Pondicherry University

Curriculum and Syllabus

BACHELOR OF TECHNOLOGY

B.Tech.

Environmental Engineering

2025-26

[UNIVERSITY DEPARTMENT]

REGULATIONS 2025-26

1. CONDITIONS FOR ADMISSION

a) Candidates for admission to the first semester of the 8 semester B.Tech. degree programme should be required to have passed:

The Higher Secondary Examination of the (10+2) curriculum (Academic Stream) prescribed by the different State Boards / Central Boards or any other examination equivalent there to with minimum of 45% marks (mere pass for OBC and SC/ST candidates) in aggregate of subjects – Mathematics, Chemistry and any one of the following optional subjects: Physics / Biotechnology / Computer Science / IT and equivalent / Biology (Botany & Zoology) or an Examination of any University or Authority recognized by the Executive Council of the Pondicherry University as equivalent thereto.

b) Candidates for admission through Lateral entry into second year (third semester) of the B.Tech. degree programme should be required to have passed:

Passed Minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in Civil / Chemical Engineering / Technology.

OR

Passed B.Sc. Degree from a recognized University as defined by UGC, with at least 45% marks (40% marks in case of candidates belonging to reserved category) and passed 10+2 examination with Mathematics as a subject.

OR

Passed D.Voc. Stream in the same or allied sector.

(The Universities/colleges will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)

2. AGE LIMIT

As per applicable AICTE norms.

3. DURATION OF PROGRAMME

The Bachelor of Technology degree programme shall extend over a period of 8 semesters spread over 4 academic years – two semesters constituting one academic year. The duration of each semester shall normally be 15 weeks excluding examinations.

4. PROGRAM STRUCTURE

The medium of instruction is English.

A student admitted to the B.Tech. programme in Environmental Engineering (EE) will earn the degree in that branch by fulfilling all the requirements prescribed in the regulations during the course of study.

The student is also permitted to opt for earning an **Honors degree in Environmental Engineering or a Minor degree** in another discipline of Engineering. The student will be allowed to exercise this option at the end of first year based on his /her academic performance in the first year. The students admitted through lateral entry can exercise this option at the end of third semester, based on the GPA scored in the third semester examination.

The student opting for B.Tech. degree with **Honors or B.Tech. degree with Minor** is required to earn additional 20 credits starting from the third semester. The students admitted in the second year through lateral entry and opting for Honors / Minor degree will earn the additional 20 credits starting from the fourth semester.

5. ELIGIBILITY FOR THE AWARD OF B.TECH. DEGREE IN ENVIRONMENTAL ENGINEERING

No candidate shall be eligible for the award of the degree of Bachelor of Technology, unless he/she has undergone the course for a period of 8 semesters (4 academic years) / 6 semesters (3 academic years for Lateral Entry candidates) in the Faculty of Engineering and has passed the prescribed examinations in all the semesters.

6. COURSE STRUCTURE AND SUBJECTS OF STUDY

Definition of Credit:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

Range of Credits: The total credits of all the branches for the four-year B. Tech. degree Programme shall be in the range of 160 to 172 (Minor variation is allowed as per AICTE guidelines). "Minor Degree or Honors will cumulatively require additional 20 credits in the specified area in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline".

The subjects of study shall include theory, practical courses and project work/internships as given in the curriculum and shall be in accordance with the prescribed syllabus.

The curriculum will have courses that are categorized as follows:

i. Humanities, Social Sciences and Management Courses (HSMC)
ii. Basic Science Courses (BSC)
iii. Engineering Science Courses (ESC)
iv. Professional Core Courses (PCC)
v. Professional Elective Courses (PEC)
vi. Open Elective Courses (OEC)
vii. Professional Activity Courses (PAC)
viii. Mandatory non-Credit Courses (MCC)

Each course will have either one or more of three components namely Lecture (L), Tutorial (T) and Practice (P). Each course is assigned credits as detailed below:

(i) Theory courses will carry either 3 or 4 credits - 3 credits for courses with 3 lecture periods per week and 4 credits for courses with 3 lecture periods and 1 tutorial period per week / 4 lecture periods per week.

(ii) All Elective courses including online courses will carry maximum 3 credits. The student can earn the credits towards the Open Elective Courses (OEC), if required, by completing the online courses offered in NPTEL anytime between third and seventh semester on prior approval of the courses by the Academic Courses Committee of the Institute. Credits earned through the NPTEL courses will be confined to 2 or 3 credits and subject to a maximum of 9 credits during the entire programme of study. Students can also earn credits for the open Elective Courses upon completing the open Elective Courses offered by other Departments in their curriculum and regulations.

(iii) Practical courses will normally carry 2 credits with 4 practice periods per week.

(iv) Out of total credits required for successful completion of the degree, 14 to 22 credits can be assigned for Project work and/or Internship.

(v) Mandatory non-credit courses carry zero credit.

7. EXAMINATIONS

The theory and practical examinations shall comprise continuous internal assessment throughout the semester in all subjects as well as university examinations conducted by Pondicherry University at the end of the semester (November / December or April /May).

Evaluation Scheme

All Credit courses are evaluated for 100 marks comprising of Internal assessment and end- semester exam.

For Theory Course, the weightage of internal assessment is 40% and end semester examination is 60%

For Practical course, the weightage of internal assessment is 60% and end semester examination is 40%

For Project, the weightage of internal assessment is 60% and end semester examination is 40%

7.1 Internal Assessment (Theory)

Total Internal Assessment mark for a theory course is 40 marks. The breakup is as follows:

Criteria	Maximum Marks
a) Internal Assessment Tests	30
b) Assignment(s)	10
Total	**40**

Course teacher of Lab courses shall evaluate the practical course for 60 marks. The break up is as follows:

Criteria	Maximum Marks
a) Laboratory exercises and Record	30
c) Mid Semester exam (Average of 2 exams)	20
c) Internal Viva voce	10
Total	**60**

The Project work carried out in the eighth semester shall be assessed as follows:

Criteria	Marks
a) Continuous assessment (Guide)	25
b) Project Evaluation Committee	35
Total	**60**

7.2 Requirement for appearing for University Examination

The End- Semester exams for all theory and practical courses based on the University academic calendar shall be scheduled by the Department and the Time Table shall be circulated to all students at least 15 days before the start of exams.

A candidate shall be permitted to appear for university examinations at the end of any semester only if : he / she secures not less than 70% attendance in each subject arrived at by taking into account the total number of periods in each subjects.

7.3 End Semester Exam Evaluation Pattern

Course	Maximum marks
a) Theory course (Sec A, Sec B and Sec C) Questions from all units of syllabus	60 marks
b) Practical course (Based on Lab exercises/Record/Practicals/Viva)	40 marks
c) Internship /Project Work (Based on Seminar/Project Work/Project report/ Presentation and viva voce)	40 marks

7.4 Consolidation of Marks and Passing Minimum

A student shall be declared to have passed the examination in a subject of study only if he/she secures not less than **40% marks individually both in internal assessment and end- semester examination or an aggregate of 40%.**

The total marks secured by the student in each course shall be converted to letter grade as per the Pondicherry University norms and regulations.

A candidate who has been declared "Fail" in a particular subject may reappear for that subject during the subsequent semesters and secure pass marks with eligible requisites.

7.5 Arrear Exams

A student who failed to secure 40% marks in aggregate is declared as "Fail" and he is eligible to take up a supplementary examination by registering to the said course in the following semester. All other candidates who failed due to shortage of attendance and those seeking to improve the grade shall repeat the course.

8 PROCEDURE FOR COMPLETING THE B.TECH. COURSE

A candidate can join/rejoin the course of study of any semester only at the time of its normal commencement and only if he/she has satisfied the course requirements for the previous semester and further has registered for the university examinations of the previous semester in all the subjects as well as all arrear subjects if any.

However, the entire B.Tech. course should be completed within 7 years (14 semesters) and six years (12 semesters) for students admitted under lateral entry.

8.1 Award of Class and Rank in B.Tech. degree

i) A candidate who satisfies the course requirements for all semesters and who passes all the examinations prescribed for all the eight semesters (six semesters for lateral entry candidates) within a maximum period of 7 years (6 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Tech. degree.

ii) A candidate who qualifies for the award of the B.Tech. degree passing in all subjects pertaining to the semesters 3 to 8 in his/her first appearance within 6 consecutive semesters (3 academic years) and in addition secures a CGPA of 9.00 and above for the semesters 3 to 8 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

6.5 A candidate who qualifies for the award of the B.Tech. degree by passing in all subjects relating to semesters 3 to 8 within a maximum period of eight semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than shall declared to have passed the examination in **FIRST CLASS**.

iii) All other candidates who qualify for the award of B.Tech. degree shall be declared to have passed the examination in **SECOND CLASS**.

9. PROVISIONS FOR HONORS/MINOR DEGREE ALONG WITH B.TECH. DEGREE

9.1 B.Tech. with Honors Degree in the same Engineering discipline

a. The student shall be given an option to earn a Honors degree in the same discipline of engineering at the end of first year based on his academic performance in the first year.

b. A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c. Honors degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d. The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of Honors degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The syllabus of these 5 courses are framed so as to cover advanced topics in that discipline of engineering.

e. The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Honors degree. Eligibility to avail this option is CGPA of 7.5 and above with no arrears in the third Semester. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering the prescribed courses offered up to the seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f. A student is eligible to get the Honors degree only on completing the programme in 'First Class with Distinction' class.

g. A student can exercise the option to withdraw from the Honors degree at any time after entry.

h. Details about the courses completed and credits earned for Honors degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Honors degree'. In the case of students who have either withdrawn from Honors degree or become ineligible for Honors degree by not securing 'First Class with Distinction', the credits

earned for the courses registered and successfully completed for Honors degree will be listed under the heading 'Additional Credits Earned'.

i. The CGPA will be calculated for all the courses credited by the students inclusive of major and honors courses.

j. Nomenclature of Honors Degree is B.Tech.(Honors) in Environmental Engineering.

The 5 advanced courses to be undertaken are as follows:

1. Advanced Wastewater Treatment Technologies (4 credits)
2. Emerging Contaminants and Risk Assessment (4 credits)
3. Advanced Air Pollution Control (4 credits)
4. Sustainable Development Goals and Environmental Planning (4 credits)
5. Project (4 credits)

In addition, one Research paper publication in SCI / SCIE journals

9.2 B.Tech. with Minor degree in another Engineering discipline

a. The student shall be given an option to earn a minor degree in another discipline of engineering of his choice at the end of first year based on his academic performance in the first year. **The Minor degree course is Environmental Pollution Control.**

b. A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c. Minor degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d. The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of minor degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The curricular content of these 5 courses are framed in such a way that that these courses will essentially cover the core minimum knowledge required to be fulfilled for award of degree in the discipline of engineering in which the student chooses to earn the minor degree.

e. The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Minor degree. Students with a CGPA of 7.5 and with no arrears in the third semester are eligible to avail this option. The student will join the existing batch of students in the fourth semester and earn 16 credits by

registering for prescribed courses offered up to seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f. A student can exercise the option to withdraw from the Minor degree at any time after entry.

g. Details about the courses completed and credits earned for Minor degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Minor degree'. In the case of students who have withdrawn from Minor degree, the credits earned for the courses registered and successfully completed for Minor degree will be listed under the heading 'Additional Credits Earned'.

h. **Nomenclature of Minor Degree is 'B.Tech. in Environmental Engineering' with Minor in 'Environmental Pollution Control'**. The five additional courses that need to be earned are as follows:

   1) Water Pollution and its Control (4 Credits)
   2) Air Pollution and its Control (4 Credits)
   3) Solid Waste Management (4 Credits)
   4) Soil Pollution and its Control (4 Credits)
   5) Environmental Impact Assessment (4 Credits)

i. The CGPA will be calculated for all the courses credited by the students inclusive of major and minor courses.

10. PROVISION FOR WITHDRAWAL

Based on the recommendation of the Head of the Institution, a candidate with valid reasons may be granted permission by the University to withdraw from writing the entire semester examination as one Unit. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire course. A candidate who has withdrawn is also eligible to be awarded DISTINCTION provided he/she satisfies the other necessary conditions. But, they are not eligible to be awarded a rank.

11. PROVISIONS FOR EXIT IN B.TECH. COURSE

(For courses where AICTE specifies exit in the model curriculum)

The curriculum and the syllabus for all B.Tech programmes have been planned in compliance with the NEP guidelines proposed by AICTE. Accordingly, students joining B.Tech programmes shall have all benefits NEP offers in terms of exercising exit option during the course of study. Every B.Tech programme governed under this school board shall adopt the NEP guidelines, as and when proposed/amended by AICTE, and the following scheme will be applied for all such B.Tech programmes specified by AICTE.

NEP 2020 suggests that a student can exercise exits at multiple stages of the course of study. As per AICTE norms, a student can have two possible exits before the completion of the Full Engineering degree and may get a UG Diploma /Certificate or B.Sc. degree in the relevant discipline if he/she fulfils the following conditions: (Subject to change as per AICTE guidelines)

11.1 UG Diploma/Certificate in the relevant branch of study

A student should be able to get a UG Diploma if he/she completes:

a. 50% of the credits for B.Tech. (80-85 credits)

b. 50% of the program core courses

c. Students exiting the program after earning 50% credit requirements will be awarded a UG Diploma provided they secure an additional 6 credits through summer internships/apprenticeship of 2 months duration.

d. Students admitted through lateral entry cannot exercise the exit option as he will not be able to meet out the 50% Credits for B.Tech. degree.

11.2. B.Sc. in the relevant branch of study

A student should be able to get a B.Sc. degree if he/she completes:

(i) 75% of the credits for B.Tech. (minimum 120 credits) and atleast 3 years in the program.

(ii) 100% of the core program courses.

(iii) Students exiting the program after earning 75% credit requirements

will be awarded a B.Sc. provided, they secure an additional 6 credits through 2 summer internships/apprenticeship for 2 months each.

(iv) With B.Sc. degree, the student is eligible for entry into programs which take B.Sc. degree as eligibility criteria.

11.3 Award of Class in B.Sc. degree

A candidate who satisfies the course requirements for all semesters and who passes all the examinations within a maximum period of 6 years (5 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Sc. degree in the relevant discipline.

1. A candidate who qualifies for the award of the B.Sc. degree passing in all subjects pertaining to semesters the 3 to 6 in his/her first appearance within 4 consecutive semesters (2 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 6 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.
2. A candidate who qualifies for the award of the B.Sc. degree by passing in all subjects relating to semesters 3 to 6 within a maximum period of six semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS.**
3. All other candidates who qualify for the award of B.Sc. degree shall be declared to have passed the examination in **SECOND CLASS**.

11.4 Re-entry to complete the program

A student exiting with B.Sc. should be entitled to re-enroll in the programme of the same Engineering discipline. Only students admitted to the B.Tech. programme and exercised an exit option are eligible for readmission to the B.Tech. programme under the same discipline. It is suggested that all credits will be transferred, if the student enrols back within a limited period (3 years) of exiting. In case a student enrols after that, then the decision on the transfer of credits should be based on the changes in the curriculum the

student studied. A candidate after exit may rejoin the course only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees to the University. The total period of completion of the B.Tech. course reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 7 years, including of the period of discontinuance.

11.5 Completion Possibility in other Institutions

A student can earn B.Sc. in one institution (Engineering) and complete the degree program in another institution (same Engineering discipline only).

12. REVISION OF REGULATIONS AND CURRICULUM

The University may from time-to-time revise, amend or change the regulations of curriculum and syllabus as and when found necessary.

GENERAL COURSE STRUCTURE & THEME

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

B. Range of Credits: The total number of credits proposed for the four-year B. Tech in Environmental Engineering is 168.

C. Structure of UG Program in Environmental Engineering (EE): The structure of UG programming Environmental Engineering (EE) shall have essentially the following categories of courses with the breakup of credits as given:

S. No	Category	Credit Breakup for EE students
1	Humanities and Social Sciences including Management courses	**7**
2	Basic Science courses	**25**
3	Engineering Science courses including Workshop, Drawing, Basics of Electronics/Electrical/Mechanical/Computer etc.	**15**
4	Professional Core courses	**71**
5	Professional Elective courses relevant to chosen Specialization/ Branch	**24**
6	Open Electives from other Technical and /or Emerging subjects	**9**
7	Project work, Seminar and Internship in Industry or elsewhere	**17**
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)
	Total	**168***

D. Course code and Definition:

Course code	Definitions
L, T, P, C	Lecture, Tutorial, Practical, Credits
EEBS	Basic Science Courses
EEES	Engineering Science Courses
EEHS	Humanities and Social Sciences including Management Courses
EEPC	Professional Core Courses
EEHL	Humanities and Social Sciences Lab Courses
EEBL	Basic Science Lab Courses
EEEL	Engineering Science Lab Courses
EEPL	Professional Core Lab Courses
EEPE	Professional Elective Courses
EEOE	Open Elective Courses
EEPROJ	Mini Project / Capstone Project/Seminar/Internship
EEMC	Mandatory Courses
EEAU	Audit Courses

Course level coding scheme: Three-digit number (odd numbers are for the odd semester courses and even numbers are for even semester courses) used as suffix with the Course Code for identifying the level of the course. Digit at hundred's place signifies the year in which course is offered. e.g.101, 102 … etc. for first year. 201, 202 …. etc. for second year. 301, 302 … etc. for third year.

Category-wise Courses

HUMANITIES & SOCIAL SCIENCES COURSES [EEHS]

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	EEHS105	Design Thinking	I	0	0	2	1
2.	EEHS107	English for Technical Writing	I	3	0	0	3
3.	EEHS204	Universal Human Values - II	II	2	1	0	3
Total Credits							**7**

BASIC SCIENCE COURSES [EEBS]

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	EEBS101	Chemistry	I	3	0	0	3
2.	EEBL101	Chemistry Laboratory	I	0	0	4	2
3.	EEBS102	Mathematics-I	I	3	1	0	4
4.	EEBS104	Biology for Engineers	I	3	0	0	3
5.	EEBS201	Physics	II	3	0	0	3
6.	EEBL201	Physics Laboratory	II	0	0	4	2
7.	EEBS202	Mathematics-II	II	3	1	0	4
8.	EEBS305	Mathematics- III	III	3	1	0	4
Total Credits							**25**

ENGINEERING SCIENCE COURSES [EEES]

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	EEEL103	Engineering Graphics & Design Laboratory	I	1	0	4	3
2.	EEES203	Programming for Problem Solving	II	3	0	0	3
3.	EEEL203	Programming for Problem Solving	II	0	0	4	2

		Laboratory					
4.	EEEL206	Workshop / Manufacturing Laboratory	II	1	0	4	2
5.	EEES301	Fluid Mechanics	III	3	0	0	3
6.	EEEL301	Fluid Mechanics Laboratory	III	0	0	4	2
Total Credits							**15**

PROFESSIONAL CORE COURSES [EEPC]

S.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	EEPC302	Environmental Health and Safety	III	3	0	0	3
2.	EEPC303	Environmental Geo Technology	III	3	0	0	3
3.	EEPL303	Environmental Geo Technology Laboratory	III	0	0	4	2
4.	EEPC304	Environmental Chemistry	III	3	0	0	3
5.	EEPL304	Environmental Chemistry Laboratory	III	0	0	4	2
6.	EEPC401	Air & Noise Pollution	IV	3	0	0	3
7.	EEPC402	Solid Waste Management	IV	4	0	0	4
8.	EEPL402	Solid Waste Management Laboratory	IV	0	0	4	2
9.	EEPC403	Environmental Microbiology	IV	3	0	0	3
10.	EEPL403	Environmental Microbiology Laboratory	IV	0	0	4	2
11.	EEPC404	Water Supply Engineering	IV	3	1	0	4
12.	EEPC501	Air and Noise Pollution Control	V	3	0	0	3
13.	EEPL501	Air and Noise Pollution Monitoring Laboratory	V	0	0	4	2
14.	EEPC502	Wastewater Engineering	V	3	1	0	4
15.	EEPL502	Water and Wastewater Engineering Laboratory	V	0	0	4	2
16.	EEPC503	Industrial Pollution Prevention	V	3	0	0	3
17.	EEPC504	Surface and Ground Water Quality Modeling	V	4	0	0	4
18.	EEPC601	Instrumentation Methods in Environmental Analysis	VI	3	0	0	3

19.	EEPL601	Instrumentation Methods in Environmental Analysis Laboratory	VI	0	0	4	2
20.	EEPC602	Design of Water and Wastewater Treatment Plants	VI	3	1	0	4
21.	EEPL602	Water and Wastewater Design and Drawing Laboratory	VI	0	0	4	2
22.	EEPC603	Environmental Impact Assessment	VI	3	0	0	3
23.	EEPC701	Sustainable Development	VII	3	0	0	3
24.	EEPL702	Environmental Field Laboratory	VII	0	0	4	2
25.	EEPC703	Environmental Management System and Auditing	VII	3	0	0	3
Total Credits							**71**

PROFESSIONAL ELECTIVE COURSES [EEPE]

S.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	EEPE	Elective 1	IV	3	0	0	3
2.	EEPE	Elective 2	IV	3	0	0	3
3.	EEPE	Elective 3	V	3	0	0	3
4.	EEPE	Elective 4	V	3	0	0	3
5.	EEPE	Elective 5	VI	3	0	0	3
6.	EEPE	Elective 6	VII	3	0	0	3
7.	EEPE	Elective 7	VII	3	0	0	3
8.	EEPE	Elective 8	VII	3	0	0	3
Total Credits							**24**

OPEN ELECTIVE COURSES [EEOE]

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	EEOE	Open Elective 1	VI	3	0	0	3
2.	EEOE	Open Elective 2	VII	3	0	0	3
3.	EEOE	Open Elective 3	VIII	3	0	0	3
Total Credits							**9**

Note: Open Elective Courses are offered to the students of other Departments.

PROJECT WORK, SEMINAR AND INTERNSHIP IN INDUSTRY OR ELSEWHERE

S. No	Course Code	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	EEPR604	Micro / Mini Project	VI	0	0	6	3
2.	EEPR704	Project Phase - I	VII	0	0	6	3
3.	EEPR705	Seminar	VII	0	0	2	1
4.	EEPR801	Project Phase - II	VIII	0	0	16	8
5.	EEPR802	Internship	VIII	0	0	4	2
Total Credits							**17**

COMMUNITY ENGAGEMENT/ MANDATORY COURSES/AUDIT COURSES [EEAU]

S.No.	Course Code	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	EEAU106	IDEA Lab Workshop	I	2	2	4	0
2.	EEAU205	Sports and Yoga	II	2	0	0	0
3.	EEAU306	Environmental Science	III	3	0	0	0
4.	EEAU505	Indian Constitution or essence of Indian Knowledge tradition	V	3	0	0	0
Total Credits							**0**

Semester	HSMC	BSC	ESC	PCC	PEC	IKS	MOPEC	PR / Seminar / INT	MC-AU	Credits Sem wise
I	4	12	3	--	--	--	--	--	0	**19**
II	3	9	7	--	--	--	--	--	0	**19**
III	--	4	5	13	--	--	--	--	0	**22**
IV	--	--	--	18	6	--	--	--	--	**24**
V	--	--	--	18	6	0	--	--	--	**24**
VI	--	--	--	14	3	--	3	3	--	**23**
VII	--	--	--	8	9	--	3	4	--	**24**
VIII	--	--	--	--	--	--	3	10	--	**13**
Total	**7**	**25**	**15**	**71**	**24**	**0**	**9**	**17**	**0**	**168**

INDUCTION PROGRAM

The Essence and Details of Induction program can also be understood from the 'Detailed Guide on Student Induction program', as available on AICTE

Portal,(Link:https://www.aicteindia.org/sites/default/files/Detailed%20Guide%20on%20Student%20Inductio n%20program.pdf).

Induction program (mandatory)	Three-week duration
Induction program for students to be offered right at the start of the first year.	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./ Branch & Innovations

Mandatory Visits /Workshop / Expert Lectures

1. It is mandatory to arrange one industrial visit every semester for the student of each branch
2. It is mandatory to conduct a One-week workshop during the winter break after fifth semester on Professional/Industry/ Entrepreneurial Orientation.
3. It is mandatory to organize at least one expert lecture per semester for each branch/inviting resource persons from domain specific industry.

CURRICULUM

Semester I						
3-Weeks Induction Programme (UHV-I)						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	EEBS101	Chemistry	3	0	0	3
2.	EEBS102	Mathematics-I	3	1	0	4
3.	EEEL103	Engineering Graphics & Design Laboratory	1	0	4	3
4.	EEBS104	Biology for Engineers	3	0	0	3
5.	EEHS105	Design Thinking	0	0	2	1
6.	EEAU106	IDEA Lab Workshop	2	2	4	0
7.	EEHS107	English for Technical Writing	3	0	0	3
8.	EEBL101	Chemistry Laboratory	0	0	4	2
Total						**19**

Semester II						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	EEBS201	Physics	3	0	0	3
2.	EEBS202	Mathematics-II	3	1	0	4
3.	EEES203	Programming for Problem Solving	3	0	0	3
4.	EEHS204	Universal Human Values - II	2	1	0	3
5.	EEAU205	Sports and Yoga	2	0	0	0
6.	EEBL201	Physics Laboratory	0	0	4	2
7.	EEEL203	Programming for Problem Solving Laboratory	0	0	4	2
8.	EEEL206	Workshop / Manufacturing Laboratory	0	0	4	2
Total						**19**

Semester-III						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	EEES301	Fluid Mechanics	3	0	0	3
2.	EEPC302	Environmental Health and Safety	3	0	0	3
3.	EEPC303	Environmental Geo technology	3	0	0	3
4.	EEPC304	Environmental Chemistry	3	0	0	3
5.	EEBS305	Mathematics- III	3	1	0	4
6.	EEAU306	Environmental Science	3	0	0	0
7.	EEEL301	Fluid Mechanics Laboratory	0	0	4	2
8.	EEPL303	Environmental Geo technology Laboratory	0	0	4	2
9.	EEPL304	Environmental Chemistry Laboratory	0	0	4	2
Total						**22**

Semester-IV						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	EEPC401	Air & Noise Pollution	3	0	0	3
2.	EEPC402	Solid Waste Management	4	0	0	4
3.	EEPC403	Environmental Microbiology	3	0	0	3
4.	EEPC404	Water Supply Engineering	3	1	0	4
5.	EEPL402	Solid Waste Management Laboratory	0	0	4	2
6.	EEPL403	Environmental Microbiology Laboratory	0	0	4	2
7.	EEPE	Elective 1	3	0	0	3
8.	EEPE	Elective 2	3	0	0	3
Total						**24**

Semester-V						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	EEPC501	Air and Noise Pollution Control	3	0	0	3
2.	EEPC502	Wastewater Engineering	3	1	0	4
3.	EEPC503	Industrial Pollution Prevention	3	0	0	3
4.	EEPC504	Surface and Ground Water Quality Modeling	4	0	0	4
5.	EEAU505	Indian Constitution or essence of Indian knowledge tradition	3	0	0	0
6.	EEPL501	Air and Noise Pollution Monitoring Laboratory	0	0	4	2
6.	EEPL502	Water and Wastewater Engineering Laboratory	0	0	4	2
7.	EEPE	Elective 3	0	0	4	3
8.	EEPE	Elective 4	3	0	0	3
Total						**24**

Semester-VI						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	EEPC601	Instrumentation Methods in Environmental Analysis	3	0	0	3
2.	EEPC602	Design of Water and Wastewater Treatment Plants	3	1	0	4
3.	EEPC603	Environmental Impact Assessment	3	0	0	3
4.	EEPL601	Instrumentation Methods in Environmental Analysis Laboratory	0	0	4	2
5.	EEPL602	Water and Wastewater Design and Drawing Laboratory	0	0	4	2
6.	EEPE	Elective 5	3	0	0	3
7.	EEPR604	Micro / Mini Project	0	0	6	3
8.	EEOE	Open Elective 1	3	0	0	3
Total						**23**

Semester-VII						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	EEPC701	Sustainable Development	3	0	0	3
2.	EEPL702	Environmental Field Laboratory	0	0	4	2
3.	EEPC703	Environmental Management System and Auditing	3	0	0	3
4.	EEPR704	Project Phase - I	0	0	6	3
5.	EEPR705	Seminar	0	0	2	1
6.	EEPE	Elective 6	3	0	0	3
7.	EEPE	Elective 7	3	0	0	3
8.	EEPE	Elective 8	3	0	0	3
9.	EEOE	Open Elective-2	3	0	0	3
Total						**24**

Semester-VIII						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1.	EEPR801	Project Phase - II	0	0	16	8
2.	EEPR802	Internship	0	0	4	2
3.	EEOE	Open Elective-3	3	0	0	3
Total						**13**

EEES301 FLUID MECHANICS

(Credits: 3; Lectures: 45 contact hours)

Objectives

The objective of this course is to acquire a sound knowledge on fluid properties, fluid statics, kinematics, dynamic characteristics of fluid flow for through pipes and porous medium, flow measurement and fluid machineries.

Unit 1: Fluid Properties and Fluid Statics **9**

Fluid density, compressible and incompressible fluids. Pressure, relationship between pressure and density for ideal gas. Hydrostatic equilibrium in gravitational and centrifugal force fields, Pascal's law. Measurement of fluid pressure, manometers, Archimedes principle and buoyancy. Methods of analysis and description, fluid as a continuum, velocity and stress field. Newtonian and non-Newtonian fluids, Classification of fluid motion.

Unit 2: Fluid Kinematics and Dynamics **9**

Classification of fluid flows, continuum hypothesis, system and control volume approach, streamline, streak-line and path-lines. Application of continuity, energy and momentum, Euler's equation of motion along a stream line, Bernoulli's equation, Linear momentum equation.

Unit 3: Flow Through Pipes and Model Studies **9**

Reynolds experiment, laminar flow through circular pipe, Darcy-Weisbach equation, Moody diagram. Major and minor losses in pipe flow. Total energy line, hydraulic grade line. Siphon, pipes in series and parallel, equivalent pipes. Fundamental dimensions, dimensional homogeneity, Buckingham Pi theorem, dimensionless parameters. Similitude and model studies, distorted and undistorted models.

Unit 4: Open Channel Flows **9**

Types of flow, characteristics of open channel, Chezy's equation, Manning equation. Hydraulically efficient channel sections, critical depth, specific energy application to channel transitions. Flow measurement in channels and natural streams, current meter, classification of hydraulic jumps, momentum equation, energy loss.

Unit 5: Pumps **9**

Types of pumps, efficiencies, selection of pump capacity. Centrifugal pump, characteristics and working principle, types of impellers, priming, NPSH, cavitation, minimum speed to start the pump, specific speed. Submersible pump, jet pump, air lift pump, sludge pump, reciprocating pump and its working principles.

Text Books

1. A.K. Jain, Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
2. R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Lakshmi Publications, 2019.

Reference Books/ Sources

1. S.K. Som, Gautam Biswas, S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill Education (India) Pvt. Ltd., 2017.
2. P.N. Chandramouli, Applied Hydraulic Engineering, Yes Dee Publisher, 2017
3. K. Subramanya, Fluid Mechanics and Hydraulic Machines: Problems and Solutions, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2018.

Course Outcomes (CO):

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

1	Outline the fundamental properties of fluids and analyze pressure measurement methods.
2	Analyze characteristics of the fluid in motion.
3	Examine the losses in pipelines and to understand the concept of application of dimensional analysis in model studies.
4	Analyze the steady uniform flow with hydraulically efficient channel sections and to measure the flows in artificial/natural channels.
5	Examine the classification and working principles of various pumps.

EEPC302 ENVIRONMENTAL HEALTH AND SAFETY

(Credits: 3; Lectures: 45 contact hours)

Objectives

To understand the relevance of environment, health and safety in industries and other occupations; health hazards; exposure, effect, assessment, and control methods; policy, regulations, and management systems

Unit 1: Introduction **8**

Importance for developing environment, health and safety systems in work places; toxic materials and substances used in work, exposure limits, toxicological investigations; international and national initiatives, policy, legislations, regulations, and codes of practice.

Unit 2: Occupational Health and Hygiene **9**

Definition of occupational health and hygiene; categories of health hazards; exposure routes and pathways, human responses, dose-response relationship; exposure assessment, occupational exposure limits; control measures – role of personal protective equipment and the selection criteria; industrial hygiene

Unit 3: Workplace Safety and Safety Systems **9**

Initiatives and preparedness by organizations for workers safety; features of satisfactory and safe design of work premises - good housekeeping, lighting, colour, ventilation and heat control; noise, chemical, radiation, electrical, fire safety; safety at construction sites, process safety

Unit 4: Hazards and Risk Management **9**

Safety appraisal – job safety analysis, control techniques, plant safety inspection; accident investigation, analysis and reporting; hazard and risk management techniques – onsite and offsite emergency plans; employee participation- education and training; case studies

Unit 5: Environmental Health and Safety Management **10**

The basic purpose and benefits of safety inspection, first-aid, appliances, shelters, rest rooms and lunch rooms, use of personal protective equipment, elements of environmental health and safety management policy, implementation and review; ISO 45001- structure and clauses; case studies

Text Books

1. K. U. Mistry Fundamentals of Industrial Safety and Health, Volumes 1 & 2, 4th Edition, Siddharth Prakashan, 2022.
2. S. Z. Mansdorf, Handbook of Occupational Safety and Health, John Wiley & Sons, Inc., 2019.

Reference Books/ Sources

1. N. P. Cheremisinoff and M. L. Graffia, Environmental and Health and Safety Management, 1st Edition, Noyes Publications, USA, 1995.
2. S. Grover, R. C. Grover, Implementing Integrated Management System for Quality, Environment, Occupational Health & Safety and Energy: ISO 9001:2015/ISO14001:2015/ISO45001:2018/ ISO50001: 2018, Notion press, 2021
3. MBE Phil Hughes, Ed Ferrett, Introduction to Health and Safety at Work, 7th Edition, Routledge, London, 2020.

Course Outcomes (CO):

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

1. Identify the various types and effects of health hazards
2. Analyze different assessment and control methods
3. Apply the methodology for preparation of emergency plans and accident investigation
4. Evaluate EHS Management System and its elements

   Apply personal and industrial hygiene

EEPC303 ENVIRONMENTAL GEOTECHNOLOGY

(Credits: 3; Lectures: 45 contact hours)

Objectives

The objective of this course is to acquire knowledge on various soil engineering aspects for land reclamation, soil conversion of degraded waste land in new landuse, the application of soil mechanics in soil improvement, soil remediation, subgrade-drainage system, enhancing slope stability in mining areas, hilly regions, etc.

Unit 1: Geotechnology and environment **8**

Characterisation and classification of soil, solids-water-air relationships, consistency, index properties

Unit 2: Soil Compaction and consolidation **9**

Factors affecting compaction, optimum moisture content, compressibility and consolidation: primary and secondary consolidation, consolidation of disturbed soil, ground improvement techniques

Unit 3: Shear strength and stress of soils **10**

Shear strength of soils and its application in waste dumps, reclaimed sites, stability analysis. stability of slopes, shear strength of soil for determination of stability conditions, effective stress, capillarity and permeability of soil, effective stress, capillarity and permeability of soil hydrodynamic case-flow condition.

Unit 4: Seepage Through Soils **9**

Flow nets through a pervious medium, two dimensional flow Laplace's equation, steady state flow, flowlines, equipotential lines. prevention of erosion, protective filters.

Unit 5: Soil exploration **9**

Soil Exploration, waste materials in geotechnical construction, application of geotextiles, instrumentation in Environmental Geotechnology, case studies, Issues in soil degradation and remediation

Text Books

1. J. Mitchell, Fundamentals of soil behaviour, Third Edition, John Wiley and Sons, 2005.
2. H. D. Sharma and K. R. Reddy, Geoenvironmental Engineering – Site Remediation, Waste Containment, Emerging waste management technologies, John Wiley and sons, 2004.

Reference Books/ Sources

1. Hsai-Yang Fang, and R. C. Chane, Introduction to Environmental Geotechnology, 2nd Edition, CRC Press, 2016.
2. D.N. Singh, A.Asadi, G.V.S.N.Sai, Environmental Geotechnology: meeting challenges through needs-based, World Scientific Publishing Co. Singapore, 2022.
3. D.E. Daniel D.E, Geotechnical Practice for Waste Disposal, Chapman and Hall. 1993.

Course Outcomes (CO):

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

1. learn about various kind of soil and environmental geotechniques to reclaim degraded land
2. apply techniques for conversion of degraded land into various land-uses like construction, infrastructure, plantation, agriculture, forestry or development of aesthetics
3. analyze and use techniques to stabilize erosion prone land, unstable hill and mine slopes
4. determine the flow of contaminants in soil and suggest soil remediation methods
5. understand exploration of soil and utilization of waste for geotechnical applications as replacement of natural soil.

EEPC304 ENVIRONMENTAL CHEMISTRY

(Credits: 3; Lectures: 45 contact hours)

Objectives

To understand aquatic, atmospheric and soil chemistry, identifying emerging pollutants and associated environmental and health effects

Unit I: Introduction to Environmental Chemistry **8**

Concept and scope of environmental chemistry, components of environment, natural cycles of matter in the environment, stoichiometry and mass balance-chemical equilibria, acid-base, solubility product, chemical kinetics

Unit II: Aquatic Chemistry **10**

Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation, degradation of synthetic chemicals, metals, complex formation, oxidation and reduction, sorption; colloids, electrical properties, environmental significance of colloids, coagulation. CO_2 solubility in water and species distribution, ocean acidification, water quality parameters – determination

Unit III: Atmospheric Chemistry **9**

Atmospheric structure, chemical and photochemical reactions, photochemical smog. ozone layer depletion, greenhouse gases and global warming, climate change, CO_2 capture and sequestration, acid rain, origin and composition of particulates. air quality parameters - determination.

Unit IV: Soil Chemistry **9**

Nature and composition of soil, clays- cation exchange capacity, acid base and io n-exchange reactions in soil, agricultural chemicals in soil, soil nutrients, reclamation of contaminated land

Unit V: Emerging Pollutants **9**

Heavy metals-chemical speciation, endocrine disrupting chemicals, pesticides, pharmaceuticals, endocrine disruptors, hormones, toxins, nanomaterials, etc.: fate, behaviour, monitoring, environmental and health risks.

Text Books

1. S. E. Manahan, Environmental Chemistry, 11th Edition, CRC Press, 2022.
2. K. De, A. K. De, Environmental Chemistry, 9th Edition, New Age International Publishers, New Delhi, 2018.

Reference Books/ Sources

1. Sawyer, P. McCarty, G. Parkin, Environmental Chemistry: A Comprehensive Approach, 5th Edition, McGraw Hill Education, 2017.
2. M. A. Hanif, F. Nadeem, I. A. Bhatti, H. M. Tauqeer, Environmental Chemistry, Scrivener Publishing LLC, 2020.
3. F. G. Calvo-Flores, J. Isac-Garcéa, J. A. Dobado, Emerging Pollutants: Origin, Structure and Properties, Wiley-VCH Verlag, 2018

Course Outcomes (CO) :

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

1) Understand the reactions involved with chemical based pollution
2) Identify the fate, movement and impacts of chemicals in water
3) Understand the effects, reactions and impacts of air pollutants
4) Understand soil composition and reclamation of contaminated land
5) Identify different emerging pollutants, their speciation, and their impacts

EEEL301 FLUID MECHANICS LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives

To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

Experiments:

1. Viscosity measurement of non-Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Water hammering

**Minimum 8 experiments shall be offered.*

Reference Books/ Sources

1. R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Lakshmi Publications, 2019.
2. Noel de Nevers, Fluid Mechanics for Chemical Engineers, 3rd Edition, McGraw- Hill, 2005.
3. W.L. McCabe, J.C. Smith, P. Harriot, Unit operations in Chemical Engineering, McGraw Hill, 7th Edition, 2021.
4. F.M. White, H. Xue, Fluid Mechanics, 9th Edition, McGraw Hill, 2022.
5. James O Wilkes, Stacy G Bike, Fluid Mechanics for Chemical Engineers, Prentice Hall PTR (International series in Chemical Engineering), 1999.
6. B.R. Munson, D.F. Young, T.H. Okiishi, Fundamentals of Fluid Mechanics, 7th Edition, John Wiley, 2013.
7. R. Darby, Raj P. Chhabra, Chemical Engineering Fluid Mechanics, 3rd Edition, CRC Press, Taylor & Francis Group, 2017.

Course Outcomes (CO):

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

1. Demonstrate fluid flow using variable area flow meters and variable head flow meters.
2. Interpret head losses through open channels.
3. Interpret viscosity of fluids.
4. Develop pump characteristics curves for the transportation of fluids based on process conditions/requirements.
5. Examine pressure drop for fluid flow around solid objects.

EEPL303 ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives

The objectives of this course is to acquire knowledge on the determination of physical and geotechnical properties of soil

Experiments

1. Identification of soil
2. Sampling and grain size distribution
3. Determination of density of soil
4. Determination of relative density and void ratio
5. Determination of specific gravity of soil
6. Permeability tests – constant and variable head
7. Swell and shrinkage test for soils
8. Compaction test
9. Consolidation test
10. Test for determination of shear strength

**Minimum 8 experiments shall be offered.*

Reference Books

1. IS 2720 : "Method of Test for Soil (relevant parts)", Indian Standards Institution, New Delhi, 1983
2. B.M. Das, Soil Mechanics Laboratory Manual, 10th Edition, Oxford University Press, 2016.

Reference Books/ Sources

1. Hsai-Yang Fang, and R. C. Chane, Introduction to Environmental Geotechnology, 2nd Edition, CRC Press, 2016.
2. D.N. Singh, A.Asadi, G.V.S.N.Sai, Environmental Geotechnology: meeting challenges through needs-based, World Scientific Publishing Co. Singapore, 2022.
3. D.E. Daniel D.E, Geotechnical Practice for Waste Disposal, Chapman and Hall. 1993.

Course Outcomes (CO):

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

1. Identify different types of soil and will learn to separate various coarse size fraction of the soil for geotechnical analysis.
2. Analyze the consistency of soil with various moisture conditions.
3. Determine density, relative density, specific density and void ratio of soil with change in various loads
4. Determine permeability of soil in constant head and falling head condition
5. Perform compaction and consolidation test of soil

EEPL304 ENVIRONMENTAL CHEMISTRY LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives

To make students gain knowledge of various techniques chemistry used in environmental monitoring. To introduce and train students in experiments used for the analysis of physico-chemical parameters of water and wastewater samples.

List of Experiments

Determination of pH using pH meter (Potentiometry)

1. Determination of Electrical Conductivity using Conductivity meter
2. Determination of Redox potential (Potentiometry)
3. Determination of Total Alkalinity by Acid-base titration
4. Estimation of Total Hardness by Titration
5. Determination of Total Solids by Gravimetry
6. Determination of Total Dissolved Solids by Gravimetry
7. Determination of Dissolved Oxygen by Azide modification of Winkler Method
8. Estimation of Chloride
9. Estimation of sulphate
10. Estimation of phosphate
11. Determination of BOD
12. Determination of COD

**minimum 8 experiments will be given*

Text Books

1. American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 24th Edition, Water Works Association, Water Environment Federation, 2022.
2. E. Popek, Sampling and Analysis of Environmental Chemical Pollutants: A Complete Guide, 2nd Edition, Elsevier, 2017.

Reference Books/ Sources

1. A. Nigam, R. Gupta, Environmental Analysis Laboratory Handbook, 1st Edition, Scrivener Publishing LLC, 2020.
2. R. A. Murphy, Environmental Chemistry in the Lab, 1st edition, CRC Press, 2022.
3. R. Gopalan, A Laboratory Manual for Environmental Chemistry, Dreamtech Press, 2020.

Course Outcomes (CO):

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

1. Understand the principle of various methods used for analyzing water and wastewater.
2. Summarize the procedures for the quantification of various water quality parameters
3. Analyze the various standard protocols used in environmental monitoring.
4. Examine and characterize the given water/wastewater.
5. Analyze the quality of water.

EEPC401 AIR AND NOISE POLLUTION

(Credits: 3; Lectures: 45 contact hours)

Objectives

The objective of this course is to understand sources and effects of air and noise pollution, study meteorological influences on pollutant behavior. Learn monitoring methods and standards and to develop skills to quantify and analyze pollution data.

Unit 1 – Air Pollution Fundamentals **9**

Composition of the Atmosphere, Structure of the atmosphere, Classification of Air Pollutants, Based on origin, physical state, chemical composition: Criteria and hazardous pollutants. Sources of Air Pollution: Natural Sources, Anthropogenic Sources: Industries, Power generation, Transportation, Agriculture, Domestic activities, Construction and mining. Effects of Air Pollution: Human Health Impacts, Acute and chronic respiratory diseases, Effects on Vegetation, Effects Materials, Climate.

Unit 2 – Meteorology and Atmospheric Dispersion **9**

Atmospheric stability and temperature inversions: Types of stability, Stability Classification, Lapse Rate Concepts, Temperature Inversions, Wind profiles and turbulence, Mixing height, Plume behavior (looping, coning, fanning, fumigation, lofting), Role of meteorology in dispersion and dilution of pollutants

Unit 3 – Emission Inventories and Sampling **9**

Principles and significance of inventories, Methodologies: bottom-up and top-down approaches, Emission factors (USEPA AP-42, IPCC guidelines), Sectoral inventories: industrial, vehicular, area sources, Case studies of emission inventories in Indian cities. Particulate sampling: high-volume samplers, PM10/PM2.5 samplers, Gaseous sampling: absorption and adsorption methods, Stack sampling methods: isokinetic sampling, Sample preservation and handling, Data interpretation and QA/QC in sampling

Unit 4 – Air Quality Monitoring and Modeling **9**

Air Quality Standards, NAAQS, WHO, CPCB guidelines Monitoring Systems, Continuous Ambient Air Quality Monitoring Stations (CAAQMS) Manual monitoring methods, Instrumentation and calibration, Data Analysis, Time-series analysis of air quality data, Statistical tools for air pollution evaluation, Dispersion Modeling, Fundamentals of Gaussian plume model, Inputs, assumptions, and limitations, Model selection and applications (AERMOD, CALPUFF), Basics of receptor modeling and source apportionment studies, Indoor air quality monitoring.

Unit 5 – Noise Pollution **9**

Basics of sound and noise measurement: Sound Fundamentals, Sound Pressure Level (SPL), Frequency Weighting, Time Weighting Sources of noise pollution : Transportation Noise, Industrial Noise, Construction Noise, Community and Neighborhood Noise, Domestic Noise. Noise standards and impact assessment: Noise Standards in India, Impact Assessment, health effects of noise: Auditory Effects, Non-Auditory Effects, Speech Interference, Vulnerable Populations.

Text Books

1. Noel de Nevers, Air Pollution Control Engineering, McGraw-Hill Education, 2nd Edition, ISBN: 9780070393673, 2010.
2. K.J Polak, Noise Pollution and Its Control, CBS Publishers and Distributors Pvt Ltd. ISBN-13 : 978-9389185461, 2020.

Reference Books/ Sources

1. Daniel A. Vallero, Air Pollution Calculations: Quantifying Pollutant Formation, Transport, Transformation, Fate and Risks. 2nd Edition, Elsevier Publication, 2023.
2. John H. Seinfeld, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, Wiley publication, ISBN-13 : 978-1118947401, 2016.
3. Daniel A. Vallero, Bruce Turner, Fundamentals of Air Pollution 6th Edition, Academic Press, 2025.

Course Outcomes (CO):

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

1 Explain the sources, classification, and effects of major air pollutants on health, vegetation, and materials.
2 Analyze meteorological parameters and their influence on the dispersion and dilution of air pollutants.
3 Apply emission inventory methods and sampling techniques for air quality assessment.
4 Interpret air quality monitoring data and use basic dispersion modeling approaches.
5 Describe sources, measurement techniques, standards, and health impacts of indoor air pollution and noise pollution.

EEPC402 SOLID WASTE MANAGEMENT

(Credits: 4; Lectures: 60 contact hours)

Objectives

The course focuses on understanding the sources, characteristics, and classification of solid waste, along with methods for collection, transportation, treatment, and disposal. It examines regulations, sustainable strategies, and technologies in solid waste management (SWM) and assesses case studies of urban and rural solid waste systems.

Unit 1: Introduction to Solid Waste **12**

Definition, Classification and sources of municipal, biomedical, industrial, hazardous, and e-waste, Composition and characteristics, Generation rates, Factors affecting waste generation, Public health and environmental impacts.

Unit 2: Waste Collection and Transportation **12**

Storage methods, Segregation at source, Collection systems (hauled and stationary container systems), Collection routing and scheduling, Transfer stations, Transportation logistics, Community participation.

Unit 3: Waste Processing and Resource Recovery **12**

Pre-treatment methods, Mechanical, biological, and thermal processing, Recycling and reuse, Composting: windrow, vermi, in-vessel, Anaerobic digestion, Waste-to-energy technologies.

Unit 4: Treatment and Disposal Methods **12**

Incineration, Pyrolysis and gasification, Landfilling: design, operation, leachate and gas management, Sanitary landfill vs. open dumping, Closure and post-closure care, Emerging treatment methods.

Unit 5: Legislation and Sustainable Practices **12**

SWM Rules 2016, Plastic Waste, E-Waste, Biomedical Waste Rules, Extended Producer Responsibility (EPR), Public-private partnerships, Life cycle analysis, Integrated solid waste management, Case studies of urban and rural SWM practices.

Text book

1. G. Tchobanoglous, H. Theisen, and S. Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, New York: McGraw-Hill, 1993. ISBN: 9780070632370.
2. P. A. Vesilind, Solid Waste Engineering, 2nd ed., Boston: Cengage Learning, 2006. ISBN: 9780495100146.

Reference Books/ Sources

1. Central Public Health and Environmental Engineering Organisation (CPHEEO), Manual on Municipal Solid Waste Management, New Delhi: Ministry of Housing and Urban Affairs, Government of India, 2016. Available at: https://mohua.gov.in
2. Ministry of Environment, Forest and Climate Change (MoEF&CC), Solid Waste Management Rules, 2016 and Amendments, Gazette of India, Government of India. Available at: https://moef.gov.in

3. Bureau of Indian Standards (BIS) and Central Pollution Control Board (CPCB), Guidelines and IS Codes for Waste Characterization and Landfill Design, Government of India. Key documents include IS 10158, IS 2720 (Part 8 & 40), and CPCB landfill design reports. Available at: https://cpcb.nic.in and https://www.services.bis.gov.in

Course Outcomes (CO):

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

1 Understand types, sources, and composition of solid waste

2 Describe collection, segregation, and transportation systems

3 Analyze processing, recycling and resource recovery techniques

4 Evaluate treatment and final disposal options

5 Understand policies, guidelines, and sustainability in SWM

EEPC403 ENVIRONMENTAL MICROBIOLOGY

(Credits: 3; Lectures: 45 contact hours)

Objectives

To understand microbial growth and metabolism, waste treatment systems and bioremediation of environmental pollutants

Unit 1: Introduction **8**

Cell chemistry, biology, and microscopy culture media: components of media, natural and synthetic media, staining techniques

Unit 2: Microbial Metabolism, Growth and Control **9**

Microbial diversity, kinetics of microbial growth; microbial metabolism: pathways of aerobic and anaerobic metabolism, energy transfer in metabolism

Unit 3: **Microbiology of Wastewater Treatment Systems** **9**

Basic microbiology of water and sewage; analysis of fecal indicator bacteria: coliforms and streptococci, treatment of sewage (primary, secondary and tertiary treatments), treatment of industrial effluents (distillery, textile, pulp and paper etc.)

Unit 4: **Microbiology of Solid Waste Treatment Systems** **9**

Solid waste types, composting, landfilling, composting, biogas production, plastic degrading microorganisms as a tool for bioremediation, challenges in waste management.

Unit 5: **Bioremediation of environmental pollutants** **10**

Basic principles of microbial transformation of organic matter, biodegradation, acclimatization of wastes, bioremediation of petroleum hydrocarbons and pesticides, microbial enhanced oil recovery, bioleaching of copper, gold and uranium, electronic waste management

Text Books

1. M. V. Yates, C, H. Nakatsu, R. V. Miller, S. D. Pillai, Manual of Environmental Microbiology, American Society for Microbiology, Wiley, 2015.
2. Pepper, C. P. Gerba, T. Gentry, Environmental Microbiology, 3rd Edition, Elsevier, 2014.

Reference books/ Sources

1. G. Bitton, Wastewater Microbiology, 4th Edition, Wiley Blackwell, 2012.
2. M. P. Shah, Modern Approaches in Waste Bioremediation: Environmental Microbiology, Springer, 2023.
3. V. Ivanov, Environmental Microbiology for Engineers, 3rd Edition, CRC Press, 2024.

Course Outcomes (CO):

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

1. Learn basic microbiological techniques such as media preparation, staining
2. Understand microbial diversity, growth and metabolism
3. Understand microbiology of wastewater treatment systems
4. Evaluate the microbiological aspects of solid waste management methods
5. Understand the principle of bioremediation techniques

EEPC404 WATER SUPPLY ENGINEERING

(Credits: 4; Lectures: 60 contact hours)

Objectives

The course objective is to identify the sources and quantity of surface and ground water bodies and their demand for the public and also to study the quality of water and their treatment techniques.

Unit 1: Public Water Supply Schemes and Quantity of Water **10**

Necessary and objectives of public water supply schemes, planning and financing. Quantity of water, water requirements, continuous and intermittent supply. Water demand, variations in rate of demand, its effect on design, design period. Population growth and forecast, estimating the quantity of water required.

Unit 2: Hydrological Concepts and Sources of Water **10**

Hydrological concepts, hydrological cycle. Sources of water, intakes, types of intakes, infiltration galleries, infiltration well. Storage reservoirs, storage capacity by analytical method and mass curve method. Types of wells, sanitary protection of wells, tests for yield of a well.

Unit 3: Quality of Water and Transportation of Water **10**

Quality of water, portable water and mineral water, contamination of water. Sampling techniques, analysis of water, bacteriological analysis, water borne diseases. Water quality standards. Transportation of water, hydraulics of pipe flow, pipes & its types. Design of pipes, joints, pipe appurtenances. Pumps, types of pumps, selection of pumps.

Unit 4: Purification of Water **20**

Treatment of water, working principles of all the unit operation/process of water treatment, purpose and its design, screening, plain sedimentation, coagulation/flocculation, filtration, disinfection, water softening and desalination. Removal of iron and manganese. Fluoridation and Defluoridation.

Unit 5: Distribution of Water **10**

Planning, methods of distribution. Service reservoirs, purpose, types, locations and height. Design aspects, requirements of good distribution system, layout of distribution system. Network analysis, preventive methods to reduce wastage of water, pipe appurtenances, house service connection.

Text Books

1. S.K. Garg, Water Supply Engineering, 37th Edition, Khanna Publishers, New Delhi, 1977.
2. B.C. Punmia, Arun K. Jain, Ashok K. Jain, Water Supply Engineering, 2nd Edition, Lakshmi Publication Private Limited, New Delhi, 2016.

Reference Books/ Sources

1. G.S. Birdie, Water Supply and Sanitary Engineering, Dhanpat Rai Publishing Company (P) Ltd, 2010.

2. N.K. Shammas, Water Supply and Wastewater Disposal, 3rd Edition, John Wiley & Sons Inc, 2010.
3. J.J. Babbit, Harold E. Donald, Water Supply Engineering, McGraw Hill Publishing Company, 1955.

Course Outcomes (CO):

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

1 Summarize the various components of water supply scheme.
2 Identify the various sources of water.
3 Analyze the quality of water and transportation of water.
4 Examine the various treatment of water.
5 Design and evaluate the water distribution system.

EEPL402 SOLID WASTE MANAGEMENT LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives

The course trains students in sampling, segregation, and characterization of solid waste, and familiarizes them with composting, calorific value estimation, and waste audit techniques. It also provides hands-on experience in landfill leachate analysis and recyclability assessment.

List of Experiments (Minimum 8 to be conducted):

1. Sample preparation, sampling techniques, coning and quartering method, overburden and other waste sampling.
2. Characterization of solid wastes and proximate analysis
   2 A. To determine the moisture percent of the waste sample.
   2 B. To determine the volatile matter percentage in the sample
3. Practical use of Bomb Calorimeter
4. To perform the ultimate analysis of solid waste.
5. Estimation of Kjeldahl Nitrogen in solid waste sample.
6. Estimates of total organic carbon (OC expressed as C) in the solid waste
7. To determination of available phosphorus in solid waste samples.
8. To determine various components of Municipal Solid Waste in your location.
9. Determination of field capacity of soil sample·
10. To understand the SDG 11.6.1 assessment methods.
11. Assessment and characteristics of waste plastics.

** Minimum 8 experiments shall be offered*

Reference

1. Tchobanoglous, G., Theisen, H., & Vigil, S. Integrated Solid Waste Management: Engineering Principles and Management Issues. McGraw-Hill Education.ISBN-13 : 978-0070632370 (1993)
2. ASTM International, ASTM Standards for Solid Waste Characterization and Analysis.
3. United Nations Statistics Division SDG Indicator 11.6.1: Methodology for Municipal Solid Waste Indicators UN, New York. (2021)
4. Stanley E. Manahan, "Environmental Chemistry (10th Edition)" by CRC Press ISBN-13 : 978-1498776936, 2017.
5. Standard Operating Procedure for Assessment & Characterization of Plastic Waste, CPCB, 2024, https://cpcb.nic.in/cpcb-technical-guidelines-sops/

Course Outcomes (CO):

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

1 Identify and classify solid waste types based on source and characteristics

2 Perform physical and chemical analysis of solid waste

3 Demonstrate composting techniques and evaluate compost quality

4 Analyze leachate and assess its environmental impact

5 Conduct waste audits and recommend waste minimization strategies

EEPL403 ENVIRONMENTAL MICROBIOLOGY LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives

To make students gain knowledge of various techniques of microbiology. To introduce and train students in experiments used for the microbiological analysis of water and wastewater.

LIST OF EXPERIMENTS

1. Preparation of growth media
2. Pure culture techniques: spread plate, pour plate, drop inoculation, streaking on plates,
3. Staining techniques
4. Isolation and culturing of microorganisms
5. Growth curve study of microorganisms
6. Biomass study of microorganisms
7. Determination of pollutant resistant isolate by plate diffusion method
8. Protein estimation by Bradford method
9. Bacteriological analysis of wastewater- Most portable number (MPN) Technique
10. Bacteriological analysis of wastewater- Micro-filtration (MF) technique
11. Heterotrophic plate count method
12. Antibiotic sensitivity assay
13. Cytotoxicity assay

** Minimum 8 experiments shall be offered*

Text Books

1. K. Sandman, D. Wood, Prescott's Microbiology, 11th edition, Joanne Willey, McGraw Hill, 2019.
2. J. G. Cappuccino, C. Welsh, Microbiology: A Laboratory Manual, 11th edition, Pearson Education, 2023.

Reference Books/ Sources

1. R. Salwan, V. Sharma, Laboratory Methods in Microbiology and Molecular Biology, 1st Edition, Elsevier, 2023.
2. O. Erkmen, Laboratory Practices in Microbiology, 1st Edition, Elsevier, 2021.
3. American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 24th Edition, Water Works Association, Water Environment Federation, 2022.

Course Outcomes (CO):

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

1. Develop skills to work on techniques for the study of micro-organisms in laboratory.
2. Understand the principle and procedure for isolation and identification of micro-organisms present in water/ wastewater.
3. Apply the methods for enumeration of micro-organisms present in water/ wastewater.
4. Analyze the various standard protocols used in environmental monitoring.
5. Examine and characterize micro-organisms present in water/wastewater

EEPC 501 AIR AND NOISE POLLUTION CONTROL

(Credits: 3; Lectures: 45 contact hours)

Objectives

The objective of the course is to learn control technologies for air and noise pollution, design air pollution control systems, understand policy frameworks and regulatory compliance.

Unit I – Air Pollution Control Approaches **9**

NCAP, Source correction methods: preventive fugitive emission, cleaner production, preventive measures, Process modification and substitution: combustion systems, raw material alternatives, adaptation of green solvents. Fuel switching: low emission fuels, renewable energy. Pollution prevention hierarchy.

Unit 2 - Particulate matter control **9**

Particulate matter: Sources, Particle size distribution. Gravity Settling Chambers: Design principles: reducing gas velocity to settle larger particles. Cyclone Separators: Principle, design parameters, Fabric Filters: filtration mechanism , filter media selection, applications. Electrostatic Precipitators (ESPs): Charging particles using corona discharge, mechanisms, design considerations, applications in thermal power plants, cement kilns, Wet Scrubbers: Principles: inertial impaction, diffusion, condensation, Types: spray tower, venturi scrubber, packed bed, Liquid-gas ratio design considerations

Unit 3-Gaseous Pollutant Control **9**

Absorption, Gas-liquid contact in packed towers, spray columns, Solubility of gases in solvents, Design parameters. Adsorption: Solid adsorbents, Breakthrough curves and bed regeneration, application. Catalytic and Thermal Combustion; Catalytic converters (precious metal catalysts) for CO, hydrocarbons, Thermal oxidizers for high-VOC streams, application in paint shops and chemical manufacturing. Control of VOCs and Hazardous Air Pollutants: Condensation techniques, leak detection and Repair (LDAR) programs, Vapor recovery units in fuel storage.

Unit 4 Vehicular and Indoor Air Pollution Control **9**

Emission Standards for Vehicles: Bharat Stage (BS) emission norms, EU emission standards, On-Board Diagnostics (OBD) regulations, Technologies for Vehicular Emission Reduction: Catalytic converters, Diesel Particulate Filters (DPF), Selective Catalytic Reduction (SCR) for NOx control, CNG/LPG retrofitting. Traffic Management Measures: Intelligent Transport Systems, Congestion pricing and low emission zones, Promoting public transport and non-motorized modes. Indoor Air Quality Management Systems: Source reduction Local exhaust ventilation, Filtration and air purification technologies, Monitoring devices, Ventilation standards

Unit 5 Noise Pollution Control **9**

Noise Propagation Modeling: calculation of attenuation over distance, reflection and diffraction effects, noise mapping tools. Noise Control at Source: equipment design improvements, maintenance and lubrication, resilient mounts and isolation pads. Noise Control in Path: Acoustic barriers, Vegetative screens, Enclosures for noisy equipment. Noise Control at Receiver: soundproofing building interiors, double-glazed windows, use of

absorptive materials indoors. Building Acoustics and Urban Planning, Regulatory Frameworks and Standards.

Text Book

1. Jeff Kuo Air Pollution Control Engineering for Environmental Engineers: Fundamentals and Applications, 1st Edition, CRC press.
2. Selma Kurra, Environmental Noise and Management: Overview from Past to Present ,Wiley Publication ISBN: 978-1-118-88742-4, 2020

Reference Book

1. C. David Cooper, F. C. Alley , Air Pollution Control: A Design Approach, 4th Edition, Waveland Pr Inc, 2010.
2. Louis Theodore, Air Pollution Control Equipment Calculations 1st Edition, Wileys Publication, 2010.
3. Kenneth C. Schifftner, Air Pollution Control Equipment Selection Guide, 3rd Edition, CRC Press, ISBN: 9781000386592, 2021.

Course Outcomes (CO):

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

1 Identify and evaluate pollution prevention approaches, including source correction, process modification, and fuel switching

2 Select, design, and assess control technologies for particulate matter and gaseous pollutants.

3 Explain standards and technologies for controlling vehicular and indoor air pollution.

4 Analyze noise propagation and recommend appropriate control measures in industrial and community settings.

5 Interpret regulatory frameworks and develop strategies for compliance with air and noise pollution standards.

EEPC502 WASTEWATER ENGINEERING

(Credits: 4; Lectures: 60 contact hours)

Objectives

The objective of this course is to help students develop the ability to apply basic understanding of physical, chemical, and biological phenomena for successful design, operation and maintenance of sewage treatment plants.

Unit 1: Planning and Design of Sewerage System **12**

Characteristics and composition of sewage. Population equivalent. Sanitary sewage flow estimation, sewer materials, hydraulics of flow in sanitary sewers, sewer design. Storm drainage, storm runoff estimation. Sewer appurtenances, corrosion in sewers, prevention and control, sewage pumping-drainage in buildings. Plumbing systems for drainage. Discharge standards for effluents.

Unit 2: Primary Treatment of Sewage **12**

Objectives, unit operations and processes, selection of treatment processes. Onsite sanitation, septic tank. Primary treatment: Principles, functions and design of sewage treatment units. Screens, grit chamber, primary sedimentation tanks. Operation and maintenance aspects.

Unit 3: Secondary Treatment of Sewage **12**

Objectives, selection of treatment methods. Activated sludge process and extended aeration systems. Rotating biological contactors, trickling filters, waste stabilization ponds. Operation and maintenance.

Unit 4: Advances in Sewage Treatment **12**

Sequencing batch reactor, moving bed biofilm reactor, membrane bioreactor, UASBR, biogas recovery. Reclamation and reuse of sewage. Constructed wetland, nutrient removal systems.

Unit 5: Sewage Disposal and Sludge Management **12**

Dilution, self-purification of surface water bodies, oxygen sag curve, deoxygenation and reaeration. Land disposal, sewage farming, sodium hazards, soil dispersion system. Sludge characterization, sludge thickening, dewatering, drying, ultimate residue disposal. Septage management.

Text Books

1. S.K. Garg, Environmental Engineering Vol.II, Khanna Publishers, New Delhi, 2015.
2. G. Tchobanoglous, F. L. Burton, H. David Stensel, Wastewater Engineering: Treatment and Reuse, MtCalf & Eddy Inc., 4th Edition, McGraw Hill Education, 2017.

Reference Books/ Sources

1. Manual on Sewerage and Sewage Treatment Systems Part A, B and C, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
2. K.N. Duggal, Elements of Environmental Engineering, S. Chand and Co. Ltd., New Delhi, 2014.

3. S.R. Qasim, Guang Zhu, Wastewater Treatment and Reuse: Theory and Design Examples, 1st Edition, CRC Press, New York, 2017.

Course Outcomes (CO):

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

1 Examine the planning and design of the sewerage system.
2 Examine the various primary treatment of sludge.
3 Analyze the various secondary treatment of sludge.
4 Examine the importance of recent advances in sewage treatment.
5 Inspect the various sewage disposal and sludge management systems.

EEPC503 INDUSTRIAL POLLUTION PREVENTION

(Credits: 3; Lectures: 45 contact hours)

Objectives

To impart knowledge on the concept and application of industrial pollution prevention, cleaner technologies, industrial wastewater treatment and residue management. Understand principles of various processes applicable to industrial wastewater treatment. Identify the best applicable technologies for wastewater treatment from the perspective of yield production.

Unit 1: Introduction **9**

The environmental challenge, source of pollution, industrial pollution problems, changing environment management concept, environmental management strategy. Benefits of industrial pollution prevention, potential pollution prevention barriers. Industrial processes, industrial wastes, toxic chemicals, waste characterization.

Unit 2: Industrial Pollution Prevention Technology & Waste Minimisation **9**

Pollution prevention technology, application in industrial processes, energy technology. Waste management hierarchy, source reduction techniques, periodic waste minimisation assessments, evaluation of pollution prevention options. Cost benefit analysis. Implementing & promoting pollution prevention programs in industries.

Unit 3: Total Environmental Quality Management & Pollution Prevention Feasibility Analyses **9**

Risk assessment and risk management, environmental audit program, design environmentally compatible products, environmental labelling. Technical feasibility analysis, environmental feasibility analysis, economic feasibility analysis, institutional feasibility analysis.

Unit 4: Industrial Facility and Implementation of Pollution Prevention Plan **9**

Organizing a pollution prevention team, establishing goals, data collecting and analyzing, identifying pollution prevention opportunities, employee awareness and involvement, education and training, proposing a pollution prevention plan. Understanding processes and wastes, selecting projects, obtaining funding, engineering implementation, reviewing and revising projects.

Unit 5: Laws, Regulations and Measuring Pollution Prevention Progress **9**

The pollution prevention related laws and regulations, executive orders promoting federal pollution prevention, EPA strategy and programs, EPA's pollution prevention research program, pollution prevention education and training, summary of pollution prevention act of 1990. Purpose of measuring pollution prevention progress, data acquisition, data analysis, methods of measuring pollution prevention progress.

Text Books

1. Thomas T. Shen, Industrial Pollution Prevention, 2nd Edition, Springer-Verlag Berlin Heidelberg, 1999.

2. Ryan R. Dupont, Kumar Ganesan, Louis Theodore, Pollution Prevention Sustainability, Industrial Ecology, and Green Engineering, 2nd Edition, CRC Press Taylor & Francis Group, New York, 2017.

Reference Books/ Sources

1. Paul L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw-Hill Inc., US, 1999.
2. N. L. Nemerow, Industrial Waste Treatment, 1st Edition, Butterworth-Heinemann, 2010.
3. Mahmoud M. El-Halwagi, Sustainable Design through Process Integration: Fundamentals and Applications to Industrial Pollution Prevention, Resource Conservation, and Profitability Enhancement, 2nd Edition, Elsevier, 2017.

Course Outcomes (CO):

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

1	Summarize the industrial pollution problems and the benefits of industrial pollution prevention.
2	Examine the various industrial pollution prevention and waste minimization technologies
3	Implement the total quality management and pollution prevention feasibility analysis.
4	Analyze the industrial facility and implementation of pollution prevention plan.
5	Execute the laws, regulations and measuring the pollution prevention progress.

EEPC504 SURFACE AND GROUNDWATER QUALITY MODELLING

(Credits: 4; Lectures: 60 contact hours)

Objectives

To introduce the fundamentals of mathematical models for water quality and the importance of model building. To educate about the water parameters modelling and various ground water quality modelling. To demonstrate the features and the use of most widely used computerized models for water quality.

Unit 1: Modelling Perceptions **12**

Engineers and mathematical models, water quality models, historical development, different types of models, steps in model development, importance of model building, calibration and verification of models. Conservation of mass and momentum, chemical reaction kinetics, law of mass action, rate constants, reaction order, types of reactions, equilibrium principles.

Unit 2: Pollutant Transport and Reactor Modelling **12**

Transport phenomena, advection, diffusion, dispersion. Simple transport models, plug flow models, steady state and time variable solutions, completely mixed systems, concept and models in mixed flow reactor, loading types, feed forward vs. feedback reactor systems

Unit 3: Surface Water Quality Modelling **12**

Water quality modelling of streams, lakes and impoundments and estuaries. Water quality model sensitivity, assessing model performance. Models for dissolved oxygen, pathogens and BOD-Streeter Phelps model for point and distributed sources, modified Streeter Phelps equations. Toxicant modelling in flowing water.

Unit 4: Groundwater Quality Modelling **12**

Groundwater flow and mass transport of solutes, degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion, basic concepts and modelling.

Unit 5: Water Quality Modelling Software **12**

Exposure to surface water and groundwater quality modelling software, MIKE 21, QUAL2E and MODFLOW Models and their application, Case studies.

Text Books

1. S. Chapra, Surface Water Quality Modeling, Medtech, 2008.
2. M. Benedini, G. Tsakiris, Water Quality Modelling for Rivers and Streams, Springer Netherlands, 2013.

Reference Books/ Sources

1. Zhen-Gang Ji, Hydrodynamics and Water Quality: Modelling Rivers, Lakes, and Estuaries, John Wiley & Sons, 2017.
2. J. Bear, Alexander H.-D. Cheng, Modelling Groundwater Flow and Contaminant Transport, Springer Science & Business Media, 2010.

3. Ne-Zheng Sun, A. Sun, Mathematical Modelling of Groundwater Pollution, Springer-Verlag New York Inc., 2012.

Course Outcomes (CO):

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

1 Outline the principles of water quality modelling.
2 Analyze the pollutant transport in surface and groundwater and modeling of reactors.
3 Analyze surface water quality modelling to predict the water quality of rivers, lakes and estuary.
4 Examine the groundwater water quality modelling to predict the groundwater contamination transport.
5 Analyze the various water quality modeling software to predict the water quality of surface and sub-surface water.

EEPL501 AIR AND NOISE POLLUTION MONITORING LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives

To familiarize students with standard methods for monitoring air and noise pollution, develop skills in handling air and noise monitoring instruments, analyze and interpret ambient data in accordance with national and international standards, understand the impact of pollutants on human health and the environment.

List of Experiments:

1. Sampling of PM10 in ambient air and the determination of its concentration
2. Sampling of PM2.5 in ambient air and the determination of its concentration
3. Measurement of Sulphur dioxide (SO2) concentration in the ambient air
4. Measurement of Nitrogen dioxide (NOX) concentration in the ambient air
5. To calculate emission rates (ER) for different exhaust gases emitting from vehicular tailpipe
6. To calculate the air change rate (ACH) of indoor environment air and deposition rate of particulate concentration of different sizes
7. Estimation of respiratory deposition doses (RDD) to the human beings under different conditions
8. To plot Wind Rose Diagram
9. To estimate the atmospheric stability within the atmospheric boundary layer of the study area.
10. a. Ambient noise monitoring b. Traffic noise monitoring
11. Frequency spectrum analysis of machine noise
12. Audiometric survey for assessing hearing accuracy Minimum experiments shall be offered

** Minimum 8 experiments shall be offered*

Reference

1. Guidelines for the Measurement of Ambient Air Pollutants (Volume 1 & 2) CENTRAL POLLUTION CONTROL BOARD, Ministry of Environment, Forests & climate change. http://www.cpcb.nic.in,2013.https://cpcb.nic.in/cpcb-technical-guidelines-sops/
2. Harris, C. M. (Ed.) Handbook of Acoustical Measurements and Noise Control (3rd Ed.). McGraw-Hill. (1991)
3. Roy M. Harrison (Editor), Roger Perry (Editor), R. Young, Handbook of Air Pollution Analysis ,ISBN-13 : 978-0412244100 Chapman and Hall; 2nd edition, 1986
4. Daniel J. Jacob, Introduction to Atmospheric Chemistry, 2nd edition, Harvard University, https://acmg.seas.harvard.edu/education-2nd-edition/ , 2025

Course Outcomes (CO):

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

1 Identify sources and characteristics of air and noise pollutants.
2 Use standard instruments to measure ambient air pollutants (SPM, SO_2, NO_2, CO, etc.).
3 Measure and assess noise pollution using sound level meters and related tools.
4 Analyze and interpret air and noise data against regulatory standards
5 Prepare technical reports on monitoring and suggest mitigation strategies.

EEPL502 WATER AND WASTEWATER ENGINEERING LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives

To develop sound practical knowledge for the students on various water/wastewater treatment technologies.

Experiments:

- Adsorption studies
- Advanced oxidation process
- Aeration
- Batch sedimentation
- Biodegradation studies
- Chemical oxidation process
- Coagulation/flocculation studies
- Electrochemical methods
- Electrodeionization
- Filtration process
- Flotation
- Ion exchange process
- Membrane separation
- Microbial fuel cell

**Minimum 8 experiments shall be offered.*

Reference Books/ Sources

1. Mark C. M. van Loosdrecht Per H. Nielsen Carlos M. Lopez-Vazquez Damir Brdjanovic, Experimental Methods in Wastewater Treatment, IWA Publishing, 2016.
2. Nelson Leonard Nemerow, Industrial Waste Treatment - Contemporary Practice and Vision for the Future, Elsevier, Singapore, 2007.
3. G. Tchobanoglous, F. L. Burton, H. David Stensel, Wastewater Engineering: Treatment and Reuse, MtCalf & Eddy Inc., 4th Edition, McGraw Hill Education, 2017.
4. Lab Manual, ISO 14001 Environmental Management, Regulatory Standards for Drinking Water and Sewage disposal.
5. C.N. Sawyer, P.L. McCarty, G.F. Parkin, Chemistry for Environmental Engineering, 4th Edition, Tata McGraw-Hill Publishing Company Limited, 2000.

Course Outcomes (CO):

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

1 Analyze the pollutant concentration in water/wastewater.
2 Select the type of treatment required for available water/wastewater quality.
3 Examine the optimized conditions for the removal of toxic pollutants from water/ wastewater.
4 Evaluate the performance of the treatment unit for the available water/wastewater quality.
5 Design the various water/wastewater treatment units to meet the drinking water/effluent discharge standards.

EEPC601: INSTRUMENTATION METHODS IN ENVIRONMENTAL ANALYSIS

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To provide information and knowledge in measurement techniques used in the field of environmental instrumentation methods of analysis. To learn about the sophisticated instrumental methods of analysis which is an essential component of environmental monitoring and assessment.

Unit 1: Electrochemistry **9**

Ohm's law; conductance; Galvanic cells; standard potentials; Nerns't equation; Equilibrium constant; electrodes and Potentiometry; Redox Titrations; Fundamentals of Electrolysis; Electrogravimetry; Coulometry; Amperometry; Conductometry; Polarography.

Unit 2: Chromatographic Techniques **9**

Chromatographic separation: principle and types; Paper chromatography; Thin layer Chromatography; Column chromatography; Gas chromatography; High performance liquid chromatography (HPLC); Gel Chromatography; Ion-exchange chromatography.

Unit 3: Methods for Organic Compounds **9**

Infrared spectroscopy; Ultraviolet spectroscopy; Nuclear Magnetic Resonance (NMR) Spectroscopy; Electron spin resonance (ESR) spectroscopy; Mass spectrometry; Polarimetry; Scanning Electron Microscopy.

Unit 4: Methods for Inorganic Compounds and Heavy metals **9**

Microwave Spectroscopy; Raman Spectroscopy; Emission spectroscopy; Mossbauer spectroscopy; Atomic absorption spectrometry; Flame photometry.

Unit 5: Thermal and X-ray Methods **9**

Thermogravimetric analysis; Differential Thermal Analysis; Derivative Thermogravimetric Analysis (DTA); Differential Scanning Calorimetry (DSC); Instrument for X-ray Diffraction; X-ray Fluorescence Spectroscopy

Text Books:

1. D. C. Harris, C. A. Lucy, Quantitative Chemical Analysis, 10th Edition, W. H. Freeman & Co Ltd, 2020.
2. V. K. Ahluwalia, Instrumental Methods of Chemical Analysis, 1st Edition, Ane Books Pvt. Ltd, 2017.

Reference Books/ Sources:

1. American Public Health Association, Water Works Association, Standard Methods for the Examination of Water and Wastewater, 24th Edition, Water Environment Federation, 2022.
2. R. Duarte, A. C. Duarte, Multidimensional Analytical Techniques in Environmental Research, 1st Edition, Elsevier, 2020.

3. F. Rouessac, A. Rouessac, J. Towey, Chemical Analysis: Modern Instrumentation Methods and Techniques, 3rd Edition, A John Wiley & Sons, Inc. Publication, 2022.

Course Outcomes (CO):

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

1. Apply the knowledge of electrochemistry for determining various parameters of water, wastewater and soil samples.
2. Make use of the chromatographic techniques for environmental applications.
3. Determine the presence and quantify the organic pollutants in water, wastewater and soil and solid waste samples.
4. Determine the presence and quantify the inorganic pollutants and heavy metals in water, wastewater and soil and solid waste samples.
5. Apply thermal and X-ray methods for characterizing waste samples.

EEPC602 DESIGN OF WATER AND WASTEWATER TREATMENT PLANTS

(Credits: 4; Lectures: 60 contact hours)

Objectives

To educate the students on the principles and process designs of various treatment systems for water and wastewater. Develop an understanding of the characteristics of water and wastewater that must be considered during design of a treatment plant. Students will gain competency in the iterative process employed in design of treatment systems and the components comprising such systems, leading to the selection of specific process equipment items.

Unit 1: Principles of Treatment **12**

Pollutants in water and wastewater, characteristics, treatment processes. Selection criteria and types of reactors. Unit operations and unit processes: screening, skimming, flotation, mixing, equalization, sedimentation, filtration, absorption, adsorption, membrane separation, neutralization, coagulation/flocculation, precipitation, solidification and stabilization, disinfection, Ion exchange, advanced oxidation process and electrochemical methods.

Unit 2: Design of Water Treatment Plants **12**

Design of water treatment plant units and upgrading existing plants: Aerators, chemical feeding, flash mixer, clariflocculator, lamella and plate settlers, filters, disinfectors, softeners, demineralization plant, reverse osmosis plants.

Unit 3: Design of Conventional Wastewater Treatment Plants **12**

Design of wastewater treatment plant units and upgrading existing plants: Screening, grit chamber, settling tanks, equalization, neutralization, flotation, activated sludge process, trickling filters, RBC, aerated lagoons, natural treatment systems, waste stabilization ponds, constructed wetland, disinfection.

Unit 4: Design of Advanced Wastewater Treatment Plants **12**

Design of sequencing batch reactors, moving bed biofilm reactors, membrane bioreactor. Reclamation and reuse of wastewater, application of membrane separation technologies in reuse of wastewater and nutrient removal systems. UASBR and anaerobic filters.

Unit 5: Residual Management Operation and Maintenance Aspects **12**

Characteristics of sludge from WTP and STP. Design of sludge management facilities for WTP and STP. Sludge thickening, sludge digestion, design of anaerobic digester and biogas generation, sludge dewatering. Case studies of retrofitting.

Text Books

1. S.K. Garg, Water Supply Engineering, 37th Edition, Khanna Publishers, New Delhi, 1977.
2. S.K. Garg, Environmental Engineering (Vol. II) Sewage Waste Disposal and Air Pollution Engineering, 43rd Edition, Khanna Publishers, New Delhi, 2024.

Reference Books/ Sources

1. G. Tchobanoglous, F. L. Burton, H. David Stensel, Wastewater Engineering: Treatment and Reuse, MtCalf & Eddy Inc., 4th Edition, McGraw Hill Education, 2017.
2. Manual on Sewerage and Sewage Treatment Systems Part A, Part B &Part C, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
3. S.J. Arceivala, S.R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, McGraw Hill, 3rd Edition, New Delhi, 2007.
4. S.R. Qasim, Guang Zhu, Wastewater Treatment and Reuse: Theory and Design Examples, 1st Edition, CRC Press, New York, 2017.

Course Outcomes (CO):

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

1	Understand the principle of water and wastewater treatment
2	Design and sizing the different components of water treatment plant.
3	Design of conventional wastewater treatment units
4	Understand in detail about the design of advanced wastewater treatment units
5	Design the different elements of sludge treatment systems and understand the importance O&M issues pertaining to WTP and STP

EEPC603 ENVIRONMENTAL IMPACT ASSESSMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To introduce the principles and evolution of EIA, to explain legal frameworks and clearance processes, to develop skills in baseline data collection, impact prediction, and evaluation, to familiarize students with emerging tools including Artificial Intelligence (AI), GIS, and remote sensing, to train students in reviewing EIA reports and applying digital methods.

Unit 1: Introduction to EIA and Policy Framework **9**

Definition, scope, objectives of EIA, Historical development globally and in India. Legislative framework: Environment Protection Act, land acquisition resettlement and rehabilitation, Coastal zones, Forest clearance, EIA Notification. Institutional arrangements, International guidelines, International Environmental Agreements, Overview of Digital Transformation in EIA.

Unit 2: Screening, Scoping, and Baseline Studies **9**

Screening criteria and categorization. Scoping and Terms of Reference preparation, Baseline study planning, Field survey techniques, Role of Data Science, Remote Sensing, and AI in baseline monitoring.

Unit 3: Impact Identification, Prediction, and Evaluation **9**

Methods: Checklists, matrices (Leopold Matrix), Network and overlay techniques. AI applications: Machine learning models for air and water quality prediction. Image analysis for land use change and biodiversity. Predictive analytic for cumulative impact assessment. Impact significance evaluation.

Unit 4: Reporting, Public Participation, and Decision-Making **9**

Structure and content of EIA reports. Stakeholder engagement and public hearings. EIA review and appraisal. Decision-making criteria. AI tools for automated report generation, sentiment analysis of public comments, decision support systems.

Unit 5: Emerging Trends and Case Studies **9**

Strategic Environmental Assessment, Health, gender and Social Impact Assessments. Integration of AI, Big Data, and Cloud Platforms: AI-powered risk mapping.AI-enabled GIS dashboards. Block-chain for environmental data integrity. International best practices. Case studies showcasing AI in EIA processes.

Text books

1. L. W. Canter, Environmental Impact Assessment, 2nd ed., New York: McGraw-Hill, ISBN: 9780071141031,1996.
2. Frank R. Spellman The Science of AI in Environmental Engineering, CRC Press ISBN-13 : 978-1040339848, 2025.

Reference Books/ Sources

1. Vandana Sharma, Balamurugan Balusamy, Munish Sabharwal, Mariya Ouaissa Sustainable Digital Technologies: Trends, Impacts and Assessments, ISBN-13 : 978-1000934359, 2023.
2. Jeffrey A. Cardille , Morgan A. Crowley , David Saah , Nicholas E. Clinton Cloud-Based Remote Sensing with Google Earth Engine: Fundamentals and Applications, Springer Publisher, ISBN-13 : 978-3031265877,2023.
3. Ministry of Environment, Forest and Climate Change (MoEF&CC) and Central Pollution Control Board (CPCB), ECO Manual: Environmental Clearance Guidance Manual for Projects Requiring Environmental Clearance, Government of India, New Delhi. Available at: https://moef.gov.in.

Course Outcomes (CO):

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

1	Describe EIA frameworks, policy, and legislation.
2	Conduct screening, scoping, and prepare Terms of Reference.
3	Apply impact prediction techniques using conventional and AI-assisted methods.
4	Analyze and synthesize data using GIS and AI tools.
5	Critically evaluate and improve EIA reports.

EEPR604 MINI / MICRO PROJECT

(Credits: 3)

Objectives

To make students apply the theoretical concepts studied as part of the curriculum. To gain practical knowledge of the core subjects by involving in real-time problems that may occur in an industry or in real life environments. Their ability to identify and solve problems based on the skills achieved so far is invoked here. To inculcate innovative thinking and thereby preparing students for main project.

Guidelines

Students can choose any real-time problem as their topic for the project work. Students shall work individually or form a group of 3 students and carry out the work. The work undertaken can be an industry defined project or environmental surveys and assessments or research projects. The students are encouraged to find out and propose solution to real time problems they observe within the institution or pertaining to the community. To identify and solve problems which demand effort that can be completed within the stipulated timing. Mini projects can be a gate way to final academic projects and if any of the identified problem demands more time and effort, such cases may be carried over to as main project. Students are required to submit detailed project report of the entire semester work of mini project at the end of the semester. The students are to present the same before the committee constituted for review of the mini project.

Course Outcomes (CO):

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

1. Apply the theoretical knowledge of the core subjects.
2. Examine real-time problems that exists in an industry or in real life environment.
3. Analyze the problem.
4. Develop solutions for the problems
5. Interpret the results and prepare report.

EEPL601 INSTRUMENTATION METHODS IN ENVIRONMENTAL ANALYSIS LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives:

To provides in depth knowledge on the various analytical and basic instrumental methods used in the laboratory for environmental chemical analysis. To equip students with skills, techniques and tools necessary for environmental analysis.

LIST OF EXPERIMENTS

1. Determination of iron in water/wastewater by UV-Visible Spectrophotometry
2. Determination of dye in water/wastewater by UV-Visible Spectrophotometry
3. Determination of heavy metals in water/wastewater by UV-Visible Spectrophotometry
4. Determination of heavy metals in water/wastewater by AAS
5. Determination of sodium and potassium in water by Flame photometry
6. Determination of carbon using Total organic carbon analyzer
7. Sample preparation and analysis using GC
8. Sample preparation and analysis using HPLC
9. Sample preparation and analysis using FTIR
10. Sample preparation and analysis using XRD
11. Sample preparation and analysis using XRF
12. Sample preparation and analysis using TGA
13. Sample preparation and analysis using DSC

**Minimum 8 experiments shall be offered*

Text Books:

1. K. Qu, D. Dan, Environmental Analytical Chemistry, 1st Edition, Elsevier, 2023.
2. P. Patnaik, Handbook of Environmental Analysis, 3rd Edition, CRC Press, 2017.

Reference Books/ Sources:

1. R. S. Khandpur, Hand Book of Analytical Instrumentation, 3rd Edition, McGraw Hill, 2015.
2. N. Grinberg, S. Rodriguez, Ewing's Analytical Instrumentation Handbook, 4th Edition, CRC Press, 2019.
3. F. M. Dunnivant, Environmental Laboratory Exercises for Instrumental Analysis and Environmental Chemistry, Wiley, 2004.

Course Outcomes (CO):

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

1. Develop skills to work on various analytical instruments used for environmental analysis.
2. Understand the principle and procedure various analytical instruments.
3. Summarize the various analytical techniques used for analyzing pollutants present in water, wastewater, solid wastes and soil samples.
4. Examine the analytical techniques for identification and quantification of various pollutants.
5. Utilize suitable analytical techniques for characterization of water, wastewater, solid wastes and soil samples.

EEPL602 WATER AND WASTEWATER DESIGN AND DRAWING LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives

The course enforces the design aspects and drawing skills and capabilities to prepare engineering drawings of water/wastewater collection and treatment facility along with plant layouts.

- Typical drawing of water distribution system
- Gravity type circular cascade aeration unit
- Plain sedimentation tank
- Sand filters
- Hydraulic flow diagram of typical/designed water treatment
- Defluoridation tank
- Screening and Grit Chamber
- Primary Sedimentation Tank
- Aeration Tank and Secondary Sedimentation Tank
- Trickling Filter and Rotating Biological Contactor (RBC)
- Aerated Lagoon and Stabilization Pond.
- Anaerobic Digester and Sludge Drying Beds
- Hydraulic Profile of Conventional Wastewater Treatment System
- Septic Tank, Dispersion Trench and Soak Pit
- Flowchart of ETP for industries
- Flowchart for CETP

**Minimum 8 design and drawings shall be offered.*

Reference Books/ Sources

1. Syed. R. Quasim, Wastewater Treatment Plants: Planning, Design and Operation, Holt Rinehart and Winston, CRC Press Inc., 1999.
2. Central Public Health & Environmental Engineering Organisation (CPHEEO), Manual on Sewerage and Sewage Treatment Systems CPHEEO Manual, New Delhi, 2013.
3. A.P. Sincero, G.A. Sincero, Environmental Engineering: A Design Approach, Pearson Education India, 2015.
4. Central Public Health & Environmental Engineering Organisation (CPHEEO), Water Supply and Treatment CPHEEO Manual (Drink from Tap), New Delhi, 2024.
5. B.S.N. Raju, Water Supply and Wastewater Engineering, Tata McGraw Hill Pvt. Co. Ltd., New Delhi, 1995.
6. M.J. Hammer, M.J. Hammer, Jr., Water and Wastewater Technology, 7th Edition, John Pearson, 2011.

Course Outcomes (CO):

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

1. Construct the layout map of water supply system, labelling the details and prepare a typical house plumbing connection.
2. Design and develop the typical drawings of selected water treatment system showing the various component.

3. Design and develop the typical drawings of selected wastewater treatment system showing the various component.
4. Design and develop the typical flowcharts for ETP and CETP.
5. Design and develop the drawings related to semi urban and rural sanitation systems.

EEPC701 SUSTAINABLE DEVELOPMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives

The course introduces the principles of sustainable development, explores the relationship between development, environment, and society, and examines global and national sustainability challenges. It also analyzes tools, strategies, and policies for sustainability.

Unit 1: Introduction to Sustainable Development **9**

Definition and evolution, Brundtland Report ,Millennium Development Goals (MDGs) to Sustainable Development Goals (SDGs) ,Key challenges: climate change, population, inequality ,Interdisciplinary nature of sustainability.

Unit 2: Dimensions and Principles **9**

Three pillars of sustainability: environment, economy, and society ,Carrying capacity, Equity and justice, Intergenerational and intra-generational equity ,Ecological footprint and biocapacity.

Unit 3: Global and National Frameworks **9**

UN Sustainable Development Goals, Paris Agreement ,National Action Plan on Climate Change (NAPCC),State Action Plans, ESG (Environmental, Social, Governance) indicators, Green GDP.

Unit 4: Sectoral Approaches and Technologies **9**

Sustainable water management, Renewable energy and energy efficiency, Sustainable urbanization, Waste minimization, Green buildings and transportation, Circular economy, Life Cycle Assessment (LCA), Case studies from India and global best practices.

Unit 5: Governance, Participation, and Policy Tools **9**

Environmental legislation and international protocols, EIA and SEA, Public participation and stakeholder engagement, Role of NGOs, corporates (CSR), and communities, Education and communication for sustainability. Industrial Ecology concepts: closed-loop systems.

Recommended Reading:

1. R.W. Kates, et al. (2001). Sustainability Science. Proceedings of the National Academy of Sciences (PNAS), 98(21), 12457–12463. https://doi.org/10.1073/pnas.1116097108
2. J.M. Harris. (2017). Environmental and Natural Resource Economics: A Contemporary Approach (4th ed.). Routledge.

Reference Books/ Sources

1. UNDP**,** UNEP**,** & MoEF&CC. (Various Years). Reports on Sustainable Development Goals (SDGs), Human Development, and Sustainability Indices. United Nations Development Programme, United Nations Environment Programme, and Ministry of Environment, Forest and Climate Change, Government of India. Available at: https://www.in.undp.org, https://www.unep.org, https://moef.gov.in
2. ICLEI & TERI. (Various Years). Local and Regional Sustainability Case Studies and Tools. ICLEI – Local Governments for Sustainability, and The Energy and Resources Institute. Available at: https://www.iclei.org, https://www.teriin.org

3. J.D. Sachs. (2015). The Age of Sustainable Development. Columbia University Press.

Course Outcomes (CO):

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

1. Explain the concept, need, and historical evolution of sustainable development
2. Interpret the environmental, social, and economic pillars of sustainability
3. Analyze global frameworks and the Sustainable Development Goals (SDGs)
4. Examine sustainable practices in energy, water, waste, and land use
5. Understand policy instruments and participatory approaches for sustainable planning.

EEPL702 ENVIRONMENTAL FIELD LABORATORY

(Credits: 2; Practical: 60 contact hours)

Objectives:

To provide hands-on experience in environmental monitoring and assessment through field studies, enabling students to collaborate with local governance bodies and rural communities for implementing sustainable solutions in areas such as water quality, waste management, air and noise pollution, sanitation, and biodiversity conservation.

Field studies in Environmental Engineering can be collaboratively facilitated with village panchayats or municipalities, and rural regions can be adopted for long-term environmental monitoring and sustainability projects. Adopting Rural Regions for Sustainability Initiatives, Establish long-term environmental monitoring stations in selected villages. Develop community-driven sustainability projects such as rainwater harvesting, organic farming, and clean energy adoption. Train local stakeholders and students in environmental monitoring and conservation practices.

Integration of Field Studies with Local Governance

1. **Water Quality Assessment**
   Collaborate with local authorities to test drinking water sources Assess contamination levels and suggest water treatment solutions.
2. **Solid Waste Management Studies**
   Conduct waste audits in villages or municipal wards. Work with panchayats to implement waste segregation and composting initiatives.
3. **Air and Noise Pollution Monitoring**
   Set up monitoring stations in rural and semi-urban areas. Evaluate the impact of vehicular and industrial emissions.
4. **Sanitation and Wastewater Management**
   Study local sewage disposal methods. Propose decentralized wastewater treatment systems.
5. **Ecological and Biodiversity Conservation**
   Assess deforestation, wetland degradation, or loss of biodiversity in rural areas. Engage communities in afforestation and conservation projects.

Course Outcomes (CO):

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

1. Conduct field-based assessments of water, air, noise, and solid waste in rural and urban settings.
2. Analyze environmental data to identify local challenges and propose practical solutions.
3. Collaborate with local governance bodies for implementing sustainable environmental practices.
4. Develop and demonstrate community-driven sustainability projects.
5. Apply environmental monitoring techniques for real-world problem solving and reporting.

EEPL703 ENVIRONMENTAL MANAGEMENT SYSTEM AND AUDITING

(Credits: 3; Lectures: 45 contact hours)

Objectives

To explain the principles and need for environmental management systems in industries and organizations, to impart knowledge of environmental policies, regulations, and ISO standards.to train students in EMS design, documentation, implementation, and auditing, to develop skills for environmental performance evaluation and sustainability reporting, to familiarize with emerging digital tools and AI applications in EMS.

Unit 1: Introduction to Environmental Management Systems **9**

Evolution and objectives of EMS, EMS vs. EIA vs. EMP, Environmental issues driving EMS adoption, Benefits and challenges of EMS implementation, Overview of ISO 14001, EMAS, and other EMS frameworks. Concept of continual improvement.

Unit 2: Environmental Policy, Planning, and Regulatory Framework **9**

Environmental policy formulation: Vision, mission, and commitment statements. Identification of aspects and impacts: Methods to assess significance. Legal and regulatory compliance: Environment Protection Act, 1986.Air and Water Acts. Hazardous Waste Management Rules. Objective and target setting. Integration with Sustainable Development Goals.

Unit 3: EMS Implementation and Operation **9**

Roles, responsibilities, and resources, Training, awareness, and competence. Communication strategies (internal and external). Documentation structure: EMS manual, procedures, records. Operational control measures. Emergency preparedness and response.

Unit 4: Environmental Performance Evaluation and Auditing **9**

Types of audits: Internal, external, compliance, certification. Audit protocols and planning. Data collection and analysis for performance indicators. Management review process. Non-conformity management and corrective actions. ISO 14031: Environmental Performance Evaluation guidelines.

Unit 5: Digital Tools, AI Applications, and Case Studies **9**

Life Cycle Assessment (LCA) and eco-labelling. Sustainability reporting (GRI Standards, ESG frameworks). Digital EMS platforms and IoT integration. AI applications in EMS: Predictive analytics for environmental risk, automated compliance monitoring, AI dashboards and reporting tools. Case studies of EMS in Indian and global industries (e.g., manufacturing, construction, mining). Emerging trends: Block chain for compliance, digital twins for environmental performance.

Text books

1. Uberoi, N.K. Environmental Management. Excel Books, New Delhi. ISBN: 9788174463404, 2004.

2. Sachin grover, Ramesh c grover, Implementing integrated management system for quality, environment, occupational health & safety and energy: ISO 9001:2015/ISO14001:2015/ISO45001:2018/ISO50001: Notion Press; 1st edition, ISBN-13 : 978-1638735113, 2021

Reference Books/ Sources:

1. Prof. Sunil S.Rao & R.K.Jain, Industrial Safety, Health And Environment Management Systems KHANNA PUBLISHERS, ISBN-13 : 978-8174092106, 2000.
2. Peter Leeson, Introduction to ISO14001: A Pragmatic Approach to Environmental Responsibility, Independently published ISBN-13 : 979-8716723214
3. Leveraging Corporate Responsibility: The Stakeholder Route to Maximizing Business and Social Value, ISBN : 1107401526, Cambridge University Press, 2011.

Course Outcomes (CO):

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

1. Explain the purpose, scope, and components of EMS frameworks
2. Develop EMS documentation including policies, objectives, and procedures.
3. Conduct internal EMS audits and management reviews.
4. Evaluate and report environmental performance indicators using standards such as ISO 14031 and GRI.
5. Apply digital tools, IoT, and AI for effective EMS implementation and monitoring

EEPR704: PROJECT PHASE - I

(Credits: 3)

Objectives

To identify a specific problem related to environment and collecting information related to the same through detailed literature review. To identify a methodology to carry out the project.

Guidelines

In this course the student is assigned topics for carrying out research. Students shall work individually or form a group of 3 students and carry out the work. They can put forth their own plans of work, consolidate the set of objectives, hypothesis and methodology and commence preliminary studies. The project may be carried out either in the institution or in an industry. The students may either opt for the work done in this semester as Mini project and start another research work in the next semester or continue the same research in the next semester in EEPR801. Students are required to submit detailed project phase I report of the entire semester at the end of the semester. The students are to present the same before the committee constituted for review of the project.

Course Outcomes (CO):

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

1. Collect literature for any environmental problem.
2. Conduct comprehensive review of literature.
3. Identify research gaps
4. Summarize research objectives.
5. Select and design research methodology.

EEPR705 SEMINAR

(Credits: 1)

Objectives

To equip students with the communication skill that is necessary for oral dissemination of scientific and engineering concepts necessary to build a professional career. To make students refine their oral presentation skills.

Guidelines

It will be a forum for the students to dispense and gain insight into current and cutting-edge technologies in environmental engineering. Students are required to research a current topic or salient points from on-going research work. The research findings are to be presented individually. Students are encouraged to observe, learn, critique and question the presentations. The students will be evaluated by the committee constituted for monitoring the seminar.

Course Outcomes (CO):

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

1. Effectively communicate technical or academic content through oral presentation, visual aids, and audience engagement.
2. Examine the ability to research a topic, analyze relevant data or literature, and synthesize key information into a coherent presentation.
3. Evaluate issues related to the seminar topic, identify challenges, and propose logical, evidence-based solutions.
4. Analyze in-depth knowledge of the seminar topic and show the ability to apply this knowledge to real-world or theoretical problems.
5. Develop professionalism and team collaboration.

EEPR801: PROJECT PHASE - II

(Credits: 8)

Objectives

To carry out experiments to solve the identified problem based on the identified methodology. To develop skills to analyze and discuss the results obtained and make conclusions.

Guidelines

In this course the student may continue the research work commenced in the previous semester or start a new research work if opted for mini project in the previous semester EEPR704 course. Besides continuous assessment made throughout, at the end of the semester, the student submits a dissertation based on the research output which he/she has carried out, followed by extensive Viva-Voce.

Course Outcomes (CO):

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

1. Analyze a real-world or technical problem, define clear objectives, and design appropriate methodologies or solutions to address it.
2. Apply domain-specific knowledge, tools, and techniques to develop and implement the project effectively.
3. Analyze the plan, organize, and manage time, resources, and tasks to complete the project within given constraints.
4. Prepare structured and comprehensive reports, presentations and publications.
5. Collaborate effectively in teams, practice professional ethics, and demonstrate responsibility, accountability, and adaptability during the project lifecycle.

EEPR802 INTERNSHIP

(Credits: 2)

Objectives

To provide industrial exposure to students related to environmental engineering, policy and regulations.

Guidelines

The course offers thorough problem-based learning approach, guided by realistic and challenging industry requirements. The course includes 24 working days of on-job training on current industry-relevant problem through supervised self-learning approach. The students shall apply their classroom learning for identification of problem, execute analysis based on available literature, data& reports and present the output. The students will identify the problems on thematic area in consultation with the host industry/organization perform literature review, interaction with industry experts, define objective and relevant tasks to be performed and define the methods to be followed and tools to be used and finally write synopsis.

Course Outcomes (CO):

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

1. Construct the company profile by compiling various data.
2. Assess its Strengths, Weaknesses, Opportunities and Threats (SWOT) of the organization.
3. Determine the challenges and future potential for his / her internship organization in particular and the sector in general.
4. Test the theoretical learning in practical situations by accomplishing the tasks.
5. Apply various soft skills such as time management, positive attitude and communication skills during performance of the tasks assigned in internship organization.

LIST OF ELECTIVES

EEPE405 ENVIRONMENTAL LAW & POLICY

(Credits: 3; Lectures: 45 contact hours)

Objectives

The course aims to familiarize students with environmental laws and regulations at the national and international levels, focusing on their role in environmental protection, sustainability, and public health.

Unit 1: Introduction to Environmental Laws **9**

Overview of environmental law and its principles. Sources of environmental law: Constitutional provisions, statutory laws, and judicial decisions. Key principles: Precautionary principle, polluter pays, and sustainable development. Compensation, rehabilitation and resettlement.

Unit 2: National Environmental Legislation (India) **9**

The Constitution of India: Environmental provisions (Article 48A, Article 51A). Key Acts: Environment Protection Act (1986), The Air Act (1981) and Water Act (1974), The Wildlife Protection Act (1972), National Green Tribunal (NGT) and its role in environmental justice.

Unit 3: International Environmental Laws and Agreements **9**

Key international environmental agreements: Paris Agreement, Kyoto Protocol, and Basel Convention. Role of international organizations: UNEP, WHO, and the UNFCCC. Global environmental governance and the role of international courts.

Unit 4: Environmental Standards and Regulations **9**

Environmental Quality Standards: Air, water, and soil. Industrial pollution control: Hazardous Waste Management Rules. Role of Pollution Control Boards (CPCB, SPCBs) in monitoring and compliance.

Unit 5: Environmental Justice and Contemporary Issues **9**

Public Interest Litigation (PIL) and landmark cases (e.g., Ganga Pollution). Role of NGOs and citizen participation in environmental decision-making. Emerging issues: Climate change laws, waste management, and circular economy.

Text Books:

1. R.L. Revesz. Environmental Law and Policy. Foundation Press. (2020)
2. C.R. Sharma. Indian Environmental Law: Key Concepts and Legal Principles. Oxford Book Company. (2019).

ReferenceBooks/ Sources:

1. P. Taylor. International Environmental Law. Pluto Press. (1998).
2. A.R. Thakur. Environmental Policy and Law: Issues and Responses. Deep & Deep Pulications. (2015)
3. M. Anderson. Environmental Law: Text, Cases, and Materials. Oxford University Press. (2016).

Course Outcomes (CO):

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

1 Understand the fundamental principles and sources of environmental laws at national and international levels.

2 Analyze key national environmental laws, their significance, and application in environmental protection.

3 Evaluate the impact and effectiveness of international environmental agreements and frameworks.

4 Apply knowledge of environmental standards and regulations in real-world pollution control and waste management scenarios.

5 Analyze landmark cases and public interest litigation related to environmental protection, and understand the role of NGOs and citizens in environmental governance.

EEPE406 COMPUTER APPLICATION IN ENVIRONMENTAL ENGINEERING

(Credits: 3; Lectures: 45 contact hours)

Objectives

To provide students with knowledge on computer programming writing skills for a variety of environmental engineering applications and stresses the need for various software for the analysis.

Unit 1: Population Forecast Programs **5**

Arithmetic increase method, geometric increase method and incremental increase method.

Unit 2: Water Supply and Treatment Units Programs **10**

Rising main design, pumping unit. Water treatment units design: cascade aerator, plain sedimentation tank, clariflocculator tank, sand filters and disinfection

Unit 3: Wastewater Collection and Treatment Units Programs **10**

Screening, grit chamber, primary sedimentation tank, aeration tank, activated sludge process, trickling filter, sludge drying beds and septic tank.

Unit 4: Water and Air Quality Programs **10**

Water quality models for discharge of conservative and nonconservative waste in rivers, dissolved oxygen models for rivers (Streeter-Phelps equation). Effective stack height calculation, Gaussian plume model for gaseous and particulate dispersion from point sources. Design of particulate control devices, settling chamber and cyclone separators.

Unit 5: Softwares **10**

Introduction to CAD and its application to environmental engineering. Introduction to computer graphics applications. RMAIN, WATPLANT, DOWATTS, LOOP, QUALOOP, EPANET, SEWER, STREAM, ISCST/LT, CALINE, MIXING ZONE MODELS, SWMM, MATLAB.

Text Books

1. R.V. Thomann, J.A. Mueller, Principles of Surface Water Quality Modeling and Control, Pearson Education India, 1997.
2. A.P. Sincero, G.A. Sincero, Environmental Engineering, A Prentice Hall of India, 1999.

Reference Books/ Sources

1. S.K. Garg, Water Supply Engineering, Khanna Publishers, New Delhi, 2017.
2. C.S. Krishna Murthy, S. Rajeev, Computer Aided Design Software, Norosa Publishing House, 1998.
3. Central Public Health & Environmental Engineering Organisation (CPHEEO), Water Supply and Treatment CPHEEO Manual (Drink from Tap), New Delhi, 2024. Central Public Health & Environmental Engineering Organisation (CPHEEO), Manual on Sewerage and Sewage Treatment Systems CPHEEO Manual, New Delhi, 2013.

Course Outcomes (CO):

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

1. Outlines and writes the programmes related to population forecasting.
2. Analyze the water supply and treatment unit's programs.
3. Examine the wastewater collection and treatment unit's programs.
4. Develop the programs for the estimation of air and water quality systems.
5. Analyze the various software's related to water and air quality prediction, design of water supply system, sewerage system and air pollution control systems.

EEPE407 ECOLOGY AND ENVIRONMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives

To help students learn about the structure and function of ecosystem and their interactions between the environment. To provide knowledge on basic concepts of ecology and environment protection.

Unit 1: Ecosystems and Energy **10**

Definition of ecology; Energy of life; First and Second law of thermodynamics; Photosynthesis and cellular respiration; Flow of energy through ecosystems; Food web; Ecological pyramids; Ecosystem productivity; Human impact on net primary productivity.

Unit 2: Ecosystems and Physical Environment **8**

Cycling of materials within the ecosystems; Solar radiation: temperature changes with latitude and seasons; Atmosphere; Global Ocean; Weather and climate; Internal planetary processes: earthquakes and volcanoes.

Unit 3: Major Ecosystems **8**

Earth's major biomes: tundra, boreal forests, temperate forests, grasslands, deserts, savanna, tropical forests, vertical zonation; Aquatic ecosystems.

Unit 4: Population and Community Ecology **10**

Habitat; Definition; Population characteristics: size, density, growth rate and dispersion; ecological age structures and age pyramids; Interaction among populations. Biological communities; Characteristics of a community; Ecological succession; Successions in biosphere and lithosphere.

Unit 5: Environmental Protection and Sustainability **9**

Role of Government; Legal aspects; Initiatives by non-governmental organizations; Environmental education; Women education; Global environmental changes; Sustainable development: sustainable future, World commission of Environment and Development, education; Environment-development- sustainability linkages; Ecological sustainability.

Text Books:

1. D. M. Hassenzahl, M. C. Hager, N. Y. Gift, L. R. Berg, P. H. Raven, Environment, 10th Edition, Wiley, 2018.
2. R. N. Bhargava, V. Rajaram, K. Olson, L. Tiede, Ecology and Environment, 1st Edition, CRC Press, 2019.

Reference Books/ Sources:

1. E. Odum, Fundamentals of Ecology, 5th Edition, Cengage India Private Limited, 2017.
2. M. N. V. Prasad, Handbook of Ecological and Ecosystem Engineering, 1st Edition, Wiley, 2021.
3. V. Singh, Textbook of Environment and Ecology, Springer Nature Singapore, 2024.

Course Outcomes (CO):

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

1. Describe the ecosystems, its structure and key functions /services.
2. Realize the importance and working of natural ecosystems.
3. Summarize the major ecosystems of the world.
4. Understand the concepts of population and community in environmental management.
5. Analyze the linkages between environment, development, and sustainability.

EEPE408 ENVIRONMENTAL BIOTECHNOLOGY

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To impart understanding of the basic concepts of biotechnology in environmental applications. To make students learn the various biotechnology techniques used for remediation, monitoring and management of environmental pollutants in today's scenario. To make students learn on emerging bio-alternatives for the conventional and pollution intensive products.

Unit 1: Introduction **8**

Role of biotechnology; Enzymes: reactivity and regulation; Energy capture; Metabolism; Genetics: DNA and RNA, chromosomes, plasmids; Information flow: transcription, translation; Phylogeny; Recombinant DNA technology and applications.

Unit 2: Bioremediation **10**

Biosorption and Bioaccumulation; Microbial remediation technology; Phytoremediation; Bioremediation: types, applications. Biosurfactants: types and potential applications; Genetic engineering for remediation of pollution.

Unit 3: Bioleaching and Biomining **9**

Mechanisms of biomining; Techniques: in-situ, dump, heap, vat; Biofilm development; Micro-organisms; Metals recovered; Biomining technology: factors affecting the process, applications, challenges.

Unit 4: Environmental Monitoring and Management **10**

Biosensors: characteristics and types; Environmental monitoring: pesticides, pathogens, toxic elements, toxins, endocrine disrupting chemicals, other compounds. Environmental management: composting, vermicomposting.

Unit 5: Biofuels and Bioplastics **8**

Biofuel: raw materials for synthesis, biohydrogen, bioethanol, environmental impacts of biofuels, food security, advantages and disadvantages; Bioplastics: need, nature, classification, constituents, applications.

Text Books:

1. B. E. Rittmann, P. L. McCarty, Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw Hill Education, 2020.
2. G. Sibi, Environmental Biotechnology: Fundamentals to modern techniques, 1st Edition, Taylor & Francis Group, 2023.

Reference Books/ Sources:

1. K. Chojnacka, Biosorption and Bioaccumulation in Practice, Nova Science Publishers, Inc, 2009.
2. M. H. Fulekar, Environmental Biotechnology, Taylor & Francis Group, 2010.
3. N. Sharma, A. S. Sodhi, N. Batra, Basic concepts in Environmental Biotechnology, 1st Edition, Taylor & Francis Group, 2022.

Course Outcomes (CO):

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

1. Understand the basic concepts of biotechnology.
2. Analyze bioremediation, bioleaching and biomining techniques for remediation of water and soil.
3. Examine and monitor pollutants in water and wastewater using biosensors.
4. Apply biological methods for waste management.
5. Summarize the methods for the production of biofuels and bioplastics.

EEPE409 CLEANER PRODUCTION

(Credits: 3; Lectures: 45 contact hours)

Objectives

To introduce the importance, and different approaches of cleaner production in industries and to impart knowledge on environmental management tools for applying cleaner production principle.

Unit 1: Introduction **9**

Concept, evolution process and benefits of cleaner production (CP), implementation of CP principles and techniques. Effect of CP on industrial economy, steps of CP in the industrial companies, application of cleaner production. Global population growth and industrial impact on the environment. Effects of industrial pollution on public health and human behaviour-sustainable consumption.

Unit 2: Cleaner Production Methodology and Implementation **9**

Six steps methodology for CP, designation of CP team, analyse process steps, generating CP opportunities, selecting CP solutions, implementation, maintaining CP, technical solutions to implement CP, balance of material and energy barrier in the process of CP.

Unit 3: Environmental Management Practices and Sustainable Production **9**

Relationship between CP and environmental management system (EMS), EMS concept and its implementation steps, best available technology concept, CP tools and environmental management practices. Environmental producer responsibility, practices on cleaner production and sustainability. Sustainable production cases.

Unit 4: Support Instruments of Prevention Methods **9**

Life cycle analysis (LCA), elements of LCA, life cycle costing, eco labelling, circular economy, eco-design. International environmental standards, ISO 14001, environmental certifications, environmental audit and environmental statement.

Unit 5: Case Studies **9**

Industrial applications of CP, LCA, EMS and environmental audits, tracking environmental performance.

Text Books

1. Francisco José Gomes da Silva, Ronny Miguel Gouveia, Cleaner Production, Springer, 2020.
2. Prasad Modak C. Visvanathan, Mandar Parasnis, Cleaner Production Audit, Environmental System Reviews, No.38, Asian Institute of Technology, Bangkok, 1995.

Reference Books/ Sources

1. Paul L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw Hill International, 2004.
2. World Bank Group, Pollution Prevention and Abatement Handbook 1998: Towards Cleaner Production, World Bank Publications, 1999.
3. Kenneth L. Mulholland, Identification of Cleaner Production Improvement Opportunities, Wiley-Interscience, 2006.

Course Outcomes (CO):

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

1. Outline the importance of cleaner production strategies.
2. Apply the concept of cleaner production methodology and implementation.
3. Analyze the environmental management practices and sustainable production.
4. Analyze the various support instruments of prevention methods in cleaner production.
5. Examine the implantation of cleaner production project development.

EEPE410 MARINE POLLUTION AND CONTROL

(Credits: 3; Lectures: 45 contact hours)

Objectives

To educate the Coastal and Marine environment. To educate the ocean dynamics. To sources of marine pollution and methods for monitoring, modelling and control.

Unit 1: Marine and Coastal Environment **9**

Seas and oceans, continental area, coastal zone, properties of sea water, principles of marine geology. Coastal features, beaches, estuaries, lagoons, salt marshes, mangroves and sand dunes. The oceans and climate, coastal zone regulation in India. National and international treaties.

Unit 2: Ocean Hydrodynamics **9**

Wave theory, waves in shallow waters, refraction, diffraction and shoaling, approximations for deep and shallow water conditions. Tidal classification, general circulation of ocean waters, ocean currents. Coastal sediment transport, onshore offshore sediment transport. Beach formation and coastal processes. Tsunamis, storm surge, El Nino effect.

Unit 3: Marine Pollution Sources **9**

Sources of marine pollution, point and non-point sources, pollution caused by effluent discharge, oil exploration, dredging, offshore mining, port and harbour activities, power plants, agriculture runoff, plastic waste, marine debris and marine litter. Effects of marine pollution on marine water quality and coastal ecosystems.

Unit 4: Marine Pollution Monitoring **9**

Basic measurements, sounding boat, echo sounders, current meters, tide gauge, use of GPS– measurement of coastal water characteristics, sea bed sampling. Modelling of pollutant transport and dispersion, oil spill models, ocean monitoring satellites, applications of remote sensing and GIS in monitoring marine pollution, online marine pollution monitoring.

Unit 5: Marine Pollution Control Measures **9**

Marine discharges and effluent standards, pollution control strategies, marine outfall design selection of optimal marine outfall locations. Total maximum daily load (TMDL) applications, protocols in marine pollution control. Integrated coastal zone management (ICZM) and sustainable development.

Text Books

1. P. Senthil Kumar, Modern Treatment Strategies for Marine Pollution, Elsevier, 2021.
2. R. Clark, Marine Pollution, 5th Edition, OUP Oxford, 2001.

Reference Books/ Sources

1. P.C. Sinha, Marine Pollution, Anmol Publications Pvt Ltd, 1998.
2. E.A. Laws, Aquatic Pollution: An Introductory Text, 3rd Edition, John Wiley & Sons, 2000.
3. A. Reichelt-Brushett, Marine Pollution – Monitoring, Management and Mitigation, Springer, 2023.

Course Outcomes (CO):

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

1 Summarize the different components of marine and coastal environment.
2 Interpret the physical concepts lying behind the tides, waves, and oceanic currents and natural processes of various activities happening over the marine environment
3 Identify and measure the marine pollution levels and effects.
4 Apply the knowledge of remote sensing and GIS for monitoring marine environment water quality.
5 Outline the various marine pollution control measures.

EEPE411 ENVIRONMENTAL ECONOMICS

(Credits: 3; Lectures: 45 contact hours)

Objectives

To impart knowledge on the basics of economics and its applications in valuing the environment. To introduce economic instruments and economic policies for environmental management to the students.

Unit 1: Introduction **8**

Theory: demand, supply; Market analysis; Elasticity of demand and supply; Welfare analysis; Malthusian hypothesis; Gross national product and Gross domestic product; Factors essential to economic growth; Kuznet's curve; Trend in recent decades: economic, environment; Sustainable development.

Unit 2: Externalities **10**

Theory of externalities: accounting and internalizing environmental costs; Negative and positive externalities; Welfare analysis; Property rights and pollution: Coase theorem, free-rider and hand-out effects; Energy economics.

Unit 3: Common Resources and Public Goods **8**

Economics of fishery; Incentives for overfishing; Marginal analysis; Economic policies for fisheries management; Managing common property resources; Public goods economics; Global commons.

Unit 4: Valuation of Environment **10**

Total economic value: use and non-use values; Valuation techniques; Revealed preference methods; Stated preference methods; Cost-benefit Analysis and discounting: overview, valuing human life, risk and uncertainty, benefit transfer, role in policy decisions. Economic analysis of climate change.

Unit 5: Pollution Control **9**

Optimal level of pollution; Equimarginal principle; Policies for pollution control: Emission standards, technology-based approaches, pollution taxes, tradable pollution permits; Scale of pollution impacts; Assessing pollution control policies; Policies in practice.

Text Books:

1. J. M. Harris, B. Roach, Environmental and Natural Resource Economics: A Contemporary Approach, 5th Edition, Routledge, Taylor & Francis Group, 2022.
2. N. Hanley, J. F. Shogren, B. White, Introduction to Environmental Economics, 2nd Edition, Oxford University Press, 2013.

Reference Books/ Sources:

1. H. Wiesmith, Environmental Economics: Theory and Application in Equilibrium, 2nd Edition, Springer Nature, 2022.
2. K. Aruga, Environmental and Natural Resource Economics, Springer Nature, 2022.
3. W. Buchholz, C. Reif, D. Rübbelke, Foundations of Environmental Economics, 2nd Edition, Springer, 2024.

Course Outcomes (CO):

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

1. Summarize the basic concepts and methods of economics used in environmental applications.
2. Understand the relation between environment, economic and development.
3. Examine and evaluate the common resources and public goods.
4. Apply cost-benefit analysis to find sustainable solutions for environmental issues.
5. Analyze the economic policies for environmental management.

EEPE412 CLIMATE SCIENCE

(Credits: 3; Lectures: 45 contact hours)

Objectives

To learn about weather and climate of our planet Earth. To impart understanding on atmosphere, its components and transfers happening in it. To help students gain knowledge and understanding on climate system and its interactions.

Unit 1: Introduction **8**

Climate system; Essential climate variables; Climate observation systems; Climate data centres. Measures using statistical procedures: Displays of statistical data, Descriptive statistics, expected frequency; Geo-spatial analysis: geographic information system (GIS), climate mapping; Climate classification techniques: Koppen classification, spatial synoptic classification.

Unit 2: Climate system **10**

Energy and entropy; Types of radiation; Radiation principles: greenhouse effect; Global radiation budget: solar radiation, ozone shield; Thermal energy across space and time; Energy considerations for the sun and earth; Controls on climate characteristics: latitudinal influences, clouds, surface characteristics, air mass exchanges, ocean circulation.

Unit 3: Water in Climate System **9**

Properties of water in earth's climate system; Humidity and saturation: vapor pressure, saturated air, relative humidity, dewpoint temperature, precipitable wate, saturation and clouds; Atmospheric stability: types, clouds, mechanism of cloud formation, fog, precipitation types; Monitoring moisture in the atmosphere.

Unit 4: Global atmospheric Circulation **9**

Forces that act on atmospheric circulation; Synergistic forcing on large scale wind circulation: geostrophic winds, gradient winds, surface winds in cyclones and anti-cyclones, monitoring wind circulations, boundary conditions; Pressure systems and wind belts; Circulation aloft; Connection from winds aloft to the surface.

Unit 5: Atmosphere-Ocean Relationship **9**

Air-sea interactions; Mean state of the ocean circulation: Ekman transport, upwelling and downwelling, thermohaline circulation; El-Nino, La Nina and southern oscillation; Other oscillations; Monsoons; Changing Ocean in a changing climate: Ocean warming, ocean as carbon sink, ocean acidification, sea-level-rise.

Text Books:

1. C. M. Kauffman, Our Changing Climate: Introduction to Climate Science, American Meteorological Society, 2017.
2. J. E. Martin, Introduction to Weather and Climate Science, Cognella Academic Publishing, 2013.

References Books / Sources:

1. A. Schmittner, Introduction to Climate Science, 1st Edition, Oregon State University, 2017.
2. E. A. Mathez and J. E. Smerdon, Climate Change, 2nd Edition, Columbia University Press, 2018.
3. G.M. Masters, W. P. Ela, Introduction to Environmental Engineering and Science, 3rd Edition, Pearson Education Limited, 2014.

Course Outcomes (CO):

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

1. Understand the importance of atmosphere and climate studies.
2. Summarize on earth's climate system and the transfers that occur in it.
3. Analyze the various formations of water in the atmosphere.
4. Analyze the different aspects of global circulation of the atmosphere.
5. Examine the interactions that exists between the atmosphere and the ocean.

EEPE506 BIODIVERSITY AND CONSERVATION

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To understand the fundamental concepts of biodiversity and conservation. To evaluate the threats to biodiversity loss. To impart knowledge on various methods for conservation of natural habitats.

Unit 1: Introduction **8**

Conservation biology; Ecosystem function; Biodiversity and species definition; Measurement: alpha, beta and gamma diversity; Rarity and diversity; Global patterns of biodiversity distribution; Biodiversity hotspots.

Unit 2: Threats to Biodiversity **8**

Global status of biodiversity; Main threats to globally threatened species; Causes of extinction; Invasive species; Trade in wildlife; Human-wildlife conflict; Industry as driver of biodiversity loss; Threats to Indian Biodiversity.

Unit 3: Conservation Methods **9**

Definition; Origins of conservation; Emergence of global conservation; IUCN and global biodiversity conservation; Conservation through ecosystem management; Value and ethics in conservation; Anthropocene: novel ecosystems, ecology of non-native and invasive species, conservation.

Unit 4: Terrestrial and Aquatic Systems **12**

Terrestrial system: heterogeneity, habitat loss, fragmentation, isolation and degradation; Conservation: protected areas, human modified landscapes; Aquatic systems: challenges, Management of freshwater habitats; Wetlands, pools and ponds; Marine habitats: biodiversity, overexploitation, conservation methods.

Unit 5: Biodiversity and Climate Change **8**

Climate and climate change; Global fingerprint of climate change on biodiversity; Foundational tools for assessing future impacts; Conservation strategies; Policy initiatives.

Text Books:

1. F. V. Dyke, R. L. Lamb, Conservation Biology: Foundations, Concepts, Applications, 3rd Edition, Springer Nature, 2020.
2. K. V. Krishnamurthy, An Advanced Textbook on Biodiversity: Principles and Practice, Oxford & IBH Publishing Co Pvt. Ltd, 2024.

Reference Books/ Sources:

1. D. W. Macdonald, Biodiversity Conservation: A Very Short Introduction, Oxford University Press, 2023.
2. G. A. Lameed, Biodiversity Conservation and Utilization in A Diverse World, In Tech, 2012.
3. K. J. Gaston, J. I. Spicer, Biodiversity: an introduction, John Wiley & Sons, 2013.

Course Outcomes (CO):

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

1. Understand the basic concepts of biodiversity and its measurement.
2. Examine the threats to biodiversity loss.
3. Apply strategies for the conservation of biodiversity.
4. Examine the importance of various conservation methods used for the conservation of terrestrial and aquatic biodiversity.
5. Analyze the biodiversity loss in changing climate.

EEPE507 ENVIRONMENTAL TOXICOLOGY

(Credits: 3; Lectures: 45 contact hours)

Objectives:

The course aims to provide information on the scope and application of toxicological principles, measures, and factors. Students will learn about contaminants, their fate, toxicity testing principles and analysis of exposure.

Unit 1: Introduction **9**

Definition and brief history; Fundamental models of toxicology; Classification of toxicological effects; Adverse outcome pathway; Complexity theory; Physicochemical properties of pollutants; Time and mode of exposure; Environmental factors; Biological factors affecting toxicity; Mixtures and their effect on toxicity; Climate change and toxicology.

Unit 2: Toxicity Testing Methods **8**

Standard methods; Classification of toxicity tests; Design of toxicity tests; Multispecies toxicity tests: design, nature, examples; Specific toxicity tests; Use of selected test species: aquatic vertebrates and invertebrates.

Unit 3: Analysis of Exposure Response and Contaminants **10**

Exposure response curve; Thresholds and hormesis; Hypothesis testing; Probit analysis; Curve fitting and regression modelling; Contaminants: gaseous pollutants, fluoride, metals, emerging contaminants including microplastics, engineered nanomaterials, insecticides, pharmaceuticals.

Unit 4: Fate and Transport of Contaminants **9**

Transport mechanisms; Persistence; Bio-transport; Abiotic transportation; Multimedia box models; Equilibrium; Fugacity approach; Bioconcentration and Biomagnification; Bioavailability.

Unit 5: Metabolism of Toxic Substances in Cells and Organisms **9**

Damage process; Mechanisms of action; Specific modes of action; Receptor-mediated toxicity and endocrine disruption; Adverse outcome pathway models; Quantitative structure-activity relationships.

Text Books:

1. S. M. Roberts, R. C. James, P. L. Williams, Principles of Toxicology: Environmental and Industrial Applications, 3rd Edition, John Wiley & Sons, Inc, 2015.
2. W. G. Landis, R. M. Sofield, M. H. Yu, Introduction to Environmental Toxicology, 5th Edition, CRC Press, Taylor & Francis Group, 2018.

Reference Books/ Sources:

1. M. H. Yu, H. Tsunoda, M. Tsunoda, Environmental Toxicology, 3rd Edition, CRC Press, Taylor & Francis Group, 2011.
2. R. B. Philp, Ecosystems and Human Health: Toxicology and Environmental Hazards, 3rd Edition, CRC Press Taylor & Francis Group, 2013.
3. T.P. Mommsen, T.W. Moon, Environmental Toxicology, Volume 6, Elsevier B.V., 2005

Course Outcomes (CO):

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

1. Understand the basic concepts of toxicology and the factors affecting toxicity of a contaminant.
2. Make use of testing methods to determine toxicity of contaminants.
3. Analyze the exposure of living organisms to various contaminants.
4. Summarize various contaminants, their fate and transport in the environment.
5. Determine the metabolism of contaminants in living organisms.

EEPE508 GREEN BUILDINGS AND SUSTAINABLE INFRASTRUCTURE

(Credits: 3; Lectures: 45 contact hours)

Objectives

To understand the concept of green building and sustainable development, materials and building techniques that are eco-friendly and cost effective, green building rating systems

Unit 1: Introduction

Green buildings and sustainable development, cost effective construction - different types of materials and their availability, recycling of building materials – brick, concrete, steel- plastics; environmental issues related to quarrying of building materials.

Unit 2: Environment-friendly and Cost-effective Building Technologies 9

Different substitute for wall construction, Flemish bond - rat trap bond, arches, panels, cavity wall, ferro cement and ferro concrete constructions; wall and roof panels, beams, columns, door and window frames, water tanks, septic tanks, alternate roofing systems, HVAC System design, ,Selection of cooling towers, Precooling of fresh air, Interior lighting system

Unit 3: Contribution of Buildings towards Global Warming 9

Carbon footprint, global efforts to reduce carbon emissions; green buildings: features, necessity, environmental, economical, health and social benefits; green materials, comparison of initial cost of green v/s conventional building, life cycle cost of buildings.

Unit 4: Green Building rating Systems 9

BREEAM – LEED - GREEN STAR -BEEs, GRIHA (Green Rating for Integrated Habitat Assessment) for new buildings: purpose, key highlights

Unit 5: Energy, water and waste management 10

Utility of solar energy in buildings, concepts of solar passive cooling and heating of buildings. low energy cooling. concepts of green composites, water utilization in buildings, low energy approaches to water management, management of solid wastes, management of sullage water and sewage, urban environment and green buildings, green cover and built environment.

Text books

1. K.S. Nanjunda K S Jagadish, B.V. Reddy, V. Rao, Alternative Building Materials and Technologies, New Age International Private Limited, New Delhi, 2023.
2. Manual on Good Construction Management Practices: GRIHA Council Publication, 1st Edition, GRIHA Council Publication, 2024

Reference books/ Sources

1. C. J. Kibert, Sustainable Construction: Green Building Design and Delivery, Wiley, 2022.
2. D. Mumovic, M. Santamouris, A Handbook of Sustainable Building Design and Engineering, An Integrated Approach to Energy, Health and Operational Performance, Routledge, London, 2018.
3. A.H. Savla, Green Building : Principles & Practices, Notion Press, India, 2021.

Course Outcomes (CO):

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

1) Understand the concept of green buildings and sustainable development
2) Analyze the cost effectiveness and suitability of different materials
3) Understand the effects and impacts of buildings and global warming
4) Apply the concept of rating of green buildings
5) Evaluate the environmental quality with respect to green building

EEPE509 INTRODUCTION TO CLIMATE CHANGE

(Credits: 3; Lectures: 45 contact hours)

Objectives

To impart knowledge on the basics of climate change and its drivers. To make the students realize the importance of climate change and the various impacts caused by it. To introduce the global policy measures in climate change management to the students.

Unit 1: Drivers of Climate Change **9**

Current state of the climate system; Natural drivers: solar changes, changes in earth's orbit, geologic contributions, Feedbacks; Biogeochemical cycles; Greenhouse gas contributions: trends, aerosols, changes in land use and land cover; Anthropogenic versus natural forcing of climate.

Unit 2: Paleoclimatology **9**

Proxy climate data sources: historical media, dendrochronology, pollen analysis, ocean sediments, speleothems, corals, glacial ice cores, geological record; Climates of geologic times: climates of Pleistocene, glaciers and landscapes, chronology and temperature trends, Heinrich events, climates of the Holocene, climates of the last millennium.

Unit 3: Future Projections **9**

Models; Global climate models; Weather vs climate models; Model limits; Physical basis for modelling earth's climate; Cycles and analogs; Assessment of climate model output; Changes in extreme events: convective weather, heavy precipitation, tropical cyclones, winter storms, drought; Climate singularities; Climate tipping points.

Unit 4: Vulnerabilities **10**

Ocean and cryosphere: rising sea level, shrinking glaciers, arctic environment, marine life; Human: agriculture, global food supply, security considerations; Biosphere: human health, ecosystem limitations, species migrations.

Unit 5: Policy Responses **8**

Policy lessons from stratospheric ozone depletion; UN Framework Convention on Climate Change; Kyoto Protocol; Doha amendment, Paris agreement; Geoengineering management and policy; Knowledge base expansion; Climate, sustainability and stewardship; Economic perspective: free markets, government regulations, analytic tools.

Text Books:

1. C. M. Kauffman, Our Changing Climate: Introduction to Climate Science, American Meteorological Society, 2017.
2. G. M. Masters, W. P. Ela, Introduction to Environmental Engineering and Science, 3rd Edition, Pearson Education Limited, 2014.

References Books / Sources:

1. IPCC sixth Assessment Report, Cambridge University Press, 2023.
2. A. E. Desseler, Introduction to Modern Climate Change, 3rd Edition, Cambridge University Press, 2022.

3. K. McGuffie, A. Henderson-Sellers, The Climate Modelling Primer, 4th Edition, John Wiley & Sons, Ltd, 2014.

Course Outcomes (CO):

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

1. Examine the various drivers of the changing climate.
2. Apply the paleoclimatology data for the better understanding of climate change and its impacts.
3. Analyze the climate models for future projections of climate.
4. Understand the impacts caused by climate change to the humans and the environment.
5. Examine the various policy measures framed and followed by the world to curb climate change.

EEPE510 RESOURCE RECOVERY FROM WASTE

(Credits: 3; Lectures: 45 contact hours)

Objectives

Understand the potential of waste for material and energy recovery; learn principles of recovery processes; explore recycling, composting, biogas, and waste-to-energy technologies; analyze environmental, economic, and policy aspects; and promote circular economy and zero waste practices.

Unit 1: Introduction to Resource Recovery **9**

Waste hierarchy and resource recovery concept, Types of recoverable wastes, Principles of circular economy, Material flow and lifecycle thinking, Global trends and case studies.

Unit 2: Material Recovery Technologies **9**

Recycling of plastics, metals, glass, paper, and e-waste, Source separation and sorting systems, Mechanical and chemical recycling, Secondary raw material market, Role of informal sector.

Unit 3: Organic Waste Valorization **9**

Composting and vermicomposting techniques, Anaerobic digestion and biogas production, Digestate management and nutrient recovery, Black soldier fly composting, Agricultural and food waste valorization.

Unit 4: Energy Recovery Technologies **9**

Incineration and waste-to-energy processes, Refuse-derived fuel (RDF) and solid recovered fuel (SRF), Pyrolysis, gasification, and plasma treatment, Energy balance and emissions control, Co-processing in industries.

Unit 5: Policy, Economics, and Sustainability **9**

Policy frameworks and incentives for resource recovery, Extended Producer Responsibility (EPR) and polluter-pays principle, Economic feasibility and business models, Environmental and social sustainability, Successful case studies and innovations.

Text Book:

1. B. Sundarakani, et al. Resource Recovery from Wastes: Towards a Circular Economy. Springer.2017.
2. E. Worrell, & M. Reuter. Handbook of Recycling: State-of-the-Art for Practitioners, Analysts, and Scientists. Elsevier. 2014.

Reference Books/ Sources:

1. World Bank & UNEP. Global Waste Management Outlook and Circular Economy Insights. United Nations Environment Programme & World Bank. Available at: https://www.worldbank.org & https://www.unep.org2018
2. CPCB & MoEFCC. Composting, RDF, and WTE Standards in India. Central Pollution Control Board & Ministry of Environment, Forest and Climate Change, Government of India. Available at: https://cpcb.nic.in & https://moef.gov.in

3. ISWA & OECD. Global Best Practices on Recycling and Energy Recovery. International Solid Waste Association & Organisation for Economic Co-operation and Development. Available at: https://www.iswa.org & https://www.oecd.org

Course Outcomes (CO):

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

1 Identify types of waste and their resource potential

2 Explain principles of energy and material recovery from waste

3 Apply technologies for composting, biogas, recycling, and WTE

4 Analyze process efficiency and environmental impact

5 Evaluate economic viability and sustainability of recovery systems

EEPE511 FATE AND TRANSPORT OF CONTAMINANTS IN THE ENVIRONMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives

To educate the students on the mechanism of transport and fate of contaminants in the geosphere of the environment.

Unit 1: Equilibrium and Transport Mechanisms **9**

Concentration and phase density, air-water equilibrium, soil-water equilibrium, earthen solid-air equilibrium. Liquid-chemical equilibrium, thermal equilibrium at environmental interfaces. Diffusion and mass transfer, molecular diffusion, Ficks Law, eddy diffusion, mass transfer theories, fundamentals of heat and mass transfer.

Unit 2: Exchange Rates between Air and Water **9**

Desorption of gases and liquids from aerated basins and rivers, completely mixed basin, plug flow basin, gas exchange rates between the atmosphere and the surface of rivers, exchange of chemical across the air-water interface of lakes and oceans.

Unit 3: Exchange Rates between Water and the Earthern Material **9**

Dissolution of chemicals, natural convection dissolution, water interface, mass transfer coefficients at the sediment, water interface. Flux of chemicals between sediment and the overlying seawater, movement of chemicals through the benthic boundary layer.

Unit 4: Exchange Rates Between Air and Soil **9**

Turbulence above the air-soil interface, the Richardson number, chemical flux rates through the lower layer of the atmosphere, evaporation of liquid chemicals spilled on land, chemical flux rates through the upper layer of earthen material.

Unit 5: Contaminant Transport Analysis **9**

Potential theory, potential functions, stream function, travel time along with stream functions. Residential time distribution theory, analysis of chemical spills and contaminant plumes, Fourier analysis of initial value, point spill analysis, vertically mix spill analysis, horizontal plane source analysis.

Text Books

1. L.J. Thibodeaux, Environmental Chemodynamics: Movement of Chemicals in Air, Water and Soil, 2nd Edition, Wiley-Intercedence, New York, 1996.
2. J.L. Schnoor, Environmental Modelling: Fate and Transport of Pollutants in Water, Air and Soil, Wiley-Interscience, 1996.

Reference Books/ Sources

1. J.C. Walton, Fate and Transport of Contaminants in the Environment, College Pub, 2008.
2. R.J. Charbeneau, Groundwater Hydraulics and Pollutant Transport, Waveland Pr Inc, 2006.
3. H.F. Hemond, E.J. Fechner, Chemicals Fate and Transport in the Environment, 3rd Edition, Academic Press, 2014.

Course Outcomes (CO):

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

1 Summarize the equilibrium and transport mechanisms.
2 Analyze the exchange rates between air and water.
3 Examine the exchange rates between water and soil.
4 Analyze the exchange rates between air and soil.
5 Examine the contaminant transports in the environmental systems.

EEPE512 BIOENERGY AND BIOFUELS

(Credits: 3; Lectures: 45 contact hours)

Objectives

Introduce students to the principles and types of bioenergy and biofuels, to understand biomass resources and their environmental implications, to explain biochemical and thermochemical conversion technologies, to analyze life cycle impacts, sustainability, and emissions associated with bioenergy systems to familiarize students with bioenergy policies, regulations, and commercialization challenges.

Unit I – Introduction to Bioenergy **8**

Definitions and classification: bioenergy, biofuels, biopower. Overview of global and Indian bioenergy potential. Biomass characteristics: proximate and ultimate analysis. Comparison with fossil fuels. Sustainability and climate change relevance.

Unit II – Biomass Resources and Pre-treatment **8**

Types of feedstocks: lignocellulosic biomass, energy crops, algae, agricultural and industrial residues. Harvesting, storage, densification. Pre-treatment methods: Size reduction, drying, Torrefaction, pyrolysis pre-processing. Environmental considerations in biomass supply chain.

Unit III – Biochemical Conversion Processes **10**

Anaerobic digestion and biogas production. Process microbiology and parameters, digesters and gas upgrading. Fermentation to produce bioethanol. Saccharification and hydrolysis, yeast fermentation. Biodiesel production, Transesterification processes, Feedstocks and catalysts. Algal biofuels: cultivation and harvesting basics.

Unit IV – Thermochemical Conversion Processes **10**

Combustion: principles, systems, and emission control. Pyrolysis: slow and fast pyrolysis, bio-oil upgrading. Gasification: fixed-bed, fluidized-bed, downdraft systems. Hydrothermal liquefaction. Syngas cleanup and Fischer-Tropsch synthesis.

Unit V – Sustainability, Policies, and Emerging Trends **9**

Life Cycle Assessment (LCA) of bioenergy systems. GHG emissions and air pollutants from biofuels. Circular bioeconomy and waste-to-energy integration. Bioenergy policies and regulations: Indian and international. Economic and social considerations in biofuel deployment. Emerging technologies: 3rd and 4th generation biofuels.

Text books:

1. Arumugam, Production of biodiesel from Non- edible sources technological updates, Elsevier Publication, ISBN 978-0-12-824295-7, 2022.
2. Sachin Kumar, Suresh Sundaramurthy, Deepak Kumar, Anuj K. Chandel Clean Energy Transition-via-Biomass Resource Utilization -A Way to Mitigate Climate Change, Springer Singapore, ISBN 978-981-97-6320-7, 2024

Reference Books/ Sources:

1. Robbie Larkin, Processes and Technologies in Biofuels and Bioenergy, Clanrye international ISBN-13 978-1632405463,2016
2. Ozcan Konur, Bioenergy and Biofuels, CRC Press, ISBN-13 : 978-1138032828, 2018.
3. Baskar Gurunathan, G Venkatesh, Biofuels and Bioenergy: Biorefinery and Circular Bioeconomy Approaches, Woodhead Publishing ISBN-13 : 978-0443292552,2024.

Course Outcomes (CO):

On successful completion of the course, the students are able to

1 Identify different biomass resources and assess their suitability for energy conversion. (Knowledge)
2 Explain biochemical and thermochemical processes used in biofuel production
3 Evaluate environmental impacts, emissions, and life cycle aspects of bioenergy systems.
4 Design a conceptual bioenergy system suitable for a specific application.
5 Critically discuss regulatory frameworks, sustainability standards, and commercialization pathways.

EEPE513 BIOCHEMICAL AND THERMOCHEMICAL CONVERSION

(Credits: 3; Lectures: 45 contact hours)

Objectives

This course aims to introduce students to the processes and technologies involved in the biochemical and thermochemical conversion of biomass and waste into energy, fuels, and value-added products. Students will learn the fundamental principles, applications, and environmental impacts of these conversion technologies.

Unit 1: Introduction to Biomass and Waste Conversion 8

Overview of Biomass: Types of biomass and waste. Biomass as a Renewable Resource: Role in energy production, sustainability, and environmental benefits. Feedstocks, Basic Conversion Principles: Introduction to biochemical and thermochemical conversion methods. Environmental Considerations: Sustainability, carbon footprint, and life cycle analysis of biomass conversion.

Unit 2: Biochemical Conversion Processes 10

Anaerobic Digestion: .Biogas production, factors influencing biogas yield, design of anaerobic digesters and reactors, applications Fermentation for Biofuels, Microbial fermentation principles for bioethanol, biobutanol, and other biofuels. Fermentation kinetics and parameters, types of fermenters, applications.

Unit 3: Thermochemical Conversion Processes 10

Combustion, Principles of combustion: Exothermic reactions and heat release. Factors influencing combustion efficiency: Temperature, oxygen availability, and feedstock properties. Applications: Power generation, industrial heating, and waste incineration. Gasification; principles, types of gasifiers, applications: Pyrolysis, Thermal decomposition of biomass at high temperatures. Products of pyrolysis: applications and char

Unit 4: Integrated Biochemical and Thermochemical Systems 10

Hybrid Systems for Bioenergy Production: Integration of anaerobic digestion and gasification, biogas and syngas co-processing., Co-generation and Biorefinery Systems: Maximizing energy recovery and value-added product production. Design and Optimization: Engineering challenges in integrating biochemical and thermochemical processes. Case Studies: Successful implementation of hybrid systems for waste-to-energy and biofuel production.

Unit 5: Environmental Impacts and Sustainability 7

Environmental Impacts of Conversion Technologies: Emissions (GHG, particulate matter), resource consumption, and waste generation. Life Cycle Assessment (LCA): Evaluating the environmental performance of biomass conversion technologies. Policy and Regulatory Issues: Waste management regulations, carbon credits, renewable energy incentives, Future Trends: Emerging technologies in bioenergy, challenges in scaling up, and research directions.

Text

1. J. Cheng. (2017). Biomass to Renewable Energy Processes. CRC Press.
2. V.C. Nelson, & K.L. Starcher. (2013). Introduction to Bioenergy. CRC Press.

Reference Books/Sources

1. S.S.Z. (Ed.). (2014). Biomass Conversion Technology: Principles and Applications. Wiley.
2. G. Lidén, & L.T.K. Nyman. (2013). Biochemical Engineering and Biotechnology. Springer.
3. N.S. Jayaraman, & G.N. Rao. (2011). Thermochemical Conversion of Biomass: Science and Technology. CRC Press.

Course Outcome (CO):

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

1	Understand and apply the principles of biochemical and thermochemical conversion.
2	Analyze and design systems for the production of renewable energy and biofuels.
3	Evaluate the sustainability and environmental impact of biomass conversion technologies.
4	Gain hands-on experience in energy recovery from biomass and waste materials.
5	Evaluate sustainable alternatives, innovations, and circular practices

EEPE605 CLIMATE CHANGE: MITIGATION AND ADAPTATION

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To gain knowledge on GHG emissions from various sectors. To impart understanding on various mitigation and adaptation measures used globally and sectorally to curb the impacts of climate change. To motivate students towards development of technologies with net zero emissions.

Unit 1: Emissions **9**

World's carbon budget and radiative forcing; global warming hotspots; CO_2 emissions rates and concentration levels; Temperature changes; Other type of emissions; Effects of emissions; Economic and social costs of carbon; Sources of emissions; Profiles of the big emitters; Mitigation policy; Vulnerable countries.

Unit 2: Energy, Transport, Industry **9**

Fossil fuels: production, emissions, subsidies, mitigation policies and actions; Electric power: emissions, renewable technologies, mitigation options, nuclear alternatives; Transport: emission patterns and trends, technologies and policies; Industry: emission patterns and trends, cement, steel, petrochemicals.

Unit 3: Building, Agriculture, Aquaculture, Forest **9**

Buildings: emissions, mitigation and adaptation measures; Agriculture: vulnerabilities, adaptation measures, emissions, mitigation measures, carbon sinks; Forests; Aquaculture: El Nino and La Nina, vulnerabilities, oceans as carbon sinks.

Unit 4: Reducing Emissions and Adaptation **9**

Carbon markets and GHG mitigation; Mitigation of GHGs; Adaptation: international context, disaster risks, systems thinking, threshold analysis, construction along coastal areas and rivers, climate change scenarios and pathways, impact chains, creating reductant infrastructure, urban centres, adaptive capacity.

Unit 5: Path to net zero **9**

Path to net zero: concept, energy, manufacturing, transport, mining/mineral production, chemical industry, construction, fugitive emissions, waste handling and disposal, afforestation and reforestation, circular economy, role of finance, stranded assets, inequality, culture and consumerism; Assessing climate policies; Carbon markets; Emission trading system; transition risks and financial risks; Lessons from the pandemic of 2020.

Text Books:

1. J. C. Shideler, J. Hetzel, Introduction to Climate Change Management, Springer Nature, 2023.
2. T. Brewer, Climate Change: An Interdisciplinary Introduction, Springer Nature, 2023.

References Books / Sources:

1. IPCC sixth Assessment Report, Cambridge University Press, 2023.

2. R. Y. Surampalli, T. C. Zhang, C. S. P. Ojha, B. R. Gurjar, R. D. Tyagi, C. M. Rao, Climate Change Modeling, Mitigation and Adaptation, American society of civil engineers, 2013.
3. A. E. Desseler, Introduction to Modern Climate Change, 3rd Edition, Cambridge University Press, 2022.

Course Outcomes (CO):

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

1. Summarize the sources and effects of GHG emissions.
2. Analyze the mitigation measures for GHG emissions in various sectors.
3. Analyze the adaptation measures for GHG emissions in various sectors.
4. Assess the various climate policies for reduction of carbon emissions.
5. Examine the path to net zero emissions in various sectors.

EEPE606 ENVIRONMENTAL NANOTECHNOLOGY

(Credits: 3; Lectures: 45 contact hours)

Objectives

The objective of this course is to get an insight of nano material for utilization in environmental conservation and to integrate theoretical and practical knowledge use of nanotechnology in environmental remediation.

Unit 1: Introduction **9**

Introduction, properties of nanomaterials, types of nanoparticles, types of engineered nanoparticles, environmental applications. Chemical synthesis of nanoparticles, biological synthesis of nanoparticles, natural nanomaterials, development of nanocomposites.

Unit 2: Advanced Characterization Methods **9**

Transmission electron microscopy, scanning tunnelling microscopy, atomic force microscopy, scanning electron microscopy, diffraction techniques, UV-vis spectroscopy, photoluminescence spectroscopy, infrared spectroscopy, surface area analysis, dynamic light scattering, Fourier transform infrared spectroscopy.

Unit 3: Nanomaterials for Remediation **9**

Nano membranes, nano meshes, nano fibres, nano clays and adsorbents, zeolites, nano catalysts, carbon nano tubes, bio-polymers, single enzyme nanoparticles, bio-metallic iron nanoparticles, nano semi-conductors, photo catalysis, nano-sensors. Environmental benefits of nanomaterials.

Unit 4: Nano-remediation Technologies **9**

Environmental nano-remediation technology, thermal, physico-chemical and biological methods, nanofiltration for treatment of waste, removal of organics, inorganics and pathogens. Nanotechnology for water remediation and purification. Treatment of hi-tech industrial waste waters using nano particles/modified structures/devices.

Unit 5: Health and Environmental Risks **9**

Health hazards, physicochemical properties of nanoparticles hazard, toxicity of nanoparticles, nanomaterials health effects, toxicity to plants, environmental hazards, risk management for nanomaterials, fate and transport of nanomaterials in the environment, analysis in environmental metrics, OSHA legislation.

Text Books

1. M. H. Fulekar, Bhawana Pathak, Environmental Nanotechnology, CRC Press, Taylor & Francis Group, 2018.
2. J. Kim, Advances in Nanotechnology and the Environment, 1st Edition, Pan Stanford Publishing Pte Ltd, 2011.

Reference Books/ Sources

1. A.K. Mishra, Application of Nanotechnology in Water Research, 1st Edition, Wiley-Scrivener, 2014.

2. M. Wiesner, J.-Y. Bottero, Environmental Nanotechnology: Applications and Impacts of Nanomaterials, 1st Edition, McGraw-Hill Education, 2007.
3. J.R. Lead, Environmental and Human Health Impacts of Nanotechnology, 1st Edition, Wiley-Blackwell (an imprint of John Wiley & Sons L, 2009.

Course Outcomes (CO):

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

1 Analyze the various types of nanoparticles and its synthesis methods.
2 Examine the various advanced characterization methods for nanomaterials.
3 Analyze the nanomaterials for remediation.
4 Examine the nano-remediation technologies.
5 Summarize the health and environmental risks due to nanoparticles.

EEPE607 FUNCTIONAL DESIGN OF RAINWATER HARVESTING SYSTEMS

(Credits: 3; Lectures: 45 contact hours)

Objectives

To meet the increasing demand of water. Assessment of site for rainwater harvesting potential and water uses. To avoid the flooding of roads. Supplement domestic water needs. To raise the underground water table.

Unit 1: Introduction **9**

Water and its importance, objectives of rainwater harvesting, principles, importance and issues. Site analysis for rainwater harvesting, water harvesting techniques, classification based on source, storage and use. Runoff harvesting, short-term and long-term techniques.

Unit 2: Groundwater **9**

Over-exploitation of groundwater, factors affecting groundwater recharge, need for artificial recharge and rainwater harvesting. Types of wells, drilling technology, design, construction and development of water wells, dug wells and bore wells, direct and reverse rotary drilling, cable tool and DTH hammer drilling, gravel packing and well development procedures.

Unit 3: Artificial Recharge Structures **9**

Types of pumps, various artificial recharge structures. Recharge ponds, recharge pits, percolation ponds, basin spreading, surface and subsurface dykes, recharge wells, recharge borewells. Rainwater harvesting in urban areas, structures, design and construction.

Unit 4: Maintenance and Monitoring of Rainwater Harvesting **9**

Estimation of probable runoff from an area including from roof tops, identify the runoff coefficient from different surfaces, identify water entry and exit points on a site. Calculate rainwater runoff volumes from different areas and surfaces, maintenance and monitoring of rainwater harvesting structures. Study of benefits, effects on local groundwater environments, remedial measures. Recycling of domestic water, sources of water for recharge in urban areas.

Unit 5: Construction and Establishing Rainwater Harvesting **9**

Precautions for source, construction and establishing rainwater harvesting structures. Exploration techniques and selection of artificial recharge zones, electrical resistivity investigations using horizontal profiling and vertical sounding techniques, interpretation of resistivity data in terms of subsurface geology. Importance of community participation in water conservation, advocacy for sustainable water policies and practices.

Text Books

1. C.A. Novak, E.V. Geisen, DeBusk M. Kathy, Designing Rainwater Harvesting Systems: Integrating Rainwater into Building Systems, John Wiley & Sons Inc, 2014.
2. A.S. Patel, Water Management - Conservation, Harvesting and Artificial Recharge, 1st Edition, New Age Publishers, 2007.

Reference Books/ Sources

1. K. Nageswara Rao, Water Resources Management: Realities and Challenges, New Century Publications, 2006.
2. M.L. Munjal, B. Venkatesham, Noise and Vibration Control, 2nd Edition, World Scientific, 2024.
3. E. G. Williams, Fourier Acoustics: Sound Radiation and Near Field Acoustic Holography, 1st Edition, Academic Press, 1999.

Course Outcomes (CO):

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

1 Summarize the importance rainwater harvesting systems.

2 Organize the issues related to over exploitation of groundwater.

3 Construct the various rainwater recharging structures.

4 Analyze the issues pertaining to monitoring and maintenance of rainwater harvesting structures.

5 Examine the construction and establishment of rainwater harvesting structures.

EEPE608 LANDFILL ENGINEERING AND REMEDIATION TECHNOLOGY

(Credits: 3; Lectures: 45 contact hours)

Objectives

Understand engineered landfill design, site selection, and environmental impact; analyze leachate and gas systems; study closure and post-closure care; and explore remediation of contaminated and Course Objectives: brownfield sites.

Unit 1: Fundamentals of Landfill Engineering **9**

Types and classification of landfills, Municipal, hazardous, and industrial landfills, Phases of landfill development, Landfill siting criteria, Regulatory framework and environmental clearance.

Unit 2: Landfill Design and Construction **9**

Design of landfill liner systems, Compacted clay liners, geomembranes, geotextiles, Leachate generation, control, and collection systems, Surface water management, Phased construction and cell design.

Unit 3: Leachate and Gas Management **9**

Leachate characteristics and treatment options, On-site and off-site treatment systems, Landfill gas generation and modeling, Gas collection, utilization, and flaring, Control of odor, explosion, and migration risks.

Unit 4: Landfill Closure and Post-Closure Management **9**

Closure design and cover systems, Final cover components and vegetative layer, Settlement and stability considerations, Long-term monitoring of leachate, gas, and groundwater, Legal and institutional responsibilities.

Unit5: Remediation Technologies and Case Studies **9**

Site assessment and risk analysis, In-situ and ex-situ remediation techniques, Soil vapor extraction, bioremediation, thermal treatment, Brownfield redevelopment, Case studies of landfill remediation and reuse projects.

Text Books:

1. R.E. Haug. (1993). The Practical Handbook of Compost Engineering. Lewis Publishers.
2. G. Tchobanoglous, & F. Kreith. (2002). Handbook of Solid Waste Management. McGraw-Hill Education.

Reference Books/ Sources:

1. P.A. Vesilind, & W. Worrell. (2002). Solid Waste Engineering. Cengage Learning.
2. D.E. Daniel. (1993). Geotechnical Practice for Waste Disposal. Springer.
3. A. Bagchi. (2004). Design of Landfills and Integrated Solid Waste Management. Wiley.

Course Outcomes (CO):

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

1 Identify the components and types of landfills

2 Explain site selection, design, and environmental impacts

3 Apply design methods for liners, leachate, and gas management systems

4 Analyze monitoring, closure, and post-closure requirements

5 Evaluate remediation technologies for landfill and contaminated sites

EEPE609 PLASTIC WASTE MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Prerequisites: Basics of Environmental Engineering or Solid Waste Management

Objectives

Understand types, sources, and challenges of plastic waste; learn relevant regulations and EPR; study recycling, reuse, and alternative technologies; analyze environmental and socio-economic impacts; and promote sustainable, circular economy-based solutions.

Unit I: Introduction to Plastic Waste **9**

Definition and classification of plastics, Types of plastic polymers and their applications, Sources and generation of plastic waste, Properties and degradation of plastics, Global and national trends in plastic waste generation.

Unit 2 Policy Framework and EPR Mechanism **9**

Plastic Waste Management Rules and amendments, Extended Producer Responsibility (EPR), Guidelines by CPCB and MoEFCC, SUP (Single-Use Plastics) ban and its enforcement, Basel Convention and international policies, Role of urban local bodies and stakeholders.

Unit 3: Collection, Segregation, and Processing **9**

Plastic waste collection systems, Sorting and segregation technologies, Material recovery facilities (MRFs), Informal sector and their role, Labeling, coding, and tracking mechanisms, Safety measures and health issues in handling.

Unit 4: Recycling and Treatment Technologies **9**

Mechanical recycling and reprocessing, Chemical recycling methods including pyrolysis and depolymerization, Co-processing in cement kilns, Incineration, energy recovery, and landfilling, Environmental and economic assessment of recycling routes.

Unit 5: Alternatives, Innovations, and Sustainability **9**

Bioplastics and biodegradable polymers, Circular economy and life cycle analysis, Eco-design and plastic footprint reduction, Innovations in product design and packaging, Community participation, public awareness, and success stories.

Recommended Books:

1. N. Mustafa. (2019). Plastics and the Environment. John Wiley & Sons.
2. V. Raghavan. (2014). Plastic Waste Management: An Overview. TERI Publications.

Reference Books/ Sources:

1. D. Hopewell, et al. (2009). Plastics Recycling: Challenges and Opportunities. Philosophical Transactions of the Royal Society B: Biological Sciences, 364(1526), 2115–2126. https://doi.org/10.1098/rstb.2008.0311
2. CPCB. (2016). Plastic Waste Management Rules, 2016 and Amendments (India). Central Pollution Control Board. Available at: https://cpcb.nic.in
3. UNEP. (2021). Single-Use Plastics and Global Plastic Waste Outlook. United Nations Environment Programme. Available at: https://www.unep.org

4. OECD. (2022). Global Plastics Outlook and Circular Economy Practices. Organisation for Economic Co-operation and Development. Available at: https://www.oecd.org

Course Outcomes (CO):

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

1 Identify sources, types, and characteristics of plastic waste
2 Explain regulatory policies and producer responsibilities
3 Apply collection, segregation, and processing techniques
4 Analyze recycling, co-processing, and disposal technologies
5 Evaluate sustainable alternatives, innovations, and circular practices

EEPE610 OPERATION AND MAINTENANCE OF WATER AND WASTEWATER TREATMENT PLANTS

(Credits: 3; Lectures: 45 contact hours)

Objectives

To educate the student on the various operation & maintenance aspects of water treatment systems, sewer systems, sewage treatment plants and effluent treatment plants.

Unit 1: Elements of Operation and Maintenance **9**

Strategy for good operation and maintenance, preventive and corrective maintenance scheduling. Operation and maintenance plan, proper and adequate tools, spare units and parts, training requirements, laboratory control, records and reports, housekeeping. Sampling procedure, analytical techniques, code of practice for analytical laboratories, measurement of flows, pressures and levels. Safety in O&M operations, management information system, measures for conservation of energy.

Unit 2: Operation and Maintenance of Water Supply Systems **9**

Operational problems, O&M practices and records of operation of reservoir and intakes, causes of failure of wells, rehabilitation of tube wells & bore wells, prevention of incrustation and corrosion, problems in transmission mains, maintenance of pipelines and leakage control, repair method for different types of pipes, preventive and corrective maintenance of water pumps, problems in the water distribution system and remedies, water quality monitoring and surveillance

Unit 3: Operation and Maintenance of Sewerage Systems **9**

Components and functions of sewerage system, maintenance of collection system, operational problems, clogging of pipes, hazards, precautions against gas hazards, precautions against infections, devices for cleaning the conduits, preventive and corrective maintenance of sewage pumps, operation and maintenance of sewage pumping stations, maintenance hazards and operator protection, SOP, case studies.

Unit 4: Operation and Maintenance of Physico-Chemical Treatment Units **9**

Operation and maintenance in screen chamber, grit chamber and clarifiers, operation issues, troubleshooting guidelines and record keeping requirements for clarifier, equalization basins, neutralization unit, chemical storage and mixing equipment, chemical metering equipment, flash mixer, filters, thickeners and centrifuges, filter press, start-up and maintenance inspection, motors and pumps, hazards in chemical handling, jar test, chlorination equipment, membrane process systems, SDI and LSI determination, process chemistry and chemical dosage calculations, SOP, case studies.

Unit 5: Operation and Maintenance of Biological Treatment Units **9**

Construction, operation and maintenance aspects of activated sludge process, trickling filters, anaerobic digester, SBR, UASBR, MBRs- startup and shutdown procedures-DO, MLSS and SVI monitoring, troubleshooting guidelines, planning, organizing and controlling of plant operations, capacity building, case studies of retrofitting, SOP, case studies.

Reference Books/ Sources

1. Central Public Health & Environmental Engineering Organisation (CPHEEO), Manual on Operation and Maintenance of Water Supply Systems, Ministry of Urban Development, Government of India, New Delhi, 2013.
2. Ministry of Drinking Water and Sanitation, Operation and Maintenance Manual for Rural Water Supplies, Government of India, 2013.
3. G. Tchobanoglous, F. L. Burton, H. David Stensel, Wastewater Engineering: Treatment and Reuse, MtCalf & Eddy Inc., 4th Edition, McGraw Hill Education, 2017.
4. Ananth S. Kodavasal, The STP Guide-Design, Operation and Maintenance, Karnataka State Pollution Control Board, Bangalore, 2011.
5. Frik Schutte, Handbook for the Operation of Water Treatment Works, The Water Research Commission, The Water Institute of Southern Africa, TT265/06, 2006.
6. Michael D. Nelson, Chair, Operation of Municipal Wastewater Treatment Plants, Water Environment Federation, Volume 2 Liquid Process, 2007.
7. Michael D. Nelson, Chair, Operation of Municipal Wastewater Treatment Plants, Water Environment Federation, Volume 1 Management and Support Systems, 6th Edition, 2007.

Course Outcomes (CO):

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

1	Summarize the elements of operation and maintenance.
2	Develop the operation and maintenance of water supply systems.
3	Organize the operation and maintenance of sewerage systems.
4	Select the operation and maintenance of physico-chemical treatment units.
5	Plan operation and maintenance of biological treatment units.

EEPE706 EPIDEMIOLOGY AND CONTROL OF COMMUNICABLE DISEASES

(Credits: 3; Lectures: 45 contact hours)

Objectives

To gain knowledge on disease outbreak, transmission via water, air, food, vectors and pollution sources, and aspects of health services

Unit 1: Epidemiology **9**

Definition, disease outbreak, epidemic, endemic, pandemic, study types – experimental, observational – descriptive, analytical, cross-sectional, case control, cohort; dynamics of disease transmission, disease control - control of source, control of mode of transmission, susceptible host, typical epidemic control, investigations.

Unit 2: Air Borne Diseases **9**

Respiratory diseases, carbon monoxide poisoning, Illness associated with building material, indoor pollutants and diseases, control of source and transmission

Unit 3: Food and Water Borne Diseases **9**

Water and Food borne diseases, reservoir of infection, agents, food decomposition, mode of transmission of diseases, control of water and food-borne diseases.

Unit 4: Vector borne diseases **9**

Vector borne diseases and zoonoses, infections from mosquitoes, house flies, rats, louse, pubic louse and other insects, control at source, control of mode of transmission.

Unit 5 Health Services **9**

Organization and tasks for the health services, major components of health services - curative, preventive, special services; statistics and health education; resources for the health services, community participation in health services.

Text Books

1. D. Liu, Handbook of Foodborne Diseases, CRC Press, 2018
2. R. C. Dubey, D. K. Maheswari, A Textbook of Microbiology, S. Chand, 2015.

Reference Books/ Sources

1. M. Duncan, Handbook Of Water And Wastewater Microbiology, Elsevier, 2013.
2. M. Burr, A. Burrells, A. Camper, R. M. Chalmers, N. F. Gray, F. Katzer, A. Nocker, M. Opsteegh, S. L. Percival, L. J. Robertson, D. W. Williams, P. W. Jones, M. V. Yates, Microbiology of Waterborne Diseases, 2nd Edition, Academic Press, 2014.
3. M. R. Adams, P. J. McClure, M. O. Moss, Food Microbiology, Royal Society of Chemistry, 2024

Course Outcomes (CO):

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

1) Understand the basics of epidemiology, disease outbreak, transmission, and control
2) Learn the different types of diseases transmitted through air
3) Understand the agent, transmission, control of water and food borne diseases
4) Comprehend the mode of transmission and control of vector borne diseases
5) Understand major components of health services

EEPE707 CARBON CAPTURE AND STORAGE

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To equip students with the knowledge, information and policies of carbon capture and storage (CCS). To impart knowledge on various carbon capture, storage and utilization strategies. To learn the status of the emerging CCS technology, globally and in India.

Unit 1: Introduction **8**

UNFCCC; Kyoto protocol; Emissions accounting policies; Copenhagen and Cancun; Risk of carbon leakage; GHG consumers vs GHG producers; Unaccounted emissions; Fossil fuels and CO_2 emissions: petroleum, coal, natural gas, industrial emission forecasts; Role of CCS: power and non-power sector; Regional applicability of CCS.

Unit 2: Carbon Capture Technologies **8**

Power sector: Pre-combustion, post-combustion, oxy-combustion, chemical looping, capture ready and retrofit power plant, zero-emission power generation; Industrial sector: cement, steel, oil refining, natural gas processing, pulp and paper production, carbon capture from industrial processes; Absorption; Adsorption; Membrane separation.

Unit 3: Carbon Separation and Carbonation **10**

Membrane separation systems: fundamentals, membrane configuration and preparation, applications; Low temperature and distillation systems: distillation systems, hydrate-based capture, cryogenic separation, Ryan-Holmes process; Mineral carbonation: Fundamentals, carbonation routes, development and deployment status.

Unit 4: Geological Storage and CO_2 Transport **10**

Underground storage solutions; CO_2 trapping mechanisms; Trapping mechanisms in coal-seams and basalt rocks; Underground storage technologies; Transport systems: Pipelines, ships.

Unit 5: CCS Regulatory Framework **9**

Emission standard and technology standard; Tax/Credit offset; Feed-in Tariff; FEEBATES; Carbon tax; Carbon cap and trade; Emission reduction policies; CCS regulations: capture, transport and storage.

Text Books:

1. S. A. Rackley, Carbon Capture and Storage, 2nd Edition, Elsevier Inc, 2017.
2. S. M. Al-Fattah, M. F. Barghouty, B. O. Dabbousi, S. Fillacier, P. Le Thiez, C. McQuale, G. Munier, Jonathan Royer-Adnot, Carbon Capture and Storage: Technologies, Policies, Economics, and Implementation Strategies, CRC Press, Taylor & Francis Group, 2011.

References Books / Sources:

1. International Energy Agency (IEA), 20 years of Carbon Capture and Storage: Accelerating future deployment, Organisation for Economic Co-operation and Development (OECD), 2016.

2. IPCC Special Report on Carbon Dioxide Capture and Storage, Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press, 2005.
3. M. Goel, M. Sudhakar, R. V. Shahi, Carbon Capture Storage and Utilization, CRC Press, Taylor & Francis Group, 2018.

Course Outcomes (CO):

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

1. Describe the importance of CCS and its applicability.
2. Analyze the various carbon capture technologies.
3. Analyze available technologies for carbon separation and carbonation.
4. Examine the geological storage technology for carbon capture, transport and storage.
5. Analyze the CCS regulatory framework.

EEPE708 IRRIGATION WATER QUALITY AND WASTEWATER MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives

To know the basics concepts of irrigation water quality. To impart knowledge on water quality for irrigation purposes, besides relevant environmental problems and recycle and reuse concepts. To understand the importance of water quality for irrigation and major uses of water and the role environmental issues.

Unit 1: Water Quality **9**

Physical and chemical properties of water, suspended and dissolved solids, electrical conductivity and pH. Water quality investigation, sampling design, samplers and automatic samplers. Data collection platforms, field kits, water quality data storage, analysis and inference, software packages.

Unit 2: Irrigation Water Quality **9**

Water quality for irrigation, salinity and permeability problem, root zone salinity. Irrigation practices for poor quality water, saline water irrigation. Future strategies.

Unit 3: Water Pollution **9**

Sources and types of pollution, organic and inorganic pollutants, BOD, DO relationships, impacts on water resources. NPS pollution and its control, eutrophication control. Water treatment technologies, constructed wetland.

Unit 4: Recycling and Reuse of Water **9**

Multiple uses of water, reuse of water in agriculture. Low-cost wastewater treatment technologies, economic and social dimensions. Packaged treatment units, reverse osmosis and desalination in water reclamation.

Unit 5: Water Quality Management **9**

Principles of water quality, water quality classification. Water quality standards, water quality indices, TMDL Concepts. Water quality models.

Text Books

1. G. Tchobanoglous, F. L. Burton, H. David Stensel, Wastewater Engineering: Treatment and Reuse, MtCalf & Eddy Inc., 4th Edition, McGraw Hill Education, 2017.
2. V. Novonty, Water Quality - Diffuse Pollution & Watershed Management, 2nd Edition, John Wiley & Sons Inc, 2002.

Reference Books/ Sources

1. M. L. Davis, David A. Cornwell, Introduction to Environmental Engineering, McGraw Hill Education, 2017.
2. W. Stumm, J.J. Morgan, Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters: 104 (Environmental Science and Technology: A Wiley-Interscience Series of Textsand Monographs), 3rd Edition, Wiley-Interscience, 1995.
3. J.W. Lloyd, J.A. Heathcote, Natural Inorganic Chemistry in Relation to Groundwater Resources, Clarendon Press, Oxford, 1985.

Course Outcomes (CO):

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

1 Analyze the various water quality parameters and its measurements.

2 Apply the concepts of water quality for irrigation.

3 Examine the types of water pollution, quality considerations and its treatment

4 Organize the method for recycling and reuse of water.

5 Plan for the management of water quality by considering the water quality standards.

EEPE709 NATURAL WASTEWATER TREATMENT SYSTEMS

(Credits: 3; Lectures: 45 contact hours)

Objectives

To gain knowledge and understanding of wetlands on types of wetlands, constructed wetland - application, design, method of treatment of both domestic and industrial wastewaters and case studies. To gain knowledge on design, construction and operation of waste stabilization pond and sludge disposal.

Unit 1: Introduction to Wetland Treatment System **9**

Definition and concept of wetland, types of wetland, ecology, flora and fauna, ecological aspects, human health and wetland, onsite applications. Introduction to constructed wetland, types, free water surface, subsurface wetland, horizontal and vertical flow-wastewaters and their application in wetland, constructed wetland plants, media in constructed wetland.

Unit 2: Constructed Wetland **9**

Site identification, construction and design of constructed wetland, startup, operation and maintenance of wetland system, wetland hydrology, hydraulics. Treatment of domestic wastewater and its performance, mechanisms of pollutant removal. Reuse of treated wastewater and its applications, limitation of constructed wetland system.

Unit 3: Case Studies on Constructed Wetland System **8**

Constructed wetland, treatment of domestic wastewater, greywater, landfill leachate, treatment of industrial wastewaters, textile wastewater, dairy wastewater and its performance. Removal of specific pollutants such as heavy metals, aromatics and emerging contaminants. Use of amendments in wetland construction, and its performance. Capital and maintenance costs.

Unit 4: Design of Wastewater Pond Systems **10**

Introduction, facultative partial mix aerated ponds, complete-mix aerated pond systems, anaerobic ponds, nitrogen removal in lagoons. Modified high performance aerated pond systems for nitrification and denitrification, nitrogen removal in ponds coupled with wetlands and gravel bed nitrification filters. Control of algae and design of settling basins. Hydraulic control of ponds, removal of phosphorous, removal of pharmaceuticals and personal care products and antibiotic resistant genes.

Unit 5: Sludge Management and Treatment **9**

Sludge quantity and characteristics, stabilization and dewatering, sludge freezing, reed beds. Vermi stabilization, comparison of bed type operations, composting land application and surface disposal of bio solids onsite wastewater systems, effluent disposal and reuse. Sludge quantity and characteristics, stabilization and dewatering, sludge freezing reed beds, vermi stabilization. Comparison of bed-type operations, composting land application and surface disposal of biosolids, on-site wastewater systems, effluent disposal and reuse.

Text Books

1. E. Joe Middlebrooks, Robert K. Bastia, Ronald W. Crites, Natural Wastewater Treatment Systems, 2nd Edition, CRC Press Inc, 2014.
2. Alexandros I. Stefanakis (Editor), Constructed Wetlands for Industrial Wastewater Treatment System, Wiley-Blackwell, 2018.

Reference Books/ Sources

1. U S Environmental Protection Agency, Design Manual Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment, Bibliogov, 2012.
2. Robert. H. Kadlec, S. Wallace, Treatment Wetlands, CRC Press Inc, 2008.
3. J. Vyamazal, L. Kropfelova, Wastewater Treatment in Constructed Wetlands with Horizontal Sub-Surface Flow, Springer, 2010.

Course Outcomes (CO):

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

1 Summarize the various aspects of wetland system, its function and its application in the treatment of wastewaters
2 Examine the importance of constructed wetland system, design and its pollutant removal mechanism.
3 Analyze the case studies on construction wetland system for the treatment of domestic and industrial wastewater.
4 Build the design of wastewater pond systems.
5 Analyze the method to manage and dispose the sludge naturally and economically.

EEPE710 E-WASTE MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives

Understand e-waste sources, composition, and hazards; study collection, segregation, and recycling principles; examine relevant regulations; learn resource recovery and disposal techniques; explore sustainable, circular economy approaches.

Unit 1: Introduction to E-Waste **9**

Definition and classification of e-waste, Sources and composition of electronic waste, Growth trends and global generation patterns, Environmental and health impacts of informal recycling, Major constituents and their toxicity.

Unit 2: Legal and Policy Framework **9**

E-Waste Management Rules, 2016 and amendments, Extended Producer Responsibility (EPR), CPCB guidelines and MoEFCC regulations, International conventions: Basel Convention and WEEE Directive, Roles of producers, dismantlers, and recyclers.

Unit 3: Collection, Storage, and Transportation **9**

E-waste collection mechanisms and channels, Take-back systems and collection centers, Labeling, storage protocols, and safety measures, Transportation regulations, Informal vs formal sector practices, Occupational health and safety.

Unit 4: Recycling and Resource Recovery **9**

Dismantling and preprocessing techniques, Manual and mechanical separation, Recovery of metals, plastics, and rare earth elements, Thermal and hydrometallurgical methods, Environmental risk during processing, Eco-design and recycling efficiency.

Unit 5: Sustainable Management and Case Studies **9**

Circular economy and urban mining concepts, Sustainable procurement and green electronics, Public awareness and stakeholder engagement, Case studies from India and abroad, Business models and innovations in e-waste handling, Challenges and future trends.

Text Books:

1. R. Johri. (2008). E-Waste: Implications, Regulations, and Management in India and Current Global Best Practices. TERI Press.
2. R. Kahhat, et al. (2008). E-Waste Management: From Waste to Resource. United Nations Environment Programme (UNEP).

Reference Book/Sources

1. S. Salhofer, & G. Schluep. (2014). Global Perspectives on E-Waste. Springer.
2. N. Seth, & S. Shrivastava. (2015). Electronic Waste Management: A Global Perspective. CRC Press.
3. CPCB & MoEFCC. (Various Years). E-Waste Management Rules (India), EPR Frameworks, and Annual Reports. Central Pollution Control Board & Ministry of Environment, Forest and Climate Change, Government of India. Available at: https://cpcb.nic.in & https://moef.gov.in

Course Outcomes (CO):

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

1 Identify sources and types of electronic waste

2 Explain e-waste regulations and extended producer responsibility (EPR)

3 Apply safe collection, segregation, and storage methods

4 Analyze recycling processes and material recovery technologies

5 Evaluate sustainable practices and policy frameworks for e-waste

EEPE711 BIOMEDICAL AND HAZARDOUS WASTE MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives

This course covers the sources, types, handling, and treatment of biomedical and hazardous wastes. It emphasizes regulatory compliance, environmental and health impacts of poor waste management practices, and promotes safe, sustainable solutions. The course enables students to develop practical skills in waste segregation, risk assessment, and treatment technology selection.

Unit 1: Introduction to Biomedical Waste **9**

Definition and classification of biomedical waste, Sources and types of biomedical waste, Quantification and generation rates, Health and environmental impacts of biomedical waste, Overview of BMW management challenges.

Unit 2: Regulations and Guidelines **9**

Biomedical Waste Management Rules, 2016 and amendments, CPCB and SPCB roles and responsibilities, WHO and Basel Convention guidelines, Roles of occupiers and operators, Compliance, authorization, and penalties.

Unit 3: Segregation, Collection, and Storage **9**

Color-coded segregation system, Labeling and barcoding, Containers and storage requirements, On-site collection and transport, Occupational safety and hygiene practices, Documentation and record-keeping.

Unit4: Treatment and Disposal Techniques **9**

Thermal and chemical treatment methods, Incineration, autoclaving, and microwaving, Shredding, encapsulation, and deep burial, Treatment of liquid biomedical waste, Comparison of technologies based on cost and efficiency.

Unit V: Hazardous Waste Management **9**

Definition and classification of hazardous waste (HW) under Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. Identification and characterization, Sources, collection, packing, storage, treatment and disposal.

Text Books

1. R.M. Harrison, et al. (2006). Environmental and Health Impact of Solid Waste Management. CRC Press.
2. Daryllyn Brooks, Hazardous Waste Management Knowledge Bakers, ISBN-13 : 978-9390 013890, 2025.

Reference Books/ Sources:

1. N.B. Ballaney. (2006). Environmental Health and Safety. Anmol Publications.
2. S. Kumar, & V. Srivastava. (2011). Biomedical Waste Management. Discovery Publishing House, New Delhi.
3. N.K. Sharma. (2005). Health Care Waste Management: Policies, Strategies and Guidelines. SBS Publishers, New Delhi.

Course Outcomes (CO):

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

1 Identify types and sources of biomedical waste
2 Explain regulations and classification of BMW
3 Apply segregation, storage, and transport procedures
4 Analyze treatment and disposal technologies
5 Evaluate environmental and health risks; recommend mitigation strategies

EEPE712 DISASTER MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To impart knowledge on concepts related to disaster, risk and vulnerability. To help students develop awareness and skills for planning and organizing disaster response and management.

Unit 1: Introduction **9**

History of disasters and its management; International decade for natural disaster reduction; The yokohama strategy; International strategy for disaster reduction; Hyogo framework for action; Modern disaster management; United Nations Office for Disaster Reduction; Global Platform for Disaster Risk Reduction; Disasters, poverty and development; Disaster trends.

Unit 2: Risk and Vulnerability **9**

Definitions: Hazard, risk, vulnerability, disaster, safe, compound disasters, humanitarian crisis; Hazard: identification, profiling, analysis, types. Risk: components, trends; Computing values; Risk evaluation; Risk acceptability; Vulnerability: physical, social, environmental, and economic profile; Risk perception.

Unit 3: Mitigation Measures **9**

Mitigation: definition, goals, types (structural and non-structural), obstacles; Risk transfer, sharing and spreading; Assessing and selecting mitigation options: impact on community, probability, Staplee method; Emergency response capacity.

Unit 4: Preparedness and Response **9**

Government preparedness: planning, exercise, training, equipment, statutory authority; Public preparedness; Response: emergency, recognition (pre and post disaster), search and rescue, first aid, evacuation, disaster assessment, information management;

Unit 5: Recovery and Participants **9**

Recovery: overview, effects of disasters, components, types; Government emergency and disaster management agencies; Bilateral disaster management assistance; National government agencies involved in disaster management; Non-governmental organizations.

Text Books:

1. D. P. Coppola, Introduction to International Disaster Management, 4th Edition, Elsevier Inc, 2021.
2. T. Bhattacharya, Disaster Science and Management, Tata McGraw Hill Education Private Limited, 2012.

References Books / Sources:

1. Government of India, National Disaster Management Policy, 2009.
2. P. K. Srivastava, S. K. Singh, U. C. Mohanty, T. Murty, Techniques for Disaster Risk Management and Mitigation, 1st Edition, John Wiley & Sons, Inc, 2020.
3. R. K. Pandey, Disaster Management in India, 1st Edition, SAGE Publications India Pvt Ltd, 2020.

Course Outcomes (CO):

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

1. Understand the basic concepts of disaster management.
2. Analyze the risks and vulnerabilities of a disaster.
3. Develop mitigation measures towards disaster management.
4. Develop disaster response skills and awareness towards it.
5. Analyze the role and responsibility of various participants in disaster management.

EEPE713 ORGANIC FARMING FOR SUSTAINABLE AGRICULTURAL PRODUCTION

(Credits: 3; Lectures: 45 contact hours)

Objectives

To understand the principle and concept of organic production, sustainable agriculture; organic crop production, organic food and human health; certification and marketing of organic foods.

Unit 1: Introduction to Organic Farming **9**

Concept, principle, and status of organic farming; need for organic farming; effect of chemical fertilizers and pesticides on the biology and fertility of soil, SWOT analysis of organic farming

Unit 2: Sustainable Agriculture **9**

Key indicators of sustainable agriculture – water, soil health, land conversion, pollution, organic farming and climate change – impacts of climate change on agriculture, projected impacts on global warming,

Unit 3: Compost Production Technology **9**

Composting, vermicomposting: principles and production technology; Compost and vermicompost: quality, stability and maturity, compost. vermicompost utilization and marketing

Unit 4: **Organic Crop Management** **9**

Field crops, horticulture and plantation crops, transition to organic crop production; plant protection measures, biopesticides, natural predators, cultural practice, seed act, traditional seed storage methods, fertilizer act,

Unit 5: Organic Food and Human Health **9**

Quality analysis of organic foods, Antioxidants and their natural source, standards of organic food certification process, marketing of organic foods, food security, WHO guidelines

Text Books

1. K. Dahama, Organic Farming for Sustainable Agriculture, 2nd Edition), Agrobios Jodhpur, India, 2014.
2. D. Nandwani, Organic Farming for Sustainable Agriculture: 9 (Sustainable Development and Biodiversity), Springer, 2018.

Reference Books/ Sources

1. S. Chandran, M.R. Unni, S. Thomas, D.K. Meena, Organic Farming: Global Perspectives and Methods, 2nd Edition, Elsevier, 2023.
2. R. Rynk, G. Black, J. Biala, J. Bonhotal, L. Cooperband, J. Gilbert, M. Schwarz, The Composting Handbook: A how-to and why manual for farm, municipal, institutional and commercial composters, Academic Press, An imprint of Elsevier, 2022.
3. A. Edwards, N. Q. Arancon, Biology and Ecology of Earthworms, 4th Edition, Springer, 2022.

Course Outcomes (CO):

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

1) Understand principles and components of organic farming
2) Understand sustainable agriculture and the associated key indicators
3) Evaluate organic crop production practices for sustainable agriculture
4) Apply the technique of compost/ vermicompost production
5) Learn about organic certification systems and marketing process, opportunities, and challenges

EEPE714 MEMBRANE TECHNOLOGY

(Credits: 3; Lectures: 45 contact hours)

Objectives:

To help students understand the concept and principles of membrane separation technology. To impart knowledge on the diverse applications of membranes in the field of environmental engineering.

Unit 1: Introduction **10**

Membrane and its function; Membrane materials: polymeric, inorganic; Membrane structures; Fundamentals of mass transport in membranes; Types of membranes; Membrane preparation and characterization.

Unit 2: Membrane Separation and Modules **10**

Principles: membrane filtration process, gas and vapor separation, dialysis, electro-membrane process, membrane contactors, membrane reactors; Membrane holding devices; Industrial type membrane modules; Concentration polarization and membrane fouling.

Unit 3: Water and Wastewater Treatment **9**

Membranes for Reverse osmosis, Ultrafiltration, microfiltration, ion exchange, carrier facilitated transport, membrane contactors: materials, performance, membrane fouling and control, applications; Adsorption- membrane filtration hybrid process; multilayer membranes;

Unit 4: Gas Cleaning **8**

Membranes for gas cleaning: classification, principle, characterization, material stability; Performance evaluation. Examples: Nanofiber membranes, carbon nanotubes, ceramic membranes, gas phase membranes. Application in indoor air cleaning and industrial exhausts purification.

Unit 5: Energy **8**

Ion exchange membranes in energy storage and conversion; Methanol fuel cells; Bioethanol production; Electrochemical energy conversion and storage devices; Palladium membranes for electricity production and carbon capture.

Text Books:

1. H. Strathmann, Introduction to Membrane Science and Technology, WILEY-VCH Verlag GmbH & Co, 2011.
2. Z. Zhong, W. Xing, Membrane Technology for Air Cleaning, Chemical Industrial Press, 2022.

References Books / Sources:

1. A. Doukelis, K. Panopoulos, A. Koumanakos and E. Kakaras, Palladium Membrane Technology for Hydrogen Production, Carbon Capture and Other Applications, Elsevier Ltd, 2015.
2. M. K. Purkait, R. Singh, Membrane Technology in Separation Science, CRC Press, Taylor & Francis Group, 2018.

3. R. W. Baker, Membrane Technology and Applications, 4th Edition, John Wiley & Sons Ltd, 2024.

Course Outcomes (CO):

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

1. Summarize the basics of membranes, their function and the principles of transport.
2. Analyze the different types of available membranes and the problems associated with their usage.
3. Design membrane technologies for the removal of pollutants from water and wastewater.
4. Design membrane technologies for the removal of gaseous pollutants in air and industrial exhausts.
5. Analyze the emerging membranes in the field of energy production.

EEPE715 GROUNDWATER AND WELL ENGINEERING

(Credits: 3; Lectures: 45 contact hours)

Objectives

To acquaint and equip the students with the techniques of groundwater development and management.

Unit 1: Ground Water Occurrence **9**

Occurrence of groundwater, temporal and spatial variability of groundwater. Essentials of groundwater modelling and management, groundwater database, methods for groundwater exploration, determination of aquifer parameters, pumping tests, assessment of groundwater potential.

Unit 2: Well Construction **9**

Groundwater structures, groundwater development and utilization, types of water wells, well hydraulics, design and construction of water wells, drilling methods, well development, well maintenance and rehabilitation, groundwater monitoring, monitoring wells, design and construction of monitoring wells.

Unit 3: Groundwater Pollution **9**

Groundwater development and quality considerations, groundwater contamination, sources and causes of groundwater pollution, contaminated systems and their rehabilitation, groundwater bioremediation, management of salt water ingress in inland and coastal aquifers.

Unit 4: Groundwater Management **9**

Management of declining and rising water table, natural and artificial groundwater recharge, groundwater recharge basins and injection wells. Groundwater management in irrigation command, conjunctive water use, water lifting, different types of pumps, selection of pumps, pump characteristics curve, cost of groundwater pumping, comparative economics of surface and groundwater use for irrigation

Unit 5: Groundwater Development Policies **9**

Major issues related to groundwater development and management in India, legal aspects of groundwater exploitation, diagnostic survey of sick wells/tube wells and their rehabilitation.

Text Books

1. W.C. Walton, Groundwater Resource Evaluation, McGraw-Hill Inc., US, 1970.
2. K. Karanth, Groundwater Assessment, Development and Management, McGraw Hill Education, 2017.

Reference Books/ Sources

1. H.M. Raghunath, Groundwater Hydrology, 3rd Edition, New Age International Pvt Ltd Publishers, 2007.
2. Michael D. Campbell, Jay H. Lehr, Water Well Technology: Field Principles of Exploration and Drilling for Ground Water and Other Selected Materials, McGraw-Hill Inc., US, 1973.

3. A.M. Michael, S.D. Khepar, S.K. Sondhi, Water Wells and Pumps, McGraw-Hill Professional, 2008.

Course Outcomes (CO):

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

1 Summarize the concepts of aquifer parameters.
2 Analyze the design and construction of wells.
3 Examine the causes of ground water pollution and its mitigation measures.
4 Organize the method to describe the management of declining and rising water table.
5 Utilize the method to prioritize and execute the groundwater development programme.

EEPE716 SLUDGE AND SEPTAGE MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives

To gain knowledge and skills on sources, characteristics and treatment of sludge. To understand the importance of septage management.

Unit 1: Sources and Characteristics of Sludge **9**

Objectives of sludge treatment, sources of sludge, sludge from WTP, STP and CETP. Sludge quantification, generation from various treatment plants, characteristics in each stage of treatment. Physico-chemical and biological, mass balance in sludge treatment.

Unit 2: Sludge Thickening and Dewatering **9**

Sludge thickening, gravity thickening, drum thickener, air floatation, centrifugation. Conditioning. sludge dewatering, centrifuge, vacuum filtration, sludge drying bed, performance of thickener and dewatering systems operation and maintenance.

Unit 3: Sludge Stabilization **9**

Aerobic and anaerobic sludge digestion processes, types of anaerobic digesters, design of Low rate and high-rate digesters, two stage digester. Aerobic digestion, pure oxygen and thermophilic aerobic digestion. Chemical and thermal stabilization process.

Unit 4: Reuse and Land Application of Sewage Sludge **9**

Beneficial use, requirements and associated risks. Handling and management, storage, operation aspects of transport and application of biosolids application. Lagooning, landfilling-land farming. Composting, windrow composting, vermicomposting. Laws and regulations on sludge management.

Unit 5: Septage Management **9**

Sources of septage, characteristics, public health and environmental hazards. Elements of septage management. Pumping and desludging septic tanks, transportation, treatment, dewatered septage sludge reuse. Operation and maintenance, planning and implementation of septage management schemes. Case studies.

Text Books

1. G. Tchobanoglous, F. L. Burton, H. David Stensel, Wastewater Engineering: Treatment and Reuse, MtCalf & Eddy Inc., 4th Edition, McGraw Hill Education, 2017.
2. Septage management in Urban India, National Urban Sanitation policy, Ministry of Urban Development Government of India, 2013.

Reference Books/ Sources

1. National Policy on Faecal Sludge and Septage Management (FSSM) Ministry of Urban Development Government of India, 2017.
2. Water Environment Federation, Operation of Municipal Wastewater Treatment Plants, 6th Edition, Volume 2, McGraw-Hill Education, 2007.
3. Water Environment Federation, Operation of Municipal Wastewater Treatment Plants, 6th Edition, Volume 1, McGraw-Hill Education, 2007.

Course Outcomes (CO):

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

1. Outline the sources and characteristics of various sources of sludge.
2. Analyze the various types of sludge thickening and dewatering units.
3. Examine the various types of sludge stabilization units.
4. Analyze the method to reuse and land application of the sewage sludge.
5. Plan and implement septage management scheme.

EEPE717 REPAIR AND REUSE TECHNOLOGIES FOR SUSTAINABLE RESOURCE MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives

To introduce repair and reuse as waste minimization strategies, study technologies and systems for material recovery, understand policies, standards, and business models supporting reuse, develop skills to assess environmental, economic, and social impacts

Unit 1: Introduction to Repair and Reuse **9**

Hierarchy of waste management: reduce, reuse, recycle. Definitions: repair, reuse, refurbish, remanufacture. Environmental and economic benefits. Barriers to repair and reuse. Overview of global and Indian status. Role of the informal sector in waste management and recycling

Unit 2: Repair and Reuse techniques **9**

Household appliances (white goods, electronics). Furniture, clothing, footwear. Automotive parts. Tools and techniques of repair. Extended Producer Responsibility (EPR). Troubleshooting and diagnosis methods, Hands-on practice with repair techniques.

Unit 3: Reuse and Re-purposing **9**

Creative re purposing and up-cycling techniques, Examples of successful reuse and repurposing projects, Hands-on project: designing and creating a repurposed or upcycled product, Construction and Demolition (C&D) Materials Reuse - Reuse of bricks, tiles, timber, metals. Deconstruction techniques. Standards and quality considerations. Design for disassembly.

Unit 4: Systems, Facilities, and Business Models **9**

Design for Repair and Reuse, Principles of design for repair and reusability, Best practices for designing products with repair and reuse in mind, Repair cafes, reuse centers, material banks. Informal sector roles. Product-service systems. Sharing and rental models. Role of NGOs and social enterprises.

Unit 5 Policies, Standards, and Life Cycle Analysis **9**

National and international policies promoting repair and reuse (e.g., EU Right to Repair). IS codes and BIS standards related to reuse. Life Cycle Assessment (LCA) of reused products. Environmental footprint comparisons. Overview of sustainable consumption practices, Strategies for reducing waste and promoting sustainability

Text Books

1. Geyer, R. (2021). The Business of Less: The Role of Companies and Households on a Planet in Peril.
2. Ellen MacArthur Foundation Reports on Circular Economy.

Reference Books/ Sources

1. CIRAIG. Life Cycle Assessment Guidelines.
2. Government of India Guidelines on C&D Waste and E-waste Management Rules.
3. Journal articles on repair and reuse case studies.

Course Outcomes (CO):

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

1 Explain the principles, definitions, and benefits of repair, reuse, refurbishing, and remanufacturing within sustainable resource management.

2 Apply techniques and tools to repair and troubleshoot common products such as electronics, furniture, and automotive parts.

3 Develop creative reuse and upcycling solutions for diverse materials, including construction and demolition waste.

4 Evaluate systems, facilities, and business models that support repair and reuse, including product-service systems and community-based initiatives.

5 Assess environmental, economic, and social impacts of repair and reuse strategies using Life Cycle Assessment and relevant policy frameworks.

EEPE718 ECO-FRIENDLY VILLAGE DESIGN AND MANAGEMENT

(Credits: 3; Lectures: 45 contact hours)

Objectives

The course aims to provide students with a comprehensive understanding of sustainable rural development principles. Students will learn about the planning, design, and management of sustainable villages, integrating environmental, social, and economic aspects while preserving natural resources and enhancing the quality of life in rural areas.

Unit 1: Introduction to Sustainable Development **9**

Sustainable Development Goals (SDGs)**:** Overview of the 17 SDGs and their relevance to rural development. Concepts of Sustainability**:** Environmental, social, and economic dimensions. Challenges in Rural Development**:** Poverty, education, healthcare, water, sanitation, and environmental degradation in villages. Principles of Sustainability in Village Development**:** Ecological, social, and cultural sustainability.

Unit 2: Rural Economy and Livelihoods **9**

Agriculture and Agro-based Livelihoods: Sustainable farming practices, organic agriculture, and agroforestry. Alternative Livelihoods: Non-farming livelihoods, rural entrepreneurship, and self-help groups. Microfinance and Rural Entrepreneurship: Role of microloans, government schemes, and local entrepreneurship in empowering rural communities. Climate Resilience in Rural Economies: Adaptation strategies for agriculture and rural industries in response to climate change.

Unit 3: Village Infrastructure and Resource Management **9**

Water Supply and Sanitation**:** Design and management of sustainable water systems, rainwater harvesting, wastewater treatment, and sanitation solutions. Energy for Rural Development**:** Renewable energy options, solar, wind, and biogas for rural electrification. Sustainable Building Practices**:** Use of local materials, energy-efficient buildings, and eco-friendly construction techniques. Waste Management in Rural Areas**:** Solid waste management, composting, and recycling practices suitable for rural environments.

Unit 4: Community Engagement and Participatory Planning **9**

Participatory Development**:** Community-based planning, participatory rural appraisal (PRA), and participatory governance. Role of NGOs and Government Bodies**:** Understanding the roles of local, state, and national organizations in rural development. Social and Cultural Sustainability: Promoting social equity, cultural diversity, and inclusive development. Case Studies of Successful Sustainable Villages**:** Examples from India and other countries.

Unit 5: Planning and Implementing Sustainable Village Projects **9**

Project Identification and Planning**:** Identifying key areas for development—agriculture, health, education, infrastructure-and planning sustainable interventions. Designing a Sustainable Village**:** Creating integrated plans considering land use, water, waste management, agriculture, housing, and energy. Monitoring and Evaluation: Methods and tools to monitor the progress of sustainable village projects and evaluate their impact. Challenges and Future Directions: Identifying barriers to implementation and exploring emerging trends and technologies for rural sustainability.

Text Books

1. R. Chambers, Rural Development: Putting the Last First, Pearson Education, 1997.
2. B.K. Sharma, Environmental Chemistry, Krishna Prakashan Media, 2008.

References

1. A.K.N. Reddy, Renewable Energy for Rural Development, Oxford University Press, 2009.
2. K.K. Verma, Sustainable Rural Development: The Role of Technology and Innovations, Springer, 2020.
3. United Nations, Sustainable Development Goals and Rural Development, UNDP.2015.

Course Outcomes (CO):

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

1 Understand the key principles of sustainable development and their application in rural areas.

2 Design and manage sustainable village infrastructure systems including water, sanitation, and energy

3 Implement sustainable farming, agro-based industries, and alternative livelihoods to enhance rural economies

4 Engage communities in participatory rural development and incorporate social and cultural sustainability.

5 Develop comprehensive, integrated plans for rural villages focusing on sustainability, resilience, and equity.

EEPE719 INDOOR AIR POLLUTION AND HUMAN HEALTH

(Credits: 3; Lectures: 45 contact hours)

Objectives

To understand sources, types, and dynamics of indoor air pollutants, to analyze the health impacts of indoor air pollution, to explore sampling techniques, standards, and control strategies, to study policies, standards, and intervention strategies for indoor air quality (IAQ) management.

Unit 1: Introduction to Indoor Air Quality (IAQ) **9**

Definition and importance of IAQ, Comparison between indoor and outdoor air quality, Indoor environments: residential, office, industrial, schools, hospitals, Factors affecting indoor air quality: ventilation, temperature, humidity, human activities.

Unit 2: Sources and Types of Indoor Air Pollutants **9**

Physical Pollutants: Particulate Matter (PM_{10}, $PM_{2.5}$), dust, Chemical Pollutants: VOCs, formaldehyde, carbon monoxide, NOx, ozone, Biological Pollutants: Molds, bacteria, allergens, pet dander, Emissions from building materials, furnishings, cleaning agents, and cooking, Indoor combustion (biomass, kerosene, LPG, tobacco smoke.

Unit 3: Monitoring and Assessment Techniques **9**

IAQ indicators and indices, Sampling and monitoring methods: passive vs active, Sensors and real-time monitors (CO_2, CO, PM, VOCs), Indoor air modeling: mass balance approach, Exposure assessment and risk characterization,

Unit 4: Health Impacts and Vulnerable Populations **9**

Short-term and long-term effects: asthma, COPD, headaches, cancer, cardiovascular impacts, Case studies: cookstove exposure in rural homes, office syndromes, Children, elderly, and chronically ill: special considerations, WHO indoor air quality guidelines.

Unit 5: Standards, Mitigation, and Control Measures **9**

Global and Indian standards (WHO, CPCB, ASHRAE, BIS) Ventilation design: natural and mechanical, Air cleaning and filtration systems, Building design and material selection for IAQ, Green building concepts (LEED, GRIHA) and IAQ

Text books:

1. Darrell W Pepper, David B Carrington ,Modeling Indoor Air Pollution, Imperial College Press,ISBN-13 : 978-1848163249,2009
2. Mohammad Hadi Dehghani , Rama Rao Karri , Teresa Vera , Salwa Kamal Mohamed Hassan ,`Health Effects of Indoor Air Pollution: Volume 2: Air Pollution, Human Health, and the Environment, Academic Press Inc ISBN-13 : 978-0443160905,2024.

Reference Books/ Sources:

1. Samet, Indoor Air Pollution: A Health Perspective, Johns Hopkins University Press ISBN-13 : 978-0801841255,1991.
2. USEPA. Indoor Air Quality Tools for Schools Action Kit.
3. Thad Godish, Indoor Air Pollution Control, CRC Pr I Llc; ISBN-13 : 978-1315894386, 2017.

Course Outcomes (CO) :

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

1. Explain the key sources, types, and characteristics of indoor air pollutants in different environments.
2. Analyze the health risks and exposure pathways associated with indoor air pollution.
3. Apply appropriate sampling and monitoring techniques for indoor air quality assessment.
4. Evaluate mitigation strategies and engineering controls to improve indoor air quality
5. Interpret and apply relevant indoor air quality standards and guidelines in real-world planning.

EEPE720 SUSTAINABLE URBAN PLANNING

(Credits: 3; Lectures: 45 contact hours)

Objectives

The course aims to provide students with an in-depth understanding of the principles and practices of sustainable urban planning. It will explore the integration of environmental, social, and economic factors in urban development, focusing on strategies that promote sustainable, resilient, and inclusive cities.

Unit 1: Introduction to Sustainable Urban Planning **9**

Concepts of Sustainability in Urban Planning**:** Definition, scope, and importance of sustainability in urban planning. Sustainable Development Goals (SDGs)**:** Relevance of SDGs to urban planning, particularly Goal 11: Sustainable Cities and Communities. Urbanization and Its Challenges**:** Rapid urbanization, issues related to land use, housing, transportation, and infrastructure. Principles of Sustainable Urban Planning: Livability, resilience, equity, and resource efficiency.

Unit 2: Urban Infrastructure and Resource Management **9**

Sustainable Urban Transport: Public transport systems, non-motorized transport, and alternative energy sources for transportation. Water Management: Sustainable urban water systems, water recycling, rainwater harvesting, and wastewater management. Energy in Urban Planning: Renewable energy integration, energy efficiency in buildings, and smart grids for urban areas. Waste Management: Strategies for reducing, reusing, and recycling urban waste, including municipal solid waste and industrial waste.

Unit 3: Environmental and Social Considerations **9**

Urban Green Spaces: Role of parks, green roofs, and urban agriculture in promoting environmental health and community well-being. Climate Change and Resilience: Adapting cities to climate change through resilient infrastructure, flood management, and sustainable land-use practices. Social Equity in Urban Planning: Inclusivity in housing, access to basic services, and addressing inequality in urban settings. Environmental Impact Assessment (EIA) in Urban Projects: Tools and techniques for evaluating the environmental impacts of urban development projects.

Unit 4: Urban Design and Sustainable Architecture **9**

Sustainable Urban Design Principles: Compact cities, mixed-use development, and pedestrian-friendly environments. Green Building Standards: LEED, BREEAM, and other sustainability certifications for urban buildings. Low-Impact Development: Designing with natural systems, permeable pavements, and sustainable drainage systems (SuDS). Smart Cities: Technological innovations, data-driven urban management, and the role of the Internet of Things (IoT) in smart city development.

Unit 5: Policies, Planning Tools, and Future Directions **9**

Urban Planning Policies: Overview of national and international policies, regulations, and frameworks guiding sustainable urban development. Planning Tools and Techniques: GIS, remote sensing, participatory planning, and scenario modeling for sustainable cities. Case Studies of Sustainable Urban Planning: Examples from cities globally (e.g., Curitiba, Singapore,

and Copenhagen). Future Trends in Sustainable Urban Planning: Urban farming, autonomous vehicles, climate-positive urbanism, and circular economy in urban development.

Textbooks

1. Wheeler, S.M., Beatley, T. Sustainable Urban Development Reader, Routledge, ISBN-13 : 978-0415707763, 2014.
2. Rao, P.K. Urban Planning and Management, S. Chand Publishing, ISBN-13 : 978-81239 07574 2019.

References

1. UN-Habitat. Planning Sustainable Cities: Policy Directions, Earthscan : 978-92-113-1929-3 (Series) 2009.
2. CPCB and MoHUA. Guidelines on Smart Cities and Urban Waste Management.
3. UNDP. Sustainable Development Goals Report, 2015 onwards.

Course Outcomes (CO) :

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

1 Understand the core principles and importance of sustainable urban planning.
2 Design urban infrastructure systems (transport, water, energy, waste) that promote sustainability.
3 Evaluate the environmental and social implications of urban development.
4 Apply sustainable architecture and urban design principles in planning projects.
5 Develop and implement policies and strategies for sustainable urban development using modern planning tools.