Geology and Mineralogy	4x18=72
EE1542	Core course VIII	2.Disaster Management	4x18=72
EE1543	Core Course Practical	3.Environmental Science lab	5x18=90
EE1571	Vocational Course VI	1.Water pollution	3x18=54
EE1572	Vocational Course VII	2.Water quality Management- II	3x18=54
EE1573	Vocational course Practical	3.Water Management lab	4x18=72
EE1551	Open course	1.Solid Waste Management	2x18=36

Core C-13; Vo C-10; Open C-2; Total =25 Instructional Hrs/week

Semester VI

Semester	Study component	Title of course	Instructional Hrs
EE1641	Core course IX	1.Environmental Pollution and Control Measures-I	3x18=54

EE1642	Core course X	2 .Environmental Pollution and Control Measures-II	2x18=36
EE1643	Core Course Practical	3.Environmental Science lab	4x18=72
EE1671	Vocational Course VIII	1.WaterAnalysis	3x18=54
EE1672	Vocational Course IX	2Watershed Management	3x18=54
EE1673	Vocational Course practical	3.Water Management lab	4x18=72
EE1661.1 EE1641.2 EE1641.3 EE1641.4	 4.Elective	a. Rain water Harvesting b. Environmental Aspects of Estuarine System c. Environmental Meteorology and Climate Change d. Elementary Concepts in GIS & GPS	2x18=36
EE1644	Project	Environmental Science/ Water Management	4 x 18 = 72

Core C-9; Vo C-10; Project -4; Elective-2; Total = 25 Instructional Hrs/week

FOUNDATION COURSE

SEMESTER I

FOUNDATION COURSE I

EE1121 COMPUTER BASICS AND INFORMATICS

Total Hours 54

Aim:

To introduce students the basics of Computer Science, Informatics and its applications

Objectives:

- To make students aware of the history and evolution of computer science and technology
- To introduce students to basics of internet and overview of Information Technology
- To make students sensitized to the social aspects of informatics
- To make students understand the applications of IT in various fields

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO1	Articulate the history and development of computers	Un, Re
2.	CO2	Describe the Internet governance	Un, Re
3.	CO3	Explain and access the various knowledge repositories of Internet	Re, Un, Ap
4.	CO4	Comprehend the societal applications of internet and use it during emergencies	Re, Un, Ap
5.	CO5	Describe the applications of internet in various fields of science and technology	Re, Un

Course Content:

Module I: History and development of computers: basic knowledge of computer systems - software and hardware - free software - M.S Word, Excel, Power point Computer ethics - software piracy – internet Piracy – privacy-computer security; computer crimes –hacking and cracking.

9 Hours

Module II: Internet: managing bodies of the internet - Internet Society - Internet Service Provider - Internet application software

9 Hours

Module III: **Overview of Information Technology**: Features of the modern personal computer and peripherals - Computer network

9 Hours

Module IV: Data information and knowledge: Internet as knowledge repository - Introduction to use of IT in teaching and learning. Educational software; INFLIBNET - academic services

9 Hours

Module V: Social Informatics: IT and society - overview of its application in medicine, health care, environmental studies-defense crime detection and communication

9 Hours

Module VI: Applications of IT: Applications in weather forecasting, education, film and media - virtual reality

9 Hours

References

1. Cultural Boundaries of Science. T.F.Gieryn, University of Chicago press, 1999
2. Alexis Leon & Mathew Leons, Computers Today, Leon Vikas.
3. Alexis Leon &Mathew Leons, ComputersToday, LeonVikas. Fundamentals of InformationTechnology. ISBN 08125907890
4. Learning Computer Fundamentals, Khanna Book Publishers, ISBN, 818752252b
5. John Ray 10 Minute Guide to Linnx PHI, ISBN 81-203-1549-9.

CORE COURSES

SEMESTER I

CORE COURSE I

EE1141 RESEARCH METHODOLOGY & PERSPECTIVES OF SCIENCE

Total Hours: 54

Aim:

To introduce students to the basics of Research_

Objectives:

- To introduce students to the basic terminology used in research
- To make students aware of the importance of using statistical techniques in improving the credibility of research
- To make students understand the basic methods used in a research

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO1	Plan a Research Process meticulously	Ap
2.	CO2	Frame an appropriate Research Design	Re, Un, Cr
3.	CO3	Identify and collect the latest and relevant data on a pertinent problem	Re, Un
4.	CO4	Analyze the collected data and process it applying suitable sampling techniques	An, Ap
5.	CO5	Articulate well-structured Research Reports	Cr

Course Content:

Module I: Introduction to Research Methodology: An overview of the meaning and significance of research - scientific thinking, application in various fields, tool in decision and policy making; Objectives of research

6 Hours

Module II: Research Process: Definition of research problem; Formulating Research Problem; Literature survey; development of hypothesis; sample design - deliberate sampling, simple random sampling, systematic sampling stratified sampling, cluster and area sampling, multi-stage sampling; definition of data; Types of data - Primary data, secondary data; data collection - personal observation, interviews, questionnaires, schedules

12 Hours

Module III: Perspective of Science: Research Design: Definition of research design; Concepts related to research design - dependent and independent variables, extraneous variables, control; experimental, treatments; Principles of experimental designs - principle of replication, principle of randomization, principle of local control

12 Hours

Module IV: Processing & analysis of data: Processing of data - editing, coding, classification, tabulation; Analysis of data - the role of statistics in research, measures of central tendency & dispersion

8 Hours

Module V: Interpretation & Report Writing: Definition of interpretation; significance of report writing; steps in report writing - logical analysis of matter, preparation of outline, preparation of rough draft, re-writing and polishing rough draft, preparation of final bibliography, writing the final report.

10 Hours

Module VI: Ethics in research: confidentiality, informed consent, role conflict, plagiarism

6 Hours

References

1. Kothari C. R. 2004. Research Methodology: Methods and Techniques. (II Edn) New Age International Publishers. Pp 1-498
2. Georgia Fouka and Marianna Mantzorou (2011) What are the Major Ethical Issues in Conducting Research? Is there a Conflict between the Research Ethics and the Nature of Nursing? Health Science Journal 5(1) pp 3 – 14.
3. Charmaz, K. (2004). Premises, Principles, and Practices in Qualitative Research: Revisiting the Foundations. Qualitative Health Research, 14(7), 976-993.
4. The Glen: What everyone should know about Science. H.Collins and T.Pinch, Cambridge University press, 1993.
5. Elements of Biostatistics. S.Prasad. ISBN 81-7133-613-2. Title code bc-33 First edition -2003. Rastogi publications, Gangotri, Shivagiroad-Meerut 250 002.
6. Introduction to Biostastitics. Pranab Kumar Banerjee and S.Chand. ISBN81-219-2329-8, First edition 2004. Rajendra Raveendra Printers Pvt. Ltd. Ram Nagar, New Delhi

SEMESTER - I

CORE COURSE PRACTICAL

EE1142 ENVIRONMENTAL SCIENCE LAB - I

Total Hours: 36

1. Sampling methods - Plant or animal community on land

2. Population censusing methods - Total count, sampling
3. Estimation of beetle in wheat flour
4. Study of common flora and fauna

VOCATIONAL COURSE I

EE1171 WATER RESOURCES AND FLUID MECHANICS

Total Hours: 54

Aim:

To introduce students the importance of water resources and concepts of fluid mechanics

Objectives:

- To make students understand the importance of water as a natural resource
- To introduce students to the principles of fluids
- To give students the basics of fluid mechanics
- To make students understand the need of using principles of fluid mechanics in real life situations

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Articulate the importance of water as a natural resource	Un, Re
2.	CO 2	Describe various principles of fluids	Un, Re
3.	CO 3	Explain the behaviour of fluids	Re, Un, Ap
4.	CO 4	Identify the flow patterns of fluids	Re, Un
5.	CO 5	Explain the mathematical expressions of fluid mechanics	Re, Un

Course Content:

Module I: Water as a Resource: Water as a natural resource, pressure on water resource – urbanization, population growth, increasing living standards, competition for water, over-consumption, climate change; Availability of freshwater in India with special reference to Kerala

10 Hours

Module II: Uses of Water: Multiple uses of water – Direct uses – drinking, bathing, cooking etc., Indirect uses – processing in industries, agriculture,

electricity; Consumptive uses – irrigation, Partial consumptive use – domestic use, institutional use, industrial use, use in thermal and nuclear power plants – Non-consumptive uses – Recreational use, Navigational use

10 Hours

Module III: Properties of fluids: Intensive property - temperature, pressure, density, viscosity, specific volume, specific gravity, surface tension; extensive property – volume, mass, size, weight and conjugate properties: enthalpy, entropy, heat capacity

10 Hours

Module IV: Fluid flow – steady and unsteady flow, uniform and non-uniform flow, one, two- and three-dimensional flow, laminar and turbulent flow

8 Hours

Module V: Fluid Mechanics: Reynold's number, Reynold's experiment, Flow in a pipe, flow in a wide duct, flow in an open channel, calculation of flow velocity, Head losses

8 Hours

Module VI: Equations in fluid dynamics: Darcy-Weisbach equation, HazenWilliam's formula, Manning's formula (No derivation).

8 Hours

References

1. David Keith (2004) Ground Water Hydrology 3 edn. Todd-Willey International. P 656
2. Asit K. Biswas (1997) Water Resources: Environmental Planning, Management, and Development McGraw-Hill P 737
3. Sharma RK (1987) Hydrology and Water Resources Engineering Dhanpat Rai 818 p
4. R. K. Sharma (1987) A Textbook of Hydrology and Water Resources Engineering Dhanpat Rai & sons 818 p
5. Er. R K Rajput (1998) A Textbook of Fluid Mechanics 6th Edn S. Chand Publishing P 1051
6. Gray N F (2010) Water Technology: An Introduction for Environmental Scientists and Engineers

SEMESTER- I
VOCATIONAL PRACTICAL
EE1172 WATER MANAGEMENT LAB - I

Total hours: 36

1. Measurement of rain fall
2. Measurement of Evaporation (Relative Humidity)
3. Measurement of atmospheric temperature
4. Record of humidity

SEMESTER II

FOUNDATION COURSE II

EE1221 COMPUTER APPLICATION FOR BIOSTATISTICS

Total Hours: 36

Aim:

To introduce students the basics of Computer applications and the basics of biostatistics

Objectives:

- To make students know the applications of computer in research
- To introduce students to various data collection and processing steps
- To make students know the various statistic that can be applied to collected data
- To make students understand the various types of statistical variability in research

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Describe the various techniques of sampling	Un, Re
2.	CO 2	Present collected data in an comprehensible form	Un, Re, Ap
3.	CO 3	Express data in various types of graphical representations	Re, Un, Ap
4.	CO 4	Perform basic statistical techniques in	Re, Un, Ap

		data	
5.	CO 5	Formulate null and alternate hypothesis on research topics	Re, Un

Course Content:

Module I: Computer applications: preliminary concepts - sampling, sampling designs - sampling techniques - sample random – systematic sampling data - data presentation – numeric –alphabetic – alphanumeric

9 Hours

Module II: Collection and representation of data: Collection and classification tabulation of data.

3 Hours

Module III: Graphical representation of data: - methods of preparation of graph – Frequency curve relative frequency map - cumulative frequency map - relative frequency map or o-give. Dot diagram -significance of graphic representation - limitations of graphic representation

6 Hours

Module IV: Measures of central tendencies - mathematical average, average of position - measures of dispersion - range-mean deviation - standard deviation - distribution patterns

5 Hours

Module V: Statistical inference and hypothesis: Tests for statistical significance: student t-test, Chi-square test, confidence level, Null and alternate hypothesis (Concept only).

4 Hours

Module VI: Types of variability-experimental variation-biological variability, real variability-experimental variability, error, subjective, objective instrumental and sampling error

9 Hours

References

1. Elements of Biostatistics -S.Prasad. ISBN 81-7133-613-2 Title code bc-33 First edition -2003 Rastogi publications, Gangotri, Shivagiroad-Meerut 250 002.
2. Methods in Biostatistics for Medical students & research works-V. K Mahajan. Jaypee Brothers Medical brothers Pvt Ltd, New Delhi- 6th edition.

3. Introduction to Biostastitics. Pranab Kumar Banerjee and S.Chand. ISBN81-219-2329-8. First edition 2004. Rajendra Raveendra Printers Pvt. Ltd., Ram Nagar, New Delhi 110 055.

SEMESTER - II

CORE COURSE - II

EE1241 ENVIRONMENTAL STUDIES

Total Hours: 72

Aim:

To introduce students to the importance of the Environment and its components

Objectives:

- To give students an understanding on the basic concepts of Environment
- To introduce students to the concept of ecosystem and the different types of it
- To introduce students to the biodiversity and the significance and uses of it
- To make students understand the various social issues related to environment

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO1	Articulate the basic concepts of Environmental Studies	Un, Re
2.	CO2	List out and describe the various Natural Resources and enumerate the conservation strategies of resources	Un, Re, Ap
3.	CO3	Explain different kinds of ecosystem	Re, Un
4.	CO4	Explain the concept of biodiversity and its type	Re, Un

Course Content:

Module I: Concepts of Environmental Studies: Multidisciplinary nature of environmental studies; Definition, scope and importance, need for public awareness

4 Hours

Module II: Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. d) Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer- pesticide problems, water logging, salinity. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources, equitable use of resources

16 Hours

Module III: Ecosystems: Concept of an ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of the following ecosystems: a) Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

12 Hours

Module IV: Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity. Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation; Hot-spots of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

14 Hours

Module V: Social Issues and the Environment: From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people; its—problems and concerns. Case Studies; Environmental ethics: Issues and possible solutions; Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies; Wasteland reclamation; Consumerism and waste products; Environment Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest

Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.

16 Hours

Module VI: Human Population and the Environment: Population growth, variation among nations; Population explosion – Family Welfare Programme; Environment and human health; Human Rights; Value Education; HIV/AIDS; Women and Child Welfare; Role of Information Technology in Environment and human health.

10 Hours

References

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd.,Ahmedabad –380 013, India, Email:mapin@icenet.net
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
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9. Jadhav, H &Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.
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12. Miller T.G. Jr. Environmental Science, Wadsworth Publishing Co. (TB)
13. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p
14. Rao M N. &Datta, A.K. 1987. Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345p.

15. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut
16. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science
17. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R)
18. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (TB)
19. Wanger K.D., 1998 Environmental Management. W.B. Saunders Co. Philadelphia, USA499p

SEMESTER- II

CORE & FOUNDATION COURSE PRACTICAL

EE 1242 ENVIRONMENTAL SCIENCE LAB-II

Total Hours: 36

Computer Application for Biostatistics

1. Create a power point presentation of wild life population.
2. Graphical representation - Bar, Pie charts of flora and fauna.
3. Plotting straight lines
4. Determination of Central tendencies

Environmental Studies

1. Identification of flora and fauna – terrestrial, marine and freshwater ecosystems
2. Estimation of primary productivity – light and dark bottle method
3. Community study : quadrat and line transect method
4. Construction of food chain/ food web : terrestrial and aquatic ecosystems

SEMESTER II

VOCATIONAL COURSE II

EE1271 WATER RESOUCE MANAGEMENT

Total Hours: 54

Aim:

To introduce students to the importance of management of water resources

Objectives:

- To make students the distribution of water on earth
- To give students an understanding of impacts of human use of water
- To make students understand the various irrigation types for water resource management
- To make students aware of the importance of sustained use of water
- To make students understand and identify the means of meeting the demand of freshwater

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Describe the distribution of water on earth	Un and Re
2.	CO 2	Reflect the impact of human use of water	Un
3.	CO 3	Articulate the various types of irrigation and develop efficient irrigation methods	Re, Un and Ap
4.	CO 4	List out the various methods for meeting increasing water demand	Re, Un
5.	CO 5	Describe sustainable use of water	Re, Un

Course Content:

Module I: Water resources: Distribution of water on earth: Forms of water – Freshwater - Types – glaciers and ice caps, precipitation, surface water – lentic and lotic; ground water: Saline water

10 Hours

Module II: Effects of human use of water: landscape changes, deforestation, Pollution, ground water exploitation, Urbanisation, Agriculture

6 Hours

Module III: Irrigation: Definition, Types of irrigation and its advantages and ill effects – surface irrigation, localized irrigation, drip irrigation, sprinkler irrigation, centre pivot irrigation, free flooding/wild/inundation, perennial system, direct irrigation: Frequency of irrigation: standards of irrigation water: Irrigation efficiency

12 Hours

Module IV: Lift irrigation: definition, advantage, requirements of lift irrigation, case study of lift irrigation

6 Hours

Module V: Meeting water demand: Rainwater harvesting, diverting surface water, dams and reservoirs, transferring water between river basins, waste water reuse, desalinisation of salt water

10 Hours

Module VI: Sustainable use of water: Freshwater shortage, management of water and conservation of water resources, Urban Decision Support System (UDSS)

10 Hours

References

1. Santosh Kumar Garg (1976) Water Resources Engineering Irrigation Engineering & hydraulic Structures Khanna Publishers 1132 p
2. Loucks, Daniel P., van Beek, Eelco (2017) Water Resource Systems Planning and Management Springer
3. M. H. Ali (2010) Fundamentals of Irrigation and On-farm Water Management: Volume 1 Springer

SEMESTER- II

VOCATIONAL PRACTICAL

EE1272 WATER MANAGEMENT LAB - II

Total hours: 36

1. Determination of pH of water sample
2. Determination of Alkalinity of water sample
3. Determination of SPM load of water
4. Determination of Surface tension by drop weight method
5. Determination of Surface tension by drop number method
6. Determination of Viscosity of a sample by Ostwalds Viscometer method
7. Determination of Humidity by Psychrometer

SEMESTER – III

CORE COURSE - III
EE1341 FUNDAMENTALS OF ECOLOGY AND CURRENT ENVIRONMENTAL ISSUES

Total Hours: 54

Aim:

To impart a detailed knowledge among the students on ecology and current environmental problems

Objectives:

- To understand the basic principles and classifications of ecology
- To gain the practical knowledge on diversity indices.
- To give an idea about the causes and impacts of current environmental issues.

Course Outcomes

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Understand the basic concepts of ecology	Un
2.	CO 2	Know the structure and principles of different types of ecology	Un
3.	CO 3	Understand the basic idea of biogeochemical and nutrient cycles	Un
4.	CO 4	Apply the knowledge on diversity indices	Ap
5.	CO 5	Describe the impacts of current environmental problems	Un
6	CO6	Generate solutions for the impacts of human use of Environment	Re, Un, Ap

Course Content:

Module I: Ecology: Definition, scope and history of ecology. Basic concept of Ecology, Terminology of ecology- species, vegetation, flora, fauna, population, community, habitat Subdivisions of ecology-Autecology and Synecology. Categories of ecological factors: climatic factors-light, temperature, rainfall, humidity, atmosphere; topographic factors- altitude, direction of mountain chains and valleys, steepness and exposure of slope; edaphic factor- soil formation, soil profile, physical and chemical properties of soil; Biotic factors-different kinds of interactions between forms of life i.e. plants, animals and microorganisms.

12 Hours

Module II: Population ecology: Population characteristics: size and density, dispersion, age structure, natality, mortality, life tables. Population interactions- Intra and inter specific interactions, symbiosis, mutualism, commensalism, competition, predation and parasitism.

8 Hours

Module III: Community Ecology: characteristics of community - species diversity, growth form and structure, dominance, succession, trophic structure. Composition, structure, origin and development of community.

Trophic pyramids and food webs. Ecological succession and its classification. Competition exclusion principle and Gause's theory of niche. Wetlands and Ramsar sites

10 Hours

Module IV: Habitat ecology: Structure and classification of different ecosystems– Freshwater, Marine, forest, grassland and deserts, Biogeographic zones. Endemic and endangered species, Invasive species and control. Biogeochemical cycles and nutrient cycles: Nitrogen cycle, carbon cycle, phosphorous. cycle, sulphur cycle.

9 Hours

Module V: Applied ecology: Species diversity, community stability and disturbance, Measurement of diversity, Abundance and frequency, Basic concepts of Diversity indices- Shannon-Weiner index, Simpson Index**,** Importance value Index.

6 Hours

Module VI: Current Environmental issues: Causes and consequences of climate change and global warming, ozone layer depletion, pollution, deforestation, soil degradation, waste disposal, water scarcity, natural resource depletion, over population, epidemiological issues-water, air and vector borne diseases.

9 Hours

References

1. Odum,E.P. 1971. Fundamentals of Ecology, W.B.Saunders Company, Philadelphia
2. Sharma.P.D. (2001). Ecology and Environment, Rastogi Publications, Meerut.
3. Rana, S.V.S. (2015). Essentials of Ecology and Environmental Science, PHI Learning Private Limited, New Delhi.
4. Chapman, J. L. and Reiss, M. J.(1992). Ecology: Principles and Application, Cambridge University Press, Cambridge

SEMESTER III

CORE COURSE IV

EE1342 PAPER II ENVIRONMENTAL MANAGEMENT

Total Hours 54

Aim:

To enable the students to identify, describe, and compare core themes and principles of the subject_

Objectives:

- To teach basics of environmental management
- To make students interpret environmental risk levels to make management decisions
- To make students aware of the National Environmental Policy and other regulatory frameworks

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
6.	CO 1	Define Environment Impact Assessment (EIA)	Re
7.	CO 2	List out the major Environmental protection laws in India	Re
8.	CO 3	Explain National Environmental Policy and Regulatory Frame Work	Un
9.	CO 4	Differentiate Environment Impact Assessment (EIA) and Environmental Impact Statement (EIS)	An
10.	CO 5	Compare Sustainable development measures taken by India and other developed nations	Ev

Course Content:

Module I: Basics of Environmental Management: Definition –Basic principles of Environmental Management. Environment Impact Assessment (EIA) -Definition and aim, Principles and Concepts of EIA, Environmental inventory, Baseline data on EIA, EIA assessment methodologies, Environmental Impact Statement (EIS) and Environmental Management Plan (EMP)

9 Hours

Module II: Sustainable Development -Meaning , Concept and Need of Sustainable Development, Indicators of Sustainable Development, Policies, UN and International conferences - Rio summit, Earth Summit, Agenda 21, Johannesburg conference on sustainable development; Copenhagen summit, Sustainable Development Goals (SDGs) Models of sustainable development; Case studies – Sustainable development scenario – global and national level.

9 Hours

Module III: National Environmental Policy and Regulatory Frame Work: Constitutional and Statutory laws in India – Article 48A, Article 51A(g); National Environment Policy, 2006; Intellectual Property Rights; Public Liability Insurance Act, 1991; Biopiracy; Green funding and taxes; Green Bench; Central and State Pollution Control Boards.

9 Hours

Module IV: Environmental Laws in India - The Wildlife Protection Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest Conservation Act, 1980; The Air Act (Prevention and Control of Pollution), 1981; The Environment Protection Act, 1986; Solid Waste Management Rules, 2016

9 Hours

Module V: Environmental Economics: Nature and scope of Environmental Economics; Interrelationship with Economy and Environment

9 Hours

Module VI: Environmental Standards: Scheme of labeling environment friendly products (Ecomark); Environmental Management and ISO Certification; Environmental Management System (EMS); ISO 14000

9 Hours

References

1. Environmental laws of India. An introduction. CPR Environmental Education Centre Chennai, 2000.
2. A text book on Environmental Studies. D.K. Asthana and Meera Athana. S.Chand and Co.
3. Ecology and Sustainable Development. P.S.Ramakrishnan. NBS New Delhi, 2001.
4. Environmental laws. Gurudip Singh. Macmillan India ltd.
5. Introductory Text of Environmental policies and laws. V.K.Garg, M.S Bishnoi, C.P Malik Kalyani Publishers, New Delhi.
6. Environmental Laws, Dharmendra.S.Sengar, Prentice Hall of India Pvt.ltd, Dew Delhi, 2000.
7. Ricci, P.F., Environmental and Health Risk Assessment and Management: Principles and Practices, Springer, 2006.
8. Theobald, R.H., Environmental management, Nova Science Publishers, 2008.
9. Madu, C.N., Environmental planning and management, Imperial College Press, 2007

SEMESTER III
CORE COURSE PRACTICAL
EE1343 ENVIRONMENTAL SCIENCE LAB-III

Total Hours: 36

1. Measuring rainfall and calculation of normal rainfall
2. Recording of maximum -minimum temperature
3. Recording of humidity
4. Preparing a field map using prismatic compass
5. A Collection and submission of 5 Eco-friendly products
6. A report of visit to a factory where Pollution abatement technology is implemented
7. A report on environmental law case study in India
8. A case study of EIA

SEMESTER III

VOCATIONAL COURSE III

EE1371 PAPER (1) HYDROLOGY - I

Total Hours: 72

Aim:

To introduce students to the basics of Surface water and Ground water Hydrology

Objectives:

- To make students understand the various factors affecting occurrence and movement of ground water
- To make students aware of the importance of sustained use of ground water
- To make students understand the potential problems of saline water intrusion

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Articulate the importance of hydrological	Un and Re

		cycling and the factors affecting	
2.	CO 2	Describe formation of rain, the factors affecting and various measuring techniques	Un
3.	CO 3	Frame an outline depicting evapo-transpiration with factors mentioned	Re, Un and Ap
4.	CO 4	Describe infiltration of water, groundwater, its occurrence and movement and the factors affecting ground water	Re, Un
5.	CO 5	Articulate connections between groundwater usage and saline water intrusion	Re, Un, Ap and An

Course Content:

Module I: Surface water hydrology: Definition and importance of surface water hydrology, Hydrological cycle – description; climatic factors affecting hydrological cycle - humidity, temperature, radiation and wind.

10 Hours

Module II: Evaporation and transpiration: Evaporation – definition; factors affecting evaporation - temperature, movement of air and wind speed, surface area and humidity; Estimation of evaporation - evaporation pan method, estimation from water balance calculation; evaporation from soil surface, factors affecting soil water evaporation - soil characteristics, tillage and environmental interactions; Transpiration – definition, factors affecting transpiration - evaporative demand of surrounding atmosphere, humidity, temperature, wind and incident sunlight.

15 Hours

Module III: Precipitation: Precipitation – definition; forms of precipitation, causes of precipitation Measurement of rainfall: measurement using rain gauge - Graduated Cylindrical or Standard Rain Gauge, Tipping Bucket Rain Gauge, Optical Rain Gauge and Acoustic Rain Gauge, measurement using radars; Rainfall intensity - Light rain, moderate rain, heavy rain, violent rain; Mean and annual rainfall, Snowfall, measurement of snow fall - snow gauges: automated and snow pillow; Characteristics of precipitation in India;

15 Hours

Module IV: Infiltration and Runoff: Infiltration – Definition; infiltration rate; factors affecting infiltration rates - precipitation, soil type, soil moisture content, land cover and slope; Runoff – definition; factors affecting runoff - climatic factors and physiographic factors; Global Water Balance.

11 Hours

Module V: Ground Water Hydrology: Ground water – definition; sources of ground water - meteoric water, connate water, magmatic water and juvenile water; ground water fluctuations; factors affecting ground water fluctuations - topography, stream flow, meteorological phenomena, evapo-transpiration and urbanization;—major sources of ground water contamination.

11 Hours

Module VI: Saline Water Intrusion and Wells: Saline water intrusion – Definition; causes of surface and ground water intrusion; control of saline water intrusion; wells – definition, types of wells - open wells/ dug wells and bore wells/ tube wells.

10 Hours

References

1. Rk Sharma and Tk Sharma (2000) Text Book Of Hydrology & Water Resources Engineering, Dhanpat Rai Publications (P) Ltd
2. K. Subramanya (1994) Hydrology, Tata McGraw-Hill Education p. 392
3. N N Basak (2017) Irrigation Engineering, McGraw Hill Education; 1 edition p. 329
4. Santosh Kumar Garg (2010) Water Supply Engineering, Khanna Publishers, p. 1196
5. David Keith Todd and Larry W. Mays (2005) Groundwater Hydrology, John Wiley & Sons; 3rd edition John Wiley & Sons; p. 656.

SEMESTER III
VOCATIONAL COURSE IV
EE13712 PAPER (2) WATER QUALITY PARAMETERS AND ASSESSMENT

Total Hours: 54

Aim:

To train the students on the basic concepts of water sampling technique and analyzing the water quality parameters

Objectives:

- To give an in-depth knowledge on sampling and preservation of water sample for physical, chemical and biological analysis.
- To gain the practical knowledge on water analysis.
- To give an idea about the water quality guidelines.

Course Outcomes:

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

Sl.No.	Course Outcome No.	Course outcome (CO)	Taxonomic Level (TL)
	CO-1	Understand the basic concepts of water and water quality parameters	Un
	CO-2	Know the principles of water sampling and preservation methods	Un
	CO-4	Understand the basic idea of drinking water quality guidelines	Un
	CO-5	Apply the knowledge on water quality monitoring	Ap

Course Content:

Module I: Physical properties of Water: Boiling Point, Melting Point, critical temperature, viscosity, Surface tension, dielectric constant, dipole moment, Heat of vaporization.

10 Hours

Module II: Water quality and Sampling: definition, importance of water quality measurement, Objectives of water quality assessment, sampling methods & collection of water samples -surface water and groundwater, Types of sampling -spot or grab samples and composite samples, sampling frequency. Types of water samplers –Van Dorn water sampler, Ruttner water sampler, Dussart-flask water sampler, Thermos-flask water sampler, pump

sampler, Niskin water sampler, Nansen water sampler, handling and preservation of water sample for physical, chemical and biological analysis.

12 Hours

Module III: Water quality parameters: physical- colour, temperature, odour, electrical conductivity, turbidity, transparency; chemical - pH, total dissolved solids, Dissolved Oxygen, Biochemical Oxygen Demand, Ca, Mg, hardness, alkalinity, acidity, Chemical Oxygen Demand, Nitrite, Nitrate, phosphate, Fluoride, chloride; bacteriological -total coliforms, faecal coliforms, E.coli and biological parameters - macrophytes, phytoplankton, chlorophyll. Tolerance limits for trace metals in drinking water- Al, B, Cd, Co, Pb, Mn, Ni. Fe, Zn, Cr, Cu, Mo, Se

12 Hours

Module IV: Analytical methods: pH, electrical conductivity, alkalinity, hardness by EDTA method, TDS, DO by Winkler method, Chloride by Titrimetry, Transparency by Seechi disc method, Coliforms by MPN method.

10 Hours

Module V: Biological Methods: Estimation of chlorophyll content, collection and preservation of phytoplankton, measurement of phytoplankton population -Sedgwick-Rafter cell method and Lackey's drop method.

8 Hours

Module VI: National and International Standards for drinking water quality: WHO, USPHS, CPCB, BIS.

2 Hours

References

1. APHA (1995). Standards methods for the examination of water and wastewater.19th Edition., American Public Health Association, Washington DC.
2. BIS (2012). Indian Standard Drinking Water-Specification (Second Revision) IS 10500 : 2012.
3. Saxena, M.M. (1998). Environmental Analysis: Air, Water and Soil. Agrobotanica, Bikaner, 184 p.
4. Trivedi, R.K. and Goel, P.K. (1986).Chemical and biological methods for water pollution studies. Environmental Publications, Karad, India, 247 p.
5. USPHS (1962). Public Health Service Drinking Water Standard (https://law.resource.org/pub/us/cfr/ibr/006/usphs.956.1962.pdf)
6. WHO (2008). Guidelines for drinking-water quality [electronic resource]:incorporating 1st and 2nd addenda, Vol.1,

Recommendations. – 3rd ed. https://www.who.int/water_sanitation_health/dwq/fulltext.pdf

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EMESTER – III

VOCATIONAL PRACTICAL

EE1373 WATER MANAGEMENT LAB - III

Total Hours: 36

1. Determination of Chlorine percentage in a sample of bleaching powder
2. Determination of concentration of chloride ion in a sample of water sample
3. Determination dissolved oxygen in a sample of water
4. Determination of density of water

SEMESTER – IV

CORE COURSE V

EE1441 - PAPER (1) ENVIRONMENTAL BIOTECHNOLOGY AND MICROBIOLOGY

Total Hours: 90

Aim:

To develop basic understanding of the principles and applications of microbiology and biotechnology in the environment

Objectives:

- To impart knowledge on the microbes in the environment and interactions of microorganisms in the various spheres of the environment
- To understand the principles of biotechnology applications of biotechnology in waste management

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO1	Describe the different types of microbes in the environment and differentiate microbes based on their metabolic	Re

		diversity	
2.	CO2	Define the various environmental factors that influence growth and activity of microbes	Re
3.	CO3	Explain the role of microorganisms in biogeochemical cycling of nutrients	Un
4.	CO4	Outline the environmental applications of biotechnology	Re
5.	CO5	Assess the bioremediation techniques for application in waste treatment	An

Course Content:

Module I: Environmental Microbiology: Microbes in the environment – diversity and types – bacteria, archaea, fungi, protozoa and algae: Growth of microorganisms Environmental factors and microbial growth: oxygen, temperature, pH, pressure. Extremophiles – microbes in the extreme environment.

15 Hours

Module II: Microbial ecology: Microbes in water; coliforms and indicators of fecal contamination; Microbiology of soil: role in soil fertility; interactions between microbes and plants – mycorrhizae; rhizobium - nitrogen fixation; microbiology of air: prevalence and environmental factors; air-borne pathogens.

15 Hours

Module III: Metabolic diversity: Phototrophs, autotrophs, heterotrophs, chemolithotrophs, heterotrophy; Aerobic and anaerobic respiration, fermentation

Role of microbes in geochemical cycles – Carbon, Nitrogen and Sulphur cycles; Microbial interactions; Interactions between microorganisms: commensalism, mutualism, parasitism and ammensalism

15 Hours

Module IV: Biotechnology-definitions: Scope of biotechnology in agriculture, food production and nutrition. Impact of biotechnology on sustainable development and sustainable agriculture: biofertilizer and biopesticides; Microorganisms in biomass and energy production: Microbes producing protein - single cell protein; Biogas production – Methane.

15 Hours

Module V: Genetic Engineering: Brief study of gene cloning in prokaryotes, Molecular tools for genetic engineering. Recombinant DNA technology and its applications; Release of genetically engineered

microorganisms; safety and environmental risks; impact of genetically modified crops

15 Hours

Module VI: Microbes in waste treatment: treatment of solid waste – biocomposting and vermicomposting: principles, technique and applications. Microbes in waste water treatment: aerobic and anaerobic waste water treatment

Bioremediation: principles and applications; in situ and ex situ remediation processes and applications; in situ remediation of groundwater contamination and petroleum hydrocarbon contamination

15 Hours

References

1. Ananthanarayanan and Panicker. 2009. Textbook of Microbiology, University Press.
2. Bhandar,S.C & L.L. Somani. 1994. Ecology and Biology of Soil microorganisms: Agretech Publishing, Udaipur.
3. Chandrawati Jee and Shagutta. 2007. Environmental Biotechnology, APH Publishing.
4. Ignacimuthu,S.J. Biotechnology: An Introduction. Tata Mc GrawHill Publication Company Ltd.
5. Kumar,H.D. Modern Concepts of Biotechnology. Vikas Publishing House.
6. Mohapatra,P.K. 2010. Textbook of Environmental Biotechnology, I.K.International Pvt.Ltd.
7. Pelczar,M. 2001. Microbiology.
8. Pepper,I. and C.P.Gerba. 2004. Environmental Microbiology (2nd Edition). Academic Press
9. Power,C.B. & Daginawala,H.F. 1982. General Microbiology Volume I & II. Himalaya Publishing house, New Delhi.
10. Purohit,S.S. 2004. A text book of Microbiology. Student edition, Jodhpur.
11. Raina M.Maier. 2000. Environmental Microbiology, Academic Press.
12. Sharma,P.D. 1989, Microbiology Restegi& Company, Meerut.
13. Singh,R.P. & Kamal. 1989. An Introduction to Microbiology Central Book Depot, Allahabad

SEMESTER IV

CORE COURSE VI

EE1442 PAPER (2) BIOPHYSICS, BIOSTATISTICS AND COMPUTER APPLICATION

Total Hours 36

Aim:

To introduce students to the instruments used in Environmental research

Objectives:

- To introduce students to the principles and techniques of various instruments
- To give students the basics of biostatistics
- To make students understand the need of using principles of statistics in environmental research
- To make students capable of browsing the internet through relevant websites for statistical analysis

Course Outcomes:

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

Sl No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO1	Articulate the importance of light and its measurements in environmental analysis	Un, Re
2.	CO2	Describe various instruments used in environmental analysis with their principles and application	Un, Re
3.	CO3	Perform statistical analysis of data provided	Re, Un
4.	CO4	Explain the significance of Redox Potential in environmental analysis	Re, Un
5.	CO5	Describe the use of internet and computer based tools for information and statistical analysis	Re, Un

Course Content:

Module I: Biophysics - Introduction: Importance of instruments in environmental anaysis

1 Hour

Module II: Effects of Light in environmental analysis: Beer Lambert's Law - Law, mathematical expression of the law, explanation on its application in environmental research; Absorption spectrum; Photochemistry – definition; fluorescence and phosphorescence - definition and principle; Photochemical reactions such as photosynthesis; Bioluminescence and photo degradation - definition

10 Hours

Module III: Redox potential - definition and significance in environmental research

1 Hour

Module IV: Instruments and techniques: Light microscopy - principle and application; electron microscopy - principle and application; spectrophotometry - principle, instrumentation and application; mass spectroscopy - principle, instrumentation and application; absorption spectroscopy - principle, instrumentation and application; X ray analytical methods - principle and application

10 Hours

Module V: Biostatistics: Significance of biostatistics in environmental studies, Population and sample – definitions; Sampling methods - probability/ random - simple random sampling, systematic sampling, stratified sampling multistage sampling, cluster sampling and non-random methods - convenience sampling, purposive sampling and quota sampling; Measures of dispersion - range, deviance and variation – definition with examples; Test of significance - chi square test, student t-test – definition with example and analysis of these using computer

12 Hours

Module VI: Internet: Basic idea on browsing websites for information and statistical analysis

2 Hours

References

1. David Burns (2016) An Introduction to Biophysics. Wentworth Press P. 456
2. Daniel M. (2012) Basic Biophysics for Biologists (I edn) Agrobios (India)
3. Veerakumari L. (2015) Bioinstrumentation (I edn) MJP Publishers; P. 578
4. Wayne W. Daniel and Chad L. Cross (2014) Biostatistics: Basic Concepts and Methodology for the Health Sciences (X edn) Wiley P. 954
5. Banerjee Pranab Kumar (2007) Introduction to Bio-Statistics (III edn) S Chand & Company P. 2018

6. Rao S (2012) Introduction to Biostatistics and Research Methods (V edn) PHI Learning Pvt. Ltd P. 280

7. James Gatenby (2001) Basic Internet Skills. Bernard Babani Publishing P. 160

SEMESTER IV

CORE COURSE PRACTICAL

EE1443 ENVIRONMENTAL SCIENCE LAB-IV

Total Hours: 36

1. Demonstration of Sterilisation by dry heat and wet heat (SteamAutoclaving)

2. Cultutre media preparation using PDA (Potato DextroseAgar)

3. Growth of E.Coli in liquid media.

4. Slides of specimens - Paramecium, Spirogyra, Pencillium, coliform bacteria

SEMESTER IV

VOCATIONAL COURSE V

EE1471 WATER QUALITY MANAGEMENT - I

Total hours: 72

Aim:

This course is designed to provide the proper understanding and hands on training on determining water quality and thereby achieving an ecological and chemical good status of all water bodies by means of sampling, laboratory analysis and management strategies. Preventing and controlling pollution of the water resources is a major challenge facing today. Over large parts of the world, rivers and lakes show increasing trends of water pollution.

Objectives:

- To find out the scientific guidelines that are safe limits of the physical, chemical, or biological characteristics of water and sediments which protect water for different uses.
- To reduce to control and prevent pollution
- To adopt cost effective and sustainable management practices to conserve water resources for the sustainable utilization.

Course Outcomes:

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

SL No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Recognize the concept of water quality criteria and standards for different purposes	Re
2.	CO 2	Understand and apply the different sampling methodologies and collection equipment needed for water quality monitoring	Un
3.	CO 3	Develop the analytical ability to set up the experiments	An
4.	CO 4	Analyze the different conventional and specific water treatment processes	An
5.	CO 5	Design sound and sustainable water quality management practices under specified conditions	Cr
6.	CO 6	Apply any of these treatment strategies wherever necessary	Ap

Course Content:

Module I: Water Quality Requirement and Standards for various uses: Water quality Criteria and standards (WHO and BIS)-drinking, industrial, irrigation, aquaculture.

6 Hours

Module II: Water Quality Monitoring and Sampling: Water quality parameters, Sampling methods for streams, lakes, waste water and sediment (Grab and Composite samples) Sampling equipments: Niskin water sampler, Nansen water sampler, Dussart flask

12 Hours

Module III: Water treatment process: Conventional methods-sedimentation, coagulation, flocculation, filtration, disinfection. Chemical methods-UV rays, ionizing radiation (X-rays, gamma rays, and electron beams), iodine and bromine, ozone, potassium permanganate, silver and chlorine. Types of chlorination- Plain chlorination, Pre-chlorination, Post-chlorination, Break point chlorination, Super chlorination, De-chlorination

18 Hours

Module IV: Specific water treatment processes: Desalination. Reverse osmosis; electrodialysis; freezing method; multi flash evaporators. Water softening methods- Lime soda process, Ion-exchange process and Permutit process

12 Hours

Module V: Methods for removal of iron and manganese-oxidation/filtration, ion exchange method. Methods for removal of chromium- Chemical precipitation, adsorption and biosorption, reverse osmosis, ion exchange, Electrodialysis. Methods for Removal of dissolved gases from water – Degasification. Methods for removal of oil from water- Oil skimming. Methods for removal of Radio materials (Uranium, Radon, Polonium) from water

14 Hours

Module VI: Water quality management: Definition, Management and conservation of water resources, national and state level policies in water quality management- The National Water Policy, 2002, The Water (Prevention & Control of Pollution) Act, 1974, Water Cess Act, 1977, Environment (Protection) Act, 1986. Polluter Pays principle

10 Hours

References

1. Annanmaki, M. and Turtiainen, T. (Eds.). Treatment Techniques for Removing Natural Radionuclides from Drinking Water, STUK—Radiation and Nuclear Safety Authority, Finland.
2. https://inis.iaea.org/collection/NCLCollectionStore/_Public/32/018/32018426.pdf
3. APHA (1995). Standards methods for the examination of water and wastewater.19th Edition. American Public Health Association, Washington DC.
4. Arceivala, S.J. Asolekar, S.R. (2007): Wastewater Treatment for Pollution Control and Reuse, Tata McGraw Hill Publishing Company Ltd, New Delhi.
5. Gray, N.F. (2010). Water Technology: An Introduction for Environmental Scientists and Engineers, Butterworth-Heinemann, 3rd Edition
6. Hammer, M.J. and Jr. Hammer, M.J. (2012). Water and Waste Water Technology, Printice Hall India Pvt. Ltd.
7. Punmia, B.C., Jain, A.K. and Jain, A.K. (1995). Water Supply Engineering, Lakshmi Publications, New Delhi.

8. Trivedi, R.K., Goel, R.K. (1984) Chemical and Biological Methods of water pollution studies. Environmental publication, Karad.
9. Michael, P. Ecological Methods for field and Laboratory Investigation, Tata McGraw Hill publishing Company. New Delhi.
10. Saxena, M.M. (1998). Environmental Analysis: Air, Water and Soil. Agrobotanica, Bikaner, 184 p.

SEMESTER IV
VOCATIONAL PRACTICAL
EE1473 WATER MANAGEMENT LAB - IV

Total Hours: 36

1. Determination of BOD of a sample of water
2. Determination of COD of a water sample
3. Determination of TDS in a sample of water
4. Determination of Salinity in a sample of water
5. Determination of hardness of water

SEMESTER V

CORE COURSE VII

EE1541 PAPER (1) ENVIRONMENTAL GEOLOGY AND MINERALOGY

Total Hours: 72

Aim:

To make them learn the basic principles of geology and develop an understanding of the methods geologists use to study the Earth.

Objectives:

- Recognize the Earth as a unique, closed system and composition of earth.
- To make students understand the role of natural geologic processes operating on earth.
- To make students aware of the different rocks and minerals – the building block of earth.

Course Outcomes:

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

Sl No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Define the scope of Environmental Geology	Re
2.	CO 2	Compare Exogenous and Endogenous processes	Un
3.	CO 3	Explain Pedogenesis and soil profiles	Un
4.	CO 4	Explain the geological processes operating on earth	An
5.	CO 5	Analysing minerals and rocks-the building block of earth	An

Course Content:

Module I Introduction to Environmental Geology: Definition and scope; Origin and Evolution of Earth- Current views on origin of earth, Geological Time Scale; Plate Tectonics – Sea floor spreading and continental drift; Forces acting on the surface of the Earth – Tectonic and Diastrophic forces.

14 hours

Module II: Processes on Earth: Exogenous (weathering, erosion, transportation, and sedimentation) and endogenous (folding, faulting and volcanism) processes operating on earth. Study of the interior of earth: Crust, mantle and core; Earth's Surface Process- Weathering of rocks – physical, chemical and biological weathering; erosion, transportation, and deposition.

14 hours

Module III: Pedogenesis: Factors affecting soil formation, factors controlling formation of soil; soil profiles

6 hours

Module IV: Geological agents: Erosion, transportation and deposition of earth's materials by water, wind and glaciers; River as a geological agent - development of river; meandering of river; drainage pattern; drainage basin; energy in streams; Rivers in India; Glaciers - Types and geological activity, Glaciers as an index of climate change.

12 hours

Module V: Minerals: Definition of mineral; Physical properties of minerals such as colour, streak, luster, hardness and specific gravity. Composition and diagnostic properties of important rock forming minerals - quartz, feldspar, calcite, biotite

12 hours

Module VI: Rocks: Petrology- Igneous, Sedimentary and Metamorphic rocks; Igneous Petrology - Brief overview of formation, structures and classification of igneous rocks. Megascopic features of Granite, Syenite, Gabbro and Basalt; Sedimentary Petrology - Brief overview of formation, structures and characteristics of sedimentary rocks. Megascopic features of Sandstone, Limestone, Shale, Breccia, Conglomerate; Metamorphic Petrology – Origin and formation of metamorphic rocks. Megascopic features of Marble, Gneiss and Schist.

14 hours

References

1. Carla Montgomery (2020). Environmental Geology (11th Edition). Mc Graw Hill. ISBN13: 9780078022951.
2. Edward. A. Keller. 2018. Introduction to Environmental Geology (5th ed.). Pearson India. 792p.
3. Jim Reichard (2020). Environmental Geology (4th Edition). Mc Graw Hill. ISBN13: 9781260368277
4. LaMoreaux James. (2019). Environmental Geology. (1st edition). springer. p 472. Print ISBN: 978-1-4939-8786-3
5. Steven Eark. 2019. Physical geology. Press Books.
6. Duggal K. N. and J. P. Soni, (1996). Elements of water resource engineering; New Age International Publisher.
7. Read, H. H. Rutley's Elements of Mineralogy. John Wiley and Sons, New York.
8. Reghunath, H.M. (1996). Hydrology – Principles, analysis and design, New Age international publisher.
9. Singh V.P (1994). Elementary Hydrology, Prentice – Hall of India.
10. Strahler, A. N. and Strahler, A.H. (1987). Physical Geography, John Wiley and Sons, New York.
11. Todd, D. K. and L.W. Mays (2005). Ground Water Hydrology, 3rd Edn. Wiley Inc.
12. Tyrell, G. W. (1978). Principles of Petrology. Chapman & Hall Ltd.
13. Mukergee,P.K, 1986. A text book of Geology.
14. Parbin Singh, S.K.Katariah & sons Engineering & General Geology, Gurunank market, New Delhi.

SEMESTER V

CORE COURSE VIII

EE1542 PAPER (2) DISASTER MANAGEMENT

Total Hours: 72

Aim:

The aim of this elective course is to improve the scientific knowledge among students about various natural and man- made disasters through the teaching of policies, programs, administrative actions and operations undertaken. This will train them to cope with the different disaster management activities like preparedness, prevention and thereby to reduce or avoid the human, physical, and economic losses suffered by individuals, by the society, and by the country at large. Also train them to reduce their personal sufferings in connection with a disaster.

Objectives:

- To make students understand the concept of disaster, perception and management of various natural disasters like flood, earthquake, landslide, cyclone, coastal erosion etc.
- To make students know the role of Remote Sensing and GIS in disaster management etc.

Course Outcomes:

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

Sl No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Understand the basic aspects of disaster	Un
2.	CO 2	Analyse the components in disaster management cycle	An
3.	CO 3	Identify the sectors in disaster management	Un
4.	CO 4	Understand the different types of natural disasters	Un
5.	CO 5	Understand the different types of anthropogenic disasters	An

Course Content:

Module I: Basic concept of disaster: Definition of hazard, vulnerability, risk, disaster.

Causative factors of disaster; Classification of disasters

8 Hours

Module II: Disaster management: Definition, components of disaster management cycle -crisis management & risk management. Crisis management- quick response and relief, recovery, rehabilitation; Risk management- risk identification, risk assessment, risk reduction in vulnerable areas – Preparedness, prevention, mitigation; Risk transfer.

15 Hours

Module III: **Important sectors in disaster management:** Health & Medical care; Communication, Insurance, Social work, NGO's, Media, Fire service, Police and Armed forces, parliamentary service

15 Hours

Module IV: Natural disasters: flood, drought, landslide, earthquake, cyclone, tsunami - causes, perception, mitigation, and management.

12 Hours

Module V: Man-made disasters: fire, industrial pollution, biological disaster, structural failure (building & Bridges), accidents (Road, rail & Water), dams

12 Hours

Module VI: Policies: Disaster management related Acts and Policies in India.

10 Hours

References

1. Gupta and Harsh, K. 2003. Disaster Management, Universities Press (India) Pvt. Ltd..
2. Janki Andharia (2020). Disaster Studies. Springer Singapore. p462. Hardcover ISBN 978-981-329-338-0
3. Jha and Kumar, M. 2010. Natural and Anthropogenic Disasters; Vulnerability, Preparedness and Mitigation, Springer.
4. Peijun Shi (2019). Disaster Risk Science. Springer Singapore. P 753. ISBN 978-981-13-6691-8
5. Singh, K .K .&. Singh, A .K. 2010. Natural and manmade disasters: vulnerability, preparedness and mitigation, Vol(1&2), M.D. publications. Pvt. Ltd. New Delhi.
6. Strahler, A.N. and Strahler, A.H. 1973. Environmental Geoscience – Interaction between natural systems and man: -Santa Barbara, California, Hamilton Publishing.
7. Talwar, A.K. &Juneja, S. 2009. Flood Disaster Management, Commonwealth publishers, New Delhi.

SEMESTER V

CORE COURSE PRACTICAL

EE1543 ENVIRONMENTAL SCIENCE LAB-V

Total Hours: 90

1. Identification of common minerals & rocks
2. Identification of soil types - red soil, alluvial soil, black soil
3. Identification of soil texture
4. Determination of soil moisture content
5. Determination of soil pH
6. Determination of conductivity.
7. Estimation of organic carbon of soil
8. Bulk density of soil
9. Soil organic matter
10. Particle density of soil
11. Soil nutrient analysis
12. Preparation of Disaster Management Plan for Flood/ Earth quake/
13. Preparation of Disaster Management Plan for Health disaster

SEMESTER V

VOCATIONAL COURSE VI

EE1571 PAPER (1) WATER POLLUTION

Total Hours: 54 Hours

Aim:

To develop basic understanding on the different sources of water pollution and its harmful effects

Objectives:

- To impart knowledge on the water quality standards, physical, chemical and bacteriological test methods
- To understand the factors responsible for surface water, marine water pollution and organic pollution.

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Will be able to describe the sources influencing water pollution and common impurities in water	Re
2.	CO 2	To understand and analyze the physical, chemical, bacteriological testing methods, water quality standards and water borne diseases	Un, An
3.	CO 3	Will be able to explain the riverine, estuarine, marine water pollution and the extent of plastic pollution	Un
4.	CO 4	Can develop knowledge on identifying the sources and type of organic pollution	Un
5.	CO 5	To understand the role of microorganisms in cleaning up and purification of water	Un

Course Contents:

Module I: **Water pollution**: General properties of water; Brief history of water pollution; Sources of water pollution; Physical pollution of water; Chemical pollution of water; Biological pollution of water.

9 Hours

Module II: **Water impurities:** Common impurities in water; testing of water; physical test; chemical test; bacteriological test.

9 Hours

Module III: Water quality: Standards of drinking water; Maintenance of purity of water; Ground water pollution, factors affecting ground water pollution, harmful effects of ground water pollution; Water borne diseases, Bio monitoring of water pollution

9 Hours

Module IV: Surface water pollution: Sources of surface water pollution; Factors affecting surface water pollution - factors affecting nutrient loss in surface water – Monitoring and control of pollution in lakes, rivers and estuaries.

9 Hours

Module V: **Sea water pollution**: Global sea water pollution - Control of pollution in seawater; role of microorganisms in cleanup operation; current scenario of plastic pollution in marine water.

9 Hours

Module VI: **Organic pollution:** Organic pollutants - synthetic detergents; eco-friendly detergents containing enzymes; eutrophication, oceanic acidification, radionuclide pollution, thermal pollution in water; pesticide pollutants. Techniques for treatment of biological wastes

9 Hours

References

1. B K Sharma, Water pollution. Goel publishing House, Meerut.
2. B C Punmia, Ashok Jain and Arun Jain, Water supply Engineering. Lakshmi Publications, New Delhi
3. P K Goel, 2006. Water pollution: Causes, Effects and Control, New age International Publishers, New Delhi
4. Anupam Rajak, 2019. Micro plastic pollution. Published by Notion Press, Chennai

SEMESTER V
VOCATIONAL COURSE VII
EE1572 PAPER (2) WATER QUALITY MANAGEMENT-II

Total Hours: 54

Aim:

The course aims to impart basic knowledge of waste water treatment process among the students and to equip the students with the skills on the management of waste water generated in industries.

Objectives:

- To give students an overview of the characteristics of waste water, waste water treatment process, disposal methods of sewage and sludge
- To make students understand sophisticated methods adopted in industries.

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Understand the basic concepts of waste	Un

		water and sewerage systems	
2.	CO 2	Articulate fundamental concepts in waste water treatment process	Un
3.	CO 3	Apply concepts and design the waste water treatment methods in industries	Ap
4.	CO 4	Know the basic principles of sewage and sludge disposal methods	Un
5.	CO 5	Develop a capacity for decision making on the management of waste generated in industries	Ap

Course Content:

Module I: Waste water or sewage: Definition, nature, sources. Types- grey water, black water, yellow water, brown water. Physical, chemical and biological properties of waste water

4 Hours

Module II: Sewage characteristics: types-domestic sewage, industrial sewage, storm sewage. Major pollutants in sewage- organic material, suspended solids, plant nutrients, microbes. Sewerage systems

2 Hours

Module III: Waste water treatment: Primary treatment - screening, skimming, grit chamber, coagulation and flocculation, filtration and sedimentation tank methods. Secondary treatment -activated sludge, trickling filters, oxidation ponds. Advanced treatment: Removal of nitrogen and phosphorous from waste water. Disinfection by chlorination

12 Hours

Module IV: Natural methods of sewage disposal: Dilution method, Sewage farming method: Sanitary water management - sanitary waste, definition, Systems of sewage disposal: Dry conservancy system & water carriage system

9 Hours

Module V: Treatment and disposal of sludge: thickening and digestion, conditioning and dewatering, incineration, anaerobic digestion, drying beds, Rotary drum filters, land filling.

9 Hours

Module VI: Characteristics and treatment of industrial waste water: breweries and wineries; distilleries; paper and pulp mill; sugar mill; oil refineries, Petrochemical industries; tanneries; pharmaceutical plants; fertilizer plant; electroplating industries; textile mills.

18 Hours

References

1. Abbasi, S.A. 1998. Environmental Pollution and its Control, Cogent International, Pondicherry.
2. Basak, N.N. (2014). Environmental Engineering, Tata Mc Graw Hill publishing company.
3. Garg, S.K. (2017). Water Supply Engineering: Environmental Engineering - Vol. I. Khanna Publishers.
4. Gray, N.F. (2010). Water Technology: An Introduction for Environmental Scientists and Engineers, Butterworth-Heinemann, 3rd Edition.
5. Mahajan, S.P. (1985). Pollution Control in Process Industries, Tata McGraw-Hill Education.

SEMESTER V

VOCATIONAL PRACTICAL

EE1573 WATER MANAGEMENT LAB - V

Total Hours: 72

1. Determination of chlorine demand a sample of water
2. Determination of residual chlorine in a municipal water sample
3. Determination of moisture percentage of soil
4. Determination of PH of soil

5. GRAVIMETRIC ESTIMATION OF

a) Sulphate, oxalate

b) Barium, calcium, iron, nickel

6. Colorimetry and turbidimetry

a) Sulphide

b) Fluoride

c) Silicate

d) Ammonia

e) Sulphate

SEMESTER V

OPEN COURSE

EE1551 SOLID WASTE MANAGEMENT

Total Hours: 36

Aim:

To make students understand the concept of Solid Waste, its composition and the problems associated and the management aspects of solid wastes and plastic wastes

Objectives:

- To introduce students to the concept and composition of solid wastes
- To make students aware of the activities creating solid wastes
- To make students understand the problems caused by hazardous wastes
- To introduce students the various management techniques of solid waste in general and plastic waste in particular

Course Outcomes:

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

Sl.No.	Course Outcome No.	Course outcome (CO)	Taxonomic Level (TL)
1.	CO-1	Define and identify the different types of solid wastes	Re
2.	CO-2	Describe the solid waste management methods	Re
3	CO-3	Explain the management of agricultural wastes	Un
4	CO-4	Outline the types of hazardous solid wastes	Re
5	CO-5	List the waste management policies	Re
6	CO-6	Explain the functioning of sanitary landfill	Re

Course Content:

Module I: Introduction: Solid wastes and its characteristics; classification of solid waste – source; factors affecting quality & quantity. Physical and chemical characteristics - collection & transportation

4 Hours

Module II: Composition: The changing nature, quantity, composition of solid wastes in urban and rural areas of India and World. (Households, Institutions, markets, Recreational places and Parks, Corporate and Business Centers, Religious Institutions, Hotels)

4 Hours

Module III: Agricultural wastes: types and sources. Disposal techniques - composting; principles of composting; factors affecting composting; Types of composting - Windrow layout

6 Hours

Module IV: Hazardous wastes: Definition, source and characteristics; Management of medical and hospital wastes, Nuclear and radioactive wastes – classification, sources and disposal; e-waste and their management

8 Hours

Module V: Management of plastic wastes: Reuse and recycling; Waste management policies; Energy recovery from solid wastes

6 Hours

Module VI: Solid waste management: source reduction - Reuse and Recycling; sanitary landfill - advantages and disadvantages of sanitary landfill. Methods of landfill - Incineration - types of incinerators - reactions involved - advantages and disadvantages of incineration.

8 Hours

References

1. Agarwal,S.K. 2005. Green Management, APH Publishing corporation, New Delhi.
2. Agarwal,S.K. 2005. Wealth from waste, APH Publishing corporation, New Delhi
3. Bhatia,S.C. 2007. Solid and Hazardous Waste Management. Atlantic Publishers and Distributors, New Delhi
4. Bide,A.D. and R.R.Sundaresan. 2001. Solid Waste Management: Collection, processing and disposal. INSDOC, New Delhi
5. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.2. Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection", Processing and Disposal, 2001
6. George Techobanoglous et al.1993. Integrated Solid Waste Management, McGraw-Hill, 1993

7. Khan,M.K. 2004. Hospital waste Management: Principles and guidelines, Kanishka Publishers, New Delhi
8. Liu,D.H.F. and R.G.Liptak. 2000. Hazardous waste and solid waste. Lewis
9. Metcalf and Eddy. 1991. Waste Water Engineering – Treatment, Disposal and Reuse. McGraw Hill International Edition, New York.
10. Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996

On-line Sources

1. https://www.epa.gov/hw/hazardous-waste-recycling
2. https://www.journals.elsevier.com/waste-management
3. https://www.wm.com/us

SEMESTER - VI

CORE COURSE IX

EE1641 PAPER (1) ENVIRONMENTAL POLLUTION AND CONTROL MEASURES - I

Total Hours: 54

Aim:

To introduce students to the pollution issues related to air

Objectives:

- To understand the structure of atmosphere
- To understand the various sources of air pollution and to understand the need of control of air pollution
- To introduce students to hazardous wastes and the problems associated with it
- To give students a basic knowledge regarding the air quality standards.

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Explain the structure of atmosphere with the features of each layer	Un, Re
2.	CO 2	Describe the quality parameters of air and	Un, Re

		air pollution with the various units for its measurements	
3.	CO 3	Explain the sources and effects of air pollution	Re, Un
4.	CO 4	Articulate the control techniques of various kinds of air pollution	Re, Un
5.	CO 5	Explain Hazardous waste and its management strategies	Re, Un

Course Content:

Module I: Atmosphere: Structure of atmosphere - troposphere, stratosphere, mesosphere and thermosphere – the features of these layers; the natural composition of air; air quality standards

6 Hours

Module II: Air pollution: Definition, units for quantification of air pollution - Micrograms per cubic meter (µg/mm^3), parts per million (ppm), parts per billion (ppb), newly introduced units of air pollution - olf and decipol; classification of air pollutants – according to origin, according to states of matter and sources - primary and secondary pollutants, photochemical smog; gaseous and particulate pollutants; according to sources – natural and manmade, case study of air pollution – Bhopal tragedy

10 Hours

Module III: Sources of Air pollution – automobile exhausts: emission standards of automobiles in India - CO_x, NO_x and SO_x; Specific emission standards such as Bharat stages – definition, BS I, BS II and BS III; air pollution from factories: hydrocarbons, polychlorinated hydrocarbons; Indoor air pollutants – definition and sources

10 Hours

Module IV: Effects of Air pollutants: Effect of particulate pollution and different gaseous pollutant on plants, human beings and materials

6 Hours

Module V: Control of Air pollution: control of pollution from factories - different methods of emission control - using impingers, electrostatic precipitators, bag houses and wet scrubbers; control of gaseous pollutants control of pollution from automobiles

12 Hours

Module VI: Hazardous wastes: definition and classification; sources and generation of hazardous wastes; health effects and environmental impacts of hazardous wastes; management of hazardous wastes - overview of: the

hazardous Wastes - Management, Handling and Trans-boundary Movement Rules, 2008 and amendment in 2009

10 Hours

References

1. Handbook Airborne Particulate Matter Pollution Prevention and Control, World Bank Group https://www.ifc.org/
2. Gopal Dutt N.H. (2016). Environmental Pollution and control (I edn) Neelkamal Publication. P 302.
3. Vincent King (2017). Air Pollution: Causes, Impacts and Control, Larsen and Keller Education, p. 240
4. Prabhakar V.K. (2004) Pollution Monitoring and Control Hardcover, Anmol Publisher p. 280
5. Cliff VanGuilder (2011). Hazardous Waste Management: An Introduction. Mercury Learning & Information; Har/Cdr edition, p. 300
6. E-Waste Rules http://cpcb.nic.in/e-waste-rules/

SEMESTER VI

CORE COURSE X

EE1642 PAPER (2) ENVIRONMENTAL POLLUTION AND CONTROL MEASURES II

Total Hours: 36

Aim:

The course aims to give the students an insight on the major environmental pollution problems and to acquire knowledge on the sources of different types of pollution and its impacts.

Objectives:

- To understand the main causes of aquatic and noise pollution, their harmful effects.
- To equip the students with the methods of control of different types of pollution.

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level

1.	CO 1	Articulate the water quality for aquatic life and the classification of industrial wastes	Un, Re
2.	CO 2	Explain the sources of soil pollution and details of pesticide pollution. Also how to control soil pollution	Un, Re
3.	CO 3	Describe the sources of noise and effect of noise pollution on human health	Re, Un
4.	CO 4	Explain on the details of types of radiations, sources of radioactive pollution, radioactive wastes and effects of radiation pollution	Re, Un
5.	CO 5	Describe thermal pollution and effects on aquatic organisms	Re, Un

Course Content:

Module I: Introduction on water pollution: Physical and chemical parameters of water pollution - standards of aquatic life. Classification of industrial wastes and its characteristics

6 Hours

Module II: Sources of Land and soil pollution: Disposal of different types of wastes on land; pesticides pollution- control of soil pollution.

6 Hours

Module III: Noise pollution: definition; measurement - decibels; effect of noise pollution on people; traffic noise pollution; industrial noise pollution. Railway noise; aircraft noise; reduction of noise; absorption of sound; Control of noise pollution

6 Hours

Module IV: Radioactive pollution: Sources of radiation; nuclear reactions; natural sources of radioactive pollution; anthropogenic sources of radiation. Radioactive waste; biological effects of radiation pollution; dangers from nuclear plants

6 Hours

Module V: Control of radiation pollution: methods of control; minimizing X-ray hazard - Hazards of Radioactive pollution - Preventive measures from radiation.

6 Hours

Module VI: Thermal Pollution: sources, effects on aquatic organisms, methods to control thermal pollution

6 Hours

References

1. A Text book on Environmental Pollution and Control. Dr .H S. Bhatia. Galgotia Publications Pvt. Ltd., Delhi.
2. Industrial Pollution. V.P.Kudesia-PragatiPrakashan, Meerut.
3. Air Pollution. V.P.Kudesia, PragathiPrakasan Meerut.
4. Water Pollution. Sharma, B.K., Goel Publishing House, Meerut.
5. Manahan S.E., Environmental Chemistry, Lewis, 1994.

SEMESTER VI

CORE COURSE PRACTICAL

EE1643 ENVIRONEMTAL SCIENCE LAB- VI

Total Hours: 72

Instrumentation (demonstration only)

1. pH meter
2. Conductivity meter
3. Turbidity meter
4. Colorimeter
5. Spectrophotometer

Experiments

1. Determination of COD
2. Analysis of anion mixture solution (2Anions) among the following – Carbonate, sulphide, Thiosulphate, Oxalate, Chloride, Nitrate, Flouride, Sulphate, Phosphate
3. Thin layer Chromatographic separation of plant pigments

SEMESTER VI

VOCATIONAL COURSE VIII

EE1671 PAPER (1) WATER ANALYSIS

Total hours: 54

Aim:

The course aims to impart basics and practical knowledge of water analysis.

Objectives:

- To enable the students to identify, describe, and compare core themes, principles and gain hands on practical experience of the subject.
- To make the students able to analyse different water samples at the end of the course.

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Define Water Analysis	Re
2.	CO 2	List out the major Water Quality Parameters	Re
3.	CO 3	Explain Protocols for Water Quality testing	Un
4.	CO 4	Differentiate Methods of Analysis for each parameter tested	An
5.	CO 5	Compare different methods of Water Quality Analysis	Ev

Course Content:

Module I: Various methods of analysis: Monitoring techniques and methodology ; Determination of pH – Specific Conductance-Dissolved Oxygen, NH_3, NO_3, NO_2, Cl^-, F^-, CN^-, S^{2-}, SO_4^{2-}, PO_4^{3-}; Method to determine the pH of given sample of water by colorimetric and electrometric method; Total hardness (Ca& Mg), B, silica, metals and metalloids As, Se, Be, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ag, Zn

9 Hours

Module II: Analysis of water: Method to determine the amount of dissolved oxygen (DO) of a water sample by Winkler Method. Chemical Oxygen Demand, Biological Oxygen Demand, Total Organic carbon, phenols, pesticides, surfactants, tannin and lignin

9 Hours

Module III: Analysis of Physical qualities of water sample: Determination of Turbidity of water sample - By Jacksons Turbidimeter, Baylis Turbidimeter and Nephelometer. Method to find the odour of given water sample; Method to find the colour of given water sample; Method to find out the Suspended solids (SS), Dissolved solids (DS) and Total Solids (TS) of a water sample

9 Hours

Module IV: Analysis of cations of water sample: Method to find the carbonate, bicarbonate and hydroxide alkalinity of a water sample. Method to determine the total hardness of a water sample by standard EDTA method

9 Hours

Module V: Method to determine the concentration of chlorides of given water sample; Method to determine the chlorine demand of a water sample; Method to determine the available chlorine percentage in a given sample of bleaching powder; Determination of residual chlorine in a given sample of water by (a) Orthotoludine Test (b) Starch Iodide Test (c) DPD Test

9 Hours

Module VI: Microbial examination of water samples: Coliforms (*Escherichia coli*) and total bacteria

9 Hours

References

1. Water supply Engineering B.C.Punmia, Asok Jain & Arun Jain. Lakshmi Publications, New Delhi.
2. Water and Waste Water Technology, Mark.J.Hammer. J Hammer, Printice Hall India Pvt. Ltd.
3. Waste Water Treatment for Pollution Control and Reuse, Tata Mac Graw Hill publishing company.
4. Water Technology, N.F Gray Butter Worth, Heimann Oxford.
5. Chemical and Biological Methods of water pollution studies. R.K. Trivedi & R. K. Goel Environmental publication, Karad 1984.
6. Standard Methods for Examination of Water and Waste Water. APHA-Washington DC1985.
7. Ecological Methods for field and Laboratory Investigation, P.Michael. Tata Macgraw Hill publishing Company. New Delhi.

SEMESTER VI

VOCATIONAL COURSE IX

EE1672 PAPER (2) WATERSHED MANAGEMENT

Total Hours: 54

Aim:

The aim of the course is to introduce the students to the concept of Watershed Management by generating a basic understanding of its principles, components and socio-economic aspects. It also enables a student to analyse and appreciate the significance of WM in the conservation of land , water and soil resources.

Objectives:

- To introduce students to the basc concepts of watershed and its management
- To establish a strong understanding of the resource components in a watershed and their significance
- To make them understand the inter relationship between the components and their impact on human socio-economy
- To introduce the technology of integrated and sustainable methods of watershed management aimed at ecosystem restoration.
- To familiarize students with the introductory concepts of watershed modelling
- To make students understand the need for a holistic approach in WM and generate a general awareness on the watershed management policies in India.

Course Outcomes:

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

S No.	Course Outcome No.	Course Outcome	Taxonomic Level
1.	CO 1	Define and Deduce the concepts and components of watershed & its management	Re
2.	CO 2	Understand the significance of land, water and soil as watershed resources	Un
3.	CO 3	Rationalize the socio-economic aspects of watershed management	Un
4.	CO 4	Comprehend the integrated and sustainable technologies for WM	Un
5.	CO 5	Outline the modelling aspects and the policies associated therein	An

Course Content:

Module I: Basic concepts of watershed management (WM): Watershed – definition - classification of watershed - sub, milli, micro and mini watershed. Basic watershed hydrology, delineation of watershed boundary.

9 Hours

Module II: Water as a resource in WM: - Watershed management for flood control, Water harvesting cum sediment detention tanks, earthen bunds, subsurface dams, Geo textiles in watershed management.

9 Hours

Module III: Land as a resource in WM: Land preparation-timely planting. Contour farming-multistoried cropping-mixed cropping-Intercropping- strip cropping; mulching-cover cropping- crop rotation, Land use changes and resource degradation in watersheds

9 Hours

Module IV: Soil as a resource in WM: Soil conservation, Vegetative hedges - barrier grass land management - agroforestery. Engineering measures - tank -vented cross bars and diversion weirs; stone pitched Contour bunds, contour trenches and embankments of drains.

9 Hours

Module V: Socio-economic aspects of WM: Agronomic measures for resource management in a watershed - choice of vegetation, Resource degradation in a watershed and its socio-economic mpact, WM and public health. Watershed Modelling**-**Introduction and concepts, An overview of watershed management policies in India

9 Hours

Module VI: Integrated and Sustainable Approaches in WM: Definition and principles Integrated water resources management, national water grid and river networking; Integrated attempts for watershed management in India. Ecosystem Restoration - Definition and guiding principles, Watershed ecology, Eco system in a watershed.

9 Hours

References

1. Allam, Gamal Ibrahim Y., Decision Support System for Integrated Watershed Management,Colorado State University, 1994.
2. American Socy. of Civil Engr., Watershed Management, American Soc. of Civil Engineers, New York, 1975.
3. Black Peter E., Watershed Hydrology, Prentice Hall, London, 1991.
4. Michael A.M., Irrigation Engineering, Vikas Publishing House, 1992.
5. Murty, J.V.S. “Watershed Management”, New Age Intl., New Delhi 1998.
6. Murthy, J.V.S., Watershed Management in India, Wiley Eastern, New Delhi, 1994 .
7. Purandare, A.P., Jaiswal A.K., Waterhed Development in India, NIRD, Hyderabad, 1995.
8. Vir Singh, Raj , Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.

SEMESTER VI

VOCATIONAL PRACTICAL

EE1673 WATER MANAGEMENT LAB - VI

Total hours: 72

1. Volumetric Estimations
    a) Carbonate hardness-Hehner’s method
    b) Non- Carbonate hardness- Hehner’s method
    c) Mixture of Carbonate-Bi carbonate-warders method (N/20 HCL & std. sodium carbonate (2600 ppm)
    d) Sulphate ion in H2 SO4 (N/20 NaOH & std sodium carbonate (2600 ppm)
    e) Iodine in the solution (N/50 thiosulphate & std pot. dichromate (1000 ppm)
    f) Estimation of Ferrous iron (N/50 potassium permanganate and standard oxalic acid 1200ppm)
    g) Estimation of ferrous iron (N/50 potassium dichromate & standard Mohrs salt)
    h) Iodometric estimation of copper (demonstration only)
    i) Complexometric estimation of Zn (demonstration only)
2. Colorimetric estimations of
    i) Nitrite
    ii) Nitrate
    iii) Phosphate
    iv) total nitrogen
    v) total phosphorous
    vi) ferrous iron and total iron

SEMESTER VI

ELECTIVE COURSE

EE1661.1 RAIN WATER HARVESTING

Total Hours: 36

Aim:

To give a detailed knowledge on Rainwater harvesting systems and water recharge methods for sustainable development.

Objectives:

- To understand the basic principles and structure of rainwater harvesting systems.
- The course explains the direct and indirect methods for artificial recharge, importance of watershed management and legal provisions in rain water harvesting.

Course Outcomes:

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

Sl.No.	Course Outcome No.	Course outcome (CO)	Taxonomic Level (TL)
1.	CO 1	Understand the principles of water harvesting and familiarize traditional water harvesting systems	Re
2.	CO 2	Know the importance and significance of Rainwater harvesting	Re
3.	CO 3	Develop an ability for problem solving skills to solve water scarcity issues	Un
4.	CO 4	Understand the legal aspects of rain water harvesting systems	Re
5.	CO 5	Apply the methods of water harvesting and conservation for sustainable development	Re

Course Content:

Module I: Principles of water harvesting and conservation: Traditional water harvesting systems in India and Kerala.

4 Hours

Module II: Introduction to Rainwater harvesting: Definition, purpose, importance and advantages. Rainwater harvesting process, collection and storage; Basic components in Rainwater harvesting - catchments, coarse

mesh, gutters, conduits, first flushing, filters and storage tank; Hydrological aspects of Rainwater harvesting.

7 Hours

Module III: Rainwater harvesting methodologies: surface runoff harvesting and roof top rain water harvesting. Concept of roof top rain water harvesting; Methods of Rooftop Rainwater Harvesting- Storage of Direct Use and Recharging groundwater aquifers-by Recharging of bore wells, Recharging of dug wells, Recharge pits, Recharge Trenches, Recharge Shafts, Percolation Tanks.

7 Hours

Module IV: Artificial recharge methods: Direct methods - Ditch and Furrows method, Bench Terracing, Contour Bunds, Contour Trenches, Gully Plugs, Nalah Bunds and Check Dams, Percolation Tanks Injection Wells or Recharge Wells, Recharge Pits and Shaft; Indirect method-induced recharge.

7 Hours

Module V: RWH methodologies: methods for rural, urban and industrial environment; Rain water harvesting for sustainable development, concept of zero run off; Applications of Rainwater harvesting with case studies, water quality of harvested rain water; The importance of watershed management in Kerala.

6 Hours

Module VI: Legal provisions in rain water harvesting in India and Kerala. Kerala Municipality Building Rules, 1999, Kerala Municipality Building (Amendment) Rules, 2004

5 Hours

References

1. Basu, M. and Xavier, S.(2016). Fundamental of environmental studies, Cambridge University Press, New Delhi
2. CGWB (2007). Manual on Artificial Recharge of Ground water. http://cgwb.gov.in/Documents/Manual-Artificial-Recharge.pdf.
3. Chatterjee, S.N. (2008). Water Resources, Conservation and Management. Atlantic Publishers, Edition edition.
4. Er. Kollegal and Meghashyam, K. (2014.). Rain Water Harvesting : A New Concept to Utilize Rainwater and Secure the Future. Published by J.M. Jaina & Brothers; 1St Edition edition.
5. Kumar, S.V. (2013). Rainwater Harvesting. LAP Lambert Academic Publishing.

6. Rooftop rain water harvesting arrangements in Kerala - Municipality Building (Amendment) Rules (2004)
7. Singh, D.K. (2012). Rain Water Harvesting. Oxford Book Company.

SEMESTER V& VI
EE 1644 PROJECT& FACTORY VISIT
AN INVESTIGATORY PROJECT REPORT

Total hour: 72

This work may be based on Environmental Science (significance for Environment) or, project based on Water quality parameters (Local, Regional, state level, or National level important issues can be the topic of interest) –To be carried out in 3rd year (Semester 5&6)