ANNAMALAI UNIVERSITY

Annamalainagar

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING

M.E.

(Environmental Engineering)

(Two year Degree Programme)

(Choice Based Credit System)

(Full-Time & Part-Time)

HAND BOOK

(2017-2018 onwards)

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING
M.E. (ENVIRONMENTAL ENGINEERING)

VISION

To impart quality education and strive to mould students to scale new heights to become leaders in the Environmental Engineering profession as practicing engineers, researchers or academicians through value-based technical education and congenial study environment.

MISSION

- To establish state-of-the-art infrastructure in a broad array of Environmental Engineering discipline and create technologically capable and intellectually motivated environmental engineers to enrich civil engineering research and practice in the area of Environmental Engineering and Management.
- To impart fundamental engineering knowledge, a broad set of required technical skills and an inquisitive attitude to take up the challenges of creating and sustaining the environment with due concern in preserving ecology and protecting nature and inspire them to be leaders of tomorrow.
- To ensure that ample opportunities are created to enable the students to serve the community as responsible environmental engineers who successfully adapt and innovative solutions in the face of uncertain information, as well as ever-changing needs, risks and constraints.
- To equip students with communications skills, ethical values and an understanding of economic, societal and environmental impacts necessary to address modern environmental engineering challenges that will benefit all stake holders.

Department of Civil Engineering
M.E. Environmental Engineering

PROGRAMME EDUCATIONAL OBJECTIVES

PEO 1: Graduates will have sound knowledge to identify and formulate challenging Environmental Engineering problems and apply appropriate research methodologies and use modern engineering tools to provide technical solutions that are economically feasible and sustainable.

PEO 2: Graduates will possess analytical and lateral thinking ability to engage in lifelong learning for professional advancement to cope up with the rapidly evolving Environmental Engineering profession which is multi-disciplinary.

PEO 3: Graduates will become socially responsible and will possess abilities to communicate effectively and work efficiently and accept leadership roles in their profession, public services and community.

PROGRAMME OUTCOMES

PO1: Acquire in-depth knowledge in Environmental Engineering, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same.

PO2: Analyze complex Environmental Engineering problems thinking critically, apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO3: Think laterally and originally, conceptualize and solve Environmental Engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors.

PO4: Extract information pertinent to unfamiliar problems through Research - literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in Environmental Engineering.

PO5: Create, select, learn and apply appropriate techniques, use modern resources and

modern engineering and IT tools, including tools for prediction and modeling, to complex Environmental Engineering activities with an understanding of their limitations.

PO6: Possess knowledge and understanding of group dynamics, Collaborate and recognize opportunities and contribute positively to Multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

PO7: Demonstrate knowledge and understanding of Engineering Project Management and management principles and apply the same.

Mapping POs with PEOs			
PO	**PEO1**	**PEO2**	**PEO3**
PO1	✓	✓	
PO2	✓	✓	
PO3	✓	✓	
PO4		✓	✓
PO5		✓	✓
PO6	✓		✓
PO7	✓		✓

ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

M.E. / M. Tech (Two-Year Full Time & Three-year Part Time) DEGREE PROGRAMME

CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS

1. **Condition for Admission**
   Candidates for admission to the first year of the four-semester **M.E / M.Tech Degree programme in Engineering** shall be required to have passed B.E / B.Tech degree of Annamalai University or any other authority accepted by the syndicate of this University as equivalent thereto. They shall satisfy the condition regarding qualifying marks and physical fitness as may be prescribed by the syndicate of the Annamalai University from time to time. The admission for part time programme is restricted to those working or residing within a radius of **90 km** from Annamalainagar. The application should be sent through their employers.
2. **Branches of Study in M.E / M.Tech**
   The Branch and Eligibility criteria of programmes are given in **Annexure 1**
3. **Courses of study**
   The courses of study and the respective syllabi for each of the M.E / M. Tech programmes offered by the different Departments of study are given separately.
4. **Scheme of Examinations**
   The scheme of Examinations is given separately.
5. **Choice Based Credit System (CBCS)**
   The curriculum includes three components namely Professional Core, Professional Electives and Open Electives in addition to Thesis. Each semester curriculum shall normally have a blend of theory and practical courses.
6. **Assignment of Credits for Courses**
   Each course is normally assigned one credit per hour of lecture / tutorial per week and one credit for two hours or part thereof for laboratory or practical per week. The total credits for the programme will be 65.
7. **Duration of the programme**
   A student of **M.E / M.Tech** programme is normally expected to complete in four semesters for full-time / six semesters for part-time but in any case not more than four years for full-time / six years for part-time from the date of admission.

8. Registration for courses

A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every other student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head of the Department along with a late fee will be done up to the last working day. Registration for the Thesis Phase - I and II shall be done at the appropriate semesters.

9. Electives

The student has to select two electives in first semester and another two electives in the second semester from the list of Professional Electives. The student has to select two electives in third semester from the list of Open Electives offered by the department/ allied department. A student may be allowed to take up the open elective courses of third semester (Full Time program) in the first and second semester, one course in each of the semesters to enable them to carry out thesis in an industry during the entire second year of study provided they should register those courses in the first semester itself. Such students should meet the teachers offering those elective courses themselves-for clarifications. No specific slots will be allotted in the time table for such courses.

Further, the two open elective courses to be studied in III semester (Full Time programme) may also be credited through the SWAYAM portal of UGC with the approval of Head of the Department concerned. In such a case, the courses must be credited before the end of III Semester.

10. Assessment

The break-up of continuous assessment and examination marks for theory courses is as follows:

First assessment (Mid-Semester Test-I)	:	10 marks
Second assessment (Mid-Semester Test-II)	:	10 marks
Third Assessment	:	5 marks
End Semester Examination	:	75 marks

The break-up of continuous assessment and examination marks for Practical courses is as follows:

First assessment (Test-I)	:	15 marks
Second assessment (Test-II)	:	15 marks
Maintenance of record book	:	10 marks
End Semester Examination	:	60 marks

The thesis Phase I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. The number of reviews must be a minimum of three per semester. 60 marks are allotted for the thesis work and viva voce examination at the end of the third

semester. The same procedure will be adopted for thesis Phase II in the fourth semester.

11. Student Counsellors (Mentors)

To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester, monitor their progress in SWAYAM courses / open elective courses and obtain the final approval of the Head of the Department.

12. Class Committee

For each of the semesters of M.E / M.Tech programmes, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from first to fourth semesters for Full time and first to sixth semesters for Part-time will be as follows:

- Teachers of the individual courses.
- A Thesis coordinator (for Thesis Phase I and II) shall be appointed by the Head of the Department from among the Thesis supervisors.
- A thesis review committee chairman shall be appointed by the Head of the Department
- One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.
- The Head of the Department may opt to be a member or the Chairman.
- All counselors of the class and the Head of the Department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees.

The class committee shall meet **three** times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory / 40 marks for practical and project work will be finalized for every student and tabulated and submitted to the Head of the Department for approval and transmission to the Controller of Examinations.

13. Temporary Break Of Study

A student can take a one-time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the mid-semester test. However, the student must complete the entire programme within the maximum period of **four years for Full time / six years for Part time.**

14. Substitute Assessments

A student who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the end of semester examination may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.

A student who wishes to have a substitute assessment for a missed assessment must apply to the Head of the Department within a week from the date of the missed assessment.

15. Attendance Requirements

The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.

A student who withdraws from or does not meet the minimum attendance requirement in a semester must re-register and repeat the same semester in the subsequent academic years.

16. Passing and declaration of Examination Results

All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the controller of examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the grade point average (GPA) and cumulative grade point average (CGPA) and prepare the mark sheets.

90 to 100 marks	Grade 'S'
80 to 89 marks	Grade 'A'
70 to 79 marks	Grade 'B'
60 to 69 marks	Grade 'C'
55 to 59 marks	Grade 'D'
50 to 54 marks	Grade 'E'
Less than 50 marks	Grade 'RA'
Withdrawn from the Examination	Grade 'W'

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course is declared to have successfully completed that course and earned the credits for that course. Such a course cannot be repeated by the student.\

A student who obtains letter grade RA / W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

S - 10; A - 9; B - 8; C - 7; D - 6; E - 5; RA - 0

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-totaling of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department.

After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester.

GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

CGPA is similarly calculated considering all the courses taken from the time of admission.

17. Awarding Degree

After successful completion of the programme, the degree will be awarded with the following classifications based on CGPA.

For First Class with Distinction the student must earn a minimum of 65 credits within four semesters for full-time / six semesters for Part time from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above.

For First Class, the student must earn a minimum of 65 credits within two years and six months for full-time / three years and six months for Part time from the time of admission and obtain a CGPA of 6.75 or above.

For Second class, the student must earn a minimum of 65 credits within four years for full-time / six years for Part time from the time of admission.

18. Ranking of Candidates

The candidates who are eligible to get the M.E /M.Tech degree in First Class with Distinction will be ranked on the basis of CGPA for all the courses of study from I to IV semester for M.E / M.Tech full-time / I to VI semester for M.E / M.Tech part-time.

The candidates passing with First Class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV semester for full-time / I to VI semester for M.E / M.Tech part-time.

19. **Transitory Regulations**

If a candidate studying under the old regulations M.E. / M.Tech could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old regulations.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.

ANNEXURE 1

S.No.	Department		Programme (Full Time & Part time)	Eligible B.E./B.Tech Programme *
1	**Civil Engineering**	i.	Environmental Engineering	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Mechanical Engg, Industrial Engg, Chemical Engg, BioChemical Engg, Biotechnology, Industrial Biotechnology, Chemical and Environmental Engg.
		ii.	Environmental Engineering & Management	
		iii.	Water Resources Engineering & Management	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Agricultural and Irrigation Engg, Geo informatics, Energy and Environmental Engg.
2	**Civil & Structural Engineering**	i.	Structural Engineering	B.E. / B.Tech – Civil Engg, Civil & Structural Engg.
		ii.	Construction Engg. and Management	
		iii.	Geotechnical Engineering	
		iv.	Disaster Management & Engg.	
3	**Mechanical Engineering**	i.	Thermal Power	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical Engg (Manufacturing).
		ii.	Energy Engineering & Management	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical (Manufacturing) Engg, Chemical Engg
4	**Manufacturing Engineering**	i.	Manufacturing Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Mechatronics Engg, Industrial Engg.
		ii.	Welding Engineering	
		iii.	Nano Materials and Surface Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Chemical Engg

5	**Electrical Engineering**	i.	Embedded Systems	B.E. / B.Tech – Electrical and Electronics Engg, Electronics & Instrumentation Engg, Control and Instrumentation Engg, Information technology, Electronics and communication Engg, Computer Science and Engg
		ii.	Smart Energy Systems	B.E. / B.Tech – Electrical and Electronics Engg, Electronics and Instrumentation Engg, Control and Instrumentation Engg.
		iii.	Power System	B.E. / B.Tech – Electrical and Electronics Engg,
6	**Electronics & Instrumentation Engineering**	i	Process Control & Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electronics Engg, Control and Instrumentation Engg, Instrumentation Engg
		ii.	Rehabilitative Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electronics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics.
		iii.	Micro Electronics and MEMS	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electronics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics, Telecommunication Engg
7	**Chemical Engineering**	i.	Chemical Engineering	B.E. / B.Tech – Chemical Engg, Petroleum Engg, Petrochemical Technology
		ii.	Food Processing Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Biochemical Engg, Agricultural Engg.
		iii.	Industrial Bio Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Leather Technology
		iv.	Industrial Safety	B.E. / B.Tech – Any Branch of

			Engineering	Engineering
8	**Computer Science & Engineering**	i.	Computer Science & Engineering	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
9	**Information Technology**	i	Information Technology	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
10	**Electronics & Communication Engineering**	i.	Communication Systems	B.E. / B.Tech - Electronics and Communication Engg, Electronics Engg.

*** AMIE in the relevant discipline is considered equivalent to B.E**

DEPARTMENT OF CIVIL ENGINEERING
Curriculum for **M.E. (ENVIRONMENTAL ENGINEERING)**
Full-Time

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
S e m e s t e r – I										
1	PC-I	ENVC101	Statistics for Water Resources and Environmental Engineers	4	-		25	75	100	3
2	PC-II	ENVC102	Environmental Chemistry & Microbiology	4	-		25	75	100	3
3	PC-III	ENVC103	Air Pollution Monitoring and Control	4	-		25	75	100	3
4	PC-IV	ENVC104	Principles and Design of Physico-Chemical Treatment Systems	4	-		25	75	100	3
5	PE-I	ENVE105	Professional Elective – I	4	-		25	75	100	3
6	PE-II	ENVE106	Professional Elective – II	4	-		25	75	100	3
7	PC Lab-I	ENVP107	Environmental Process Monitoring Laboratory	-	-	3	40	60	100	2
			Total	**24**		**3**	**190**	**510**	**700**	**20**

Sl. No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
S e m e s t e r – II										
1	PC-V	ENVC201	Principles and Design of Biological Treatment Systems	4	-	-	25	75	100	3
2	PC-VI	ENVC202	Solid Waste Management	4	-	-	25	75	100	3
3	PC-VII	ENVC203	Industrial Waste Management	4	-	-	25	75	100	3
4	PC-VIII	ENVC204	Environmental Impact Assessment	4	-	-	25	75	100	3
5	PE-III	ENVE205	Professional Elective – III	4	-	-	25	75	100	3
6	PE-IV	ENVE206	Professional Elective –IV	4	-	-	25	75	100	3
7	PC Lab-II	ENVP207	Unit Operations & Process Laboratory	-	-	3	40	60	100	2
8	Seminar	ENVS208	Seminar	-	-	2	100	-	100	1
			Total	**24**	**-**	**5**	**190**	**510**	**700**	**21**

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
S e m e s t e r – III										
1	OE-I	ENVE301	Open Elective – I	4		-	25	75	100	3
2	OE-II	ENVE302	Open Elective – II	4		-	25	75	100	3
3	Thesis	ENVT303	Thesis Phase-I	-	4	-	40	60	100	4
4	Ind Train	ENVI 304	Industrial Training		*	-	100	-	100	2
			Total	**8**	**4**	**-**	**90**	**210**	**300**	**12**

Note: * - Four weeks during the summer vacation at the end of IIth Semester.

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits
S e m e s t e r – IV										
1	Thesis	ENVT401	Thesis Phase-II	-	8	-	60	40	100	12
			Total	**-**	**8**	**-**	**40**	**60**	**100**	**12**

L- Lecture ; **P-** Practical; **T-** Thesis; **CA-** Continuous Assessment; **FE-** Final Examination

DEPARTMENT OF CIVIL ENGINEERING
Curriculum for **M.E. (ENVIRONMENTAL ENGINEERING)**

Part Time

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
S e m e s t e r – I											
1	PC-I	PENVC 101	Statistics for Water Resources and Environmental Engineers	4	-	-	25	75	100	3	ENVC 101
2	PC-II	PENVC 102	Environmental Chemistry & Microbiology	4	-	-	25	75	100	3	ENVC 102
3	PC-III	PENVC 103	Principles and Design of Physico-Chemical Treatment Systems	4	-	-	25	75	100	3	ENVC 104
			Total	**12**	**-**	**-**	**75**	**225**	**300**	**9**	

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
S e m e s t e r – II											
1	PC-IV	PENVC 201	Air Pollution Monitoring and Control	4	-	-	25	75	100	3	ENVC 103
2	PC-V	PENVC 202	Principles and Design of Biological Treatment Systems	4	-	-	25	75	100	3	ENVC 201
3	PC-VI	PENVC 203	Solid Waste Management	4	-	-	25	75	100	3	ENVC 202
			Total	**12**	**-**	**-**	**75**	**225**	**300**	**9**	

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
Semester – III											
1	PC-VII	PENVC 301	Industrial Waste Management	4	-	-	25	75	100	3	ENVC 203
2	PE-I	PENVE 302	Professional Elective – I	4	-	-	25	75	100	3	ENVE 105
3	PE-II	PENVE 303	Professional Elective – II	4	-	-	25	75	100	3	ENVE 106
4	PC Lab-I	PENVP 304	Environmental Process Monitoring Laboratory	-	-	3	40	60	100	2	ENVP 107
			Total	**12**	-	**3**	**115**	**285**	**400**	**11**	

S.No	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
Semester – IV											
1	PC-VIII	PENVC 401	Environmental Impact Assessment	4	-	-	25	75	100	3	ENVC 204
2	PE-III	PENVE 402	Professional Elective – III	4	-	-	25	75	100	3	ENVE 205
3	PE-IV	PENVE 403	Professional Elective – IV	4	-	-	25	75	100	3	ENVE 206
4	PC Lab-II	PENVP 404	Unit Operations & Process Laboratory	-	-	3	40	60	100	2	ENVP 207
5	Seminar	PENVS 405	Seminar		-	2	100		100	1	ENVS 208
			Total	**12**	-	**5**	**115**	**285**	**400**	**12**	

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
S e m e s t e r – V											
1	OE-I	PENVE 501	Open Elective – I	4	-	-	25	75	100	3	ENVE 301
2	OE-II	PENVE 502	Open Elective – II	4	-	-	25	75	100	3	ENVE 302
3	Thesis	PENVT 503	Thesis Phase-I	-	4	-	40	60	100	4	ENVT 303
4	Ind. Training	PENVI 504	Industrial Training		*	-	100	-	100	2	ENVI 304
			Total	**8**	**4**	**-**	**90**	**210**	**300**	**12**	

Note: * - Four weeks during the summer vacation at the end of IVth Semester.

Sl. No.	Category	Course Code	Course	L	T	P	CA	FE	Total	Credits	Equivalent Course Code in M.E. Full Time
S e m e s t e r – VI											
1	Thesis	PENVT 601	Thesis Phase-II	-	8	-	40	60	100	12	ENVT 401
			Total	**-**	**8**	**-**	**40**	**60**	**100**	**12**	

L- Lecture ; **P-** Practical; **T-** Thesis; **CA-** Continuous Assessment; **FE-** Final Examination

LIST OF PROFESSIONAL ELECTIVES

S. No.	Course Title
1	Noise Pollution and Control Engineering
2	Air Pollution Meteorology and Modelling
3	Climate Change and Adaptation
4	Environmental Management
5	Transport of Water & Wastewater
6	Water Quality Modelling
7	Operation and Maintenance of ETP Systems
8	Environmental Biotechnology
9	Marine Pollution & Control
10	Membrane Separation for Water & Wastewater Treatment
11	Landfill Engineering & Remediation
12	Computation Techniques in Environmental Engineering
13	Environment, Health & Safety for Industries
14	Fundamentals of Sustainable Development

LIST OF OPEN ELECTIVES

S. No.	Course Title
1	Remote Sensing & GIS for Environmental Engineering
2	Research Methodology
3	Environmental Sociology
4	Environmental Instrumentation
5	Energy Engineering
6	Cleaner Production and Environmental Management

ENVC101	STATISTICS FOR WATER RESOURCES AND ENVIRONMENTAL ENGINEERS	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To provide commonly used hypothesis tests, present univariate statistical methods, provide methods for gaining a preliminary understanding of a multivariate data base.
- To summarize some important concepts related to the assessment of model reliability.
- To discuss the commonly used bivariate and multivariate regression methods, spurious modelling, and contrasting methods for calibrating multivariate models, stepwise regression, PCRA.
- To introduce the basics of times series and stochastic modeling.

Introduction: Statistical decision making – Definition of a model – The Modelling process Hypothesis Tests on Means: The Analysis of Variance problem – Objective – One-sample and Two – sample t Tests – One-Way ANOVA – Multiple comparisons in the ANOVA test – Randomized Block Design – Two-Way ANOVA; Hypothesis Tests of Variances: One-sample χ^2 test – Two sample F test – Barlett's test for group variances. *Frequency Analysis***:** Probability paper – plotting the data – Fitting Normal, Log-Normal and Log-Pearson Type-III distributions – Low-flow frequency analysis – Binomial risk

Nonparametric Methods: One-sample run test for randomness – Pearson test and Spearman tests for serial dependence – Durbin-Watson test for autocorrelation – Kendall test for trend – Mann-Whitney test for distribution inequality – Chi-square test for goodness of fit – Kolmogorov – Smirnov One-sample and Two-sample tests. *Assessing Model Reliability***:** Model rationality – Bias in estimation – SEE – Correlation coefficient – Accuracy of model coefficients – Analysis of the residuals

Correlation and Regression Analysis: Bivariate correlation – correlation in multivariate systems; Bivariate linear regression – statistical optimization – principle of least squares – reliability of the regression equation – reliability of point estimates of regression coefficients – confidence interval of the regression equation – correlation versus regression
Multiple Regression Analysis: Matrix solution of the standardized model - criteria for evaluating a multiple regression model – Analysis of residuals

Spurious Correlation and Regression: Transformation of a bivariate regression equation – Transformation involving ratios of variables – the ratio correlation problem – ratio correlation cases; Stepwise Regression: Objective – model structure – Total and partial F tests
Principal components Regression Analysis – PCRA method; Polynomial regression analysis: Transformation and calibration – Analysis of variance of polynomial models – PCRA of polynomial equations

Numerical Optimization: Nonlinear model structures – objective function – response surfaces – Phase I search – Step sizes – Constraints – Goodness of fit - Calibration of power models – criteria for measuring optimality. *Time Series and Stochastic Modeling***:** Components of a Time Series – Moving-Average filtering – Autocorrelation analysis – Cross-correlation analysis – Identification of random component – Autoregression and Cross-regression models

REFERENCES

1. Gupta, S.C. and Kapoor, V. K., "Fundamentals of Mathematical Statistics", Eleventh Edition (Reprint), Sultan Chand & Sons, 2014
2. Richard H McCuen, "Statistical Methods for Engineers", Prentice-Hall, Englewood Cliffs, N.J., 1985
3. Richard H McCuen, "Microcomputer Applications in Statistical Hydrology", Prentice-Hall, Englewood Cliffs, N.J., 1993
4. Vic Barnett, "Environmental Statistics: Methods and Applications", John Wiley & Sons, Inc., 2003
5. Gupta, S.C. and Kapoor, V. K., "Fundamentals of Applied Statistics", Fourth Edition (Reprint), Sultan Chand & Sons, 2014
6. Richard H McCuen and Willard M Snyder, "Hydrologic Modelling: Statistical Methods and Applications", Prentice-Hall, Englewood Cliffs, N.J., 1986
7. Paul Mac Berthouex and Linfield C. Brown, "Statistics for Environmental Engineers", Second Edition, Lewis Publishers, Washington D.C. , 2002

COURSE OUTCOMES:

At the end of the course students will be able to

1. Recognize that statistical methods are decision-making tools and will view them as a part of a process.
2. Demonstrate different examples to illustrate each statistical method, recognizing that there are a great many possible applications of statistical methods.
3. Explore the use of statistical software and develop microcomputer applications for solving real-time problems in Water Resources Engineering and Environmental Engineering.
4. Realize that the course contains the statistical methods necessary to solve a wide array of real-world problems in Water Resources Engineering and Environmental Engineering.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓					
CO2	✓						
CO3			✓	✓	✓		
CO4						✓	

ENVC102	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To impart knowledge on various aspects of chemical equilibrium, kinetics, pollution in the environment and its effects on the biological systems.
- To enable the students to systematically analyze different materials using analytical chemistry and imply them in characterization and treatment of industrial and municipal wastes.
- To study the living organisms of microscopic size, which include bacteria, fungi, algae, protozoa and the infectious agents and their form, structure, reproduction, physiology, metabolism and classification.
- To study their distribution in nature, their relationship to each other and to other organisms, their effects on human beings and on other animals and plants, their abilities to make physical and chemical changes in our environment, and their reactions to physical and chemical agents.

Part – A: Environmental Chemistry

Physico-chemical principles and processes – Stoichiometry – Mass Balance – Ideal solutions and Gases – Concentration – Standard solutions – Primary and Secondary standards – Chemical Equilibrium – Acid base – Oxidation-reduction and Solubility equilbria – Adsorption isotherms – Photochemical processes.

Water Chemistry - Water Quality parameters – Significance and determination – trace element contamination – Contamination by fertilizer and pesticides – Eutrophication and Environmental tolerances. Water Treatment Processes – Softening – Principles of precipitation, coagulation and filtration – Ion exchange – Acid mine drainage.

Atmospheric chemistry - Structure of atmosphere – Thermo chemical and Photochemical reactions – Atmospheric cycles – Ozone chemistry – acid rain – Green house gases – Global warming – Air quality parameters – Hazardous air pollutants effects and determination – Electromagnetic radiation and its effects.

Instrumentation techniques - Error analysis – sources of errors and determination – Introduction to spectrophotometric analysis – Colorimetry – Nephlometry – UV-VIS spectroscopy – FTIR spectroscopy – Chromatography – Gas and Liquid.

Emerging areas - Principle of Green Chemistry – Renewable energy systems – Biomass utilization – Hydrogen energy – Nano Technology – Carbon materials

and composites – Environmental applications.

Part – B: Environmental Microbiology

Fundamentals of Microbiology: Cell – Prokaryotes Vs Eukaryotes – Classification of microbes – Ultra structure of a bacterial cell and cell wall – Size, shape and arrangement of bacterial cells – Structure of DNA (double helical and chemical) – RNA types and plasmids – Types of Microbiological media – Methods of sterilization and inoculation – Isolation, development of pure culture and preservation of soil bacteria – Simple and Gram staining – Growth of bacteria – Factors influencing growth – Growth curve – Determination of growth.

Microbial Ecology and Metabolism: Ecological group of microorganisms based on Oxygen requirement, Carbon source, temperature, habitat and nutrient requirements – Extremophile bacterial types – Types of interaction – symbiosis, mutualism, commensalism, competition, parasitism and predation – Plant and animal microbes interactions – Glycolysis – Kreb's cycle – β-Oxidation and Electron transport chain.

Soil Microbiology: Soil bacteria, actinomycetes, algae, fungi and protozoans and their role – Rhizosphere microbes – Carbon, Nitrogen, Phosphorous and Sulfur cycles – Biodegradation (cellulose, pectin) and Bio-deterioration (leather) – Bioremediation of oil spills – Microbial leaching of mineral ores – Bioaccumulation and Biomagnification – Environmental monitoring – Environmental impacts and their assessments using bio-indicators, biomarkers, biosensors and toxicity testing.

Aquatic Microbiology: Hydrological cycle – Marine, Brackish and Fresh water ecosystems – Water borne bacterial diseases – Cholera and typhoid – Microbiological analysis of water for coliform bacteria – Presumptive, Confirmed and Completed tests – IMViC test – Biological indicators of water pollution – Quality checking of potable water – Algae in water supplies – problems and control – Microbiology of sewage treatment.

Atmospheric Microbiology: Aerofungi, algae and bacteria – Microbial aeroallergens – Deposition of microbes in atmosphere – Gravitational setting, Surface impaction and rain and electrostatic deposition – Air borne microbial diseases – Pertussis, Q fever – Methods of air sampling – Impingement, Centrifugation, Filtration and Deposition. *Instrumentation in Microbiology*: Compound and Electron (SEM and TEM) Microscopes – pH meter – Colorimeter – Autoclave – Laminar air flow chamber – Colony counter – Hemocytometer.

REFERENCES

1. Clair N Sawyer, Perry L. McCarty & Gene. F.Parkin, "Chemistry for Environmental Engineering", Tata McGraw Hill, Fourth Edition, 2000.
2. Dara. S.S., "Environmental Chemistry", 3rd Edition, S.Chand & Co, New Delhi, 2001.

3. De. A. K, " Environmental Chemsitry", New Age International (P) Limited, 3rd Edition 1994.
4. Sharma B.K and Kaur H., "Environmental Chemistry", Goel Publishing House 3rd Edition, 1996-97.
5. Stanley E. Manohar, "Environmental Chemistry", Williard Grant Press, Beston, Massachutes.
6. Atlas, R.A. and Bartha, R., "Microbial Ecology – Fundamentals and Application", Benjamin Cummings, New York, 2000.
7. Egbert Boeker and Rienk Vangrondella, "Environmental Science", John Wiley & Sons Ltd., USA, 2001.
8. Grant, Wd. and Long, PL., "Environmental Microbiology", Blackie Glasgow, London, 1981.
9. Grerard J. Tortora, Berdell R. Funke, Christine and L. Case, " Microbiology: An Introduction", Benjamin Cummings, U.S.A., 2004.
10. Pelczar Jr. MJ, Chan ECS and Krieg, NR., "Microbiology", McGraw Hill. Inc, New York, 1993.
11. Prescott, L.M., Harley, J.P. and Klein, D.A., "Microbiology", McGraw Hill, New York, 2006.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Explain the chemical concepts involved in miscibility of solutions and gases.
2. Determine the water quality parameters like alkalinity, Total hardness and Oxygen demand in sewage and industrial effluents.
3. Suggest suitable qualitative and quantitative analysis of different materials in solid, liquid and gaseous forms.
4. Understand the characteristics and structure of microbes.
5. Isolate and identify different microbes present in various sources.
6. Acquire knowledge on soil, aquatic and air microbiology.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		✓					
CO2		✓	✓				
CO3			✓	✓	✓		
CO4		✓	✓				
CO5			✓	✓			
CO6			✓				

ENVC 103	AIR POLLUTION MONITORING AND CONTROL	L	T	P
		4	0	0

COURSE OBJECIVES:

- To impart knowledge on air quality measurement in compliance with the standards.
- To enable students to learn about various air pollution control systems, related theory, working principles, engineering design and management.

Composition and structure of atmosphere-Definition-Air Pollution-Sources-Classification-Types - On meteorological conditions-Ozone layer disturbance, green house effects.

Introduction- Standards-ambient air quality standards-emission standards-Air sampling methods-Modern air pollution measurement sensors-working principle-Emission inventory-Air quality index-Measurement-ambient and source sampling-pressure-gas flow rate-relative humidity-Sample train-determination particle size distribution-Gas stream calculations and conditioning.

Air Pollution Control – General-Gravitational settling chambers-Inertial separators-Cyclone-introduction-industrial application-multiple cyclone-Fabric filtration-introduction-principle and theory-application-engineering design-operation. *Electrostatic precipitation*-introduction-principles of operation-design methodology and considerations-application-problems and corrections-Dry and wet Scrubbing-introduction-dry scrubbers-wet scrubbers.

Condensation-introduction-pre and post treatment-engineering consideration and design-management .Flare process-introduction-pretreatment-engineering consideration and design-management. *Thermal and Catalytic oxidation*-introduction- pretreatment and engineering consideration-supplementary fuel requirements-design and operation-management. Gas-phase activated carbon adsorption-introduction and definitions-adsorption theory-carbon adsorption pretreatment-design and operation.

Gas Phase Bio-filtration-introduction-types of air treatment systems-operational consideration-design consideration/parameters-case studies-process control and monitoring-limitations of the technology. Emerging air Pollution Control Technologies-introduction-process modification-vehicle air pollution and its control-mechanical particulate collectors-Entrainment separation- IC engines-Membrane process-UV photolysis-High efficiency particulate air filters-Technical and economical feasibility of selected emerging technologies.

Indoor air quality management: Measurement, control and preventive measures of indoor air quality measures and management. *Control Measures for Industrial Applications*: Control methods – Processes based control mechanisms – mineral products – asphaltic concrete, cement plants and glass manufacturing plants; Thermal power plants, Petroleum refining and storage plants, Fertilizers, Pharmaceuticals and wood processing industry.

REFERENCES

1. Lawrence K.Wang, Norman C.Pereira and Yung-Tse Hung. "Air Pollution Control Engineering", Humana Press, New Jersey, 2004.
2. Noel De Nevers, "Air Pollution control Engineering", McGraw-Hill International Edition, Civil Engineering Series, Singapore, 2000.
3. Arthur C.Stern, "Air Pollution", Volume-III, Academic Press, New Delhi, 2006.
4. Wayne T.Davis, "Air Pollution Engineering Manual", John Wiley & Sons Inc., New Delhi, 2000.
5. J.R.Mudakavi, "Principles and Practices of Air Pollution Control and Analysis", I.K. International Publishing House Pvt. Ltd., New Delhi, 2012.
6. Louis Theodore, "Air Pollution Control Equipment Calculation", John Wiley & Sons Inc, New Delhi, 2006.
7. "Programme Objective Series (PROBES)", Open Source of Central Pollution Control Board, Ministry of Environment, Forest and Climate Change, Govt. of India (www.cpcb.nic.in).

COURSE OUTCOMES:

At the end of the course students will be able to

1. Conduct air quality monitoring programme for routine or site specific air quality parameters with conventional as well as modern sensors.
2. Design air pollution control systems.
3. Select the appropriate cost effective control system with high efficiency to be adopted in any type of air polluting industry.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓				
CO2		✓	✓	✓			
CO3			✓	✓	✓	✓	✓

ENVC104	PRINCIPLES AND DESIGN OF PHYSICO-CHEMICAL TREATMENT SYSTEMS	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To learn the principles and significance of various physical and chemical treatment systems.
- To design physical and chemical treatment systems practiced in water and waste water treatment.

Physico – Chemical treatment – Principle – Need – Objectives – Significance - Role in Water/Wastewater treatment - Selection criteria - Advantages and Disadvantages - Application. Physical Treatment-Screening – Coarse, fine & baskets screens – Mixing,

Equalization – Sedimentation – Filtration – back washing – Evaporation – Sorption theory - Absorption and Adsorption – Principles – Isotherms - kinetics-regeneration - Membrane separation – Principles - Reverse Osmosis - Nano filtration - Ultra filtration-Micro filtration - hyper filtration electro dialysis – Distillation – Stripping and Crystallization - Physical methods of Sterilization and Disinfection - Heat-Radiation - Filtration.

Chemical Treatment – Coagulation – Coagulant – types – Flocculation – Orthokinetic – Perikinetic – Precipitation – flotation, solidification and stabilization – Disinfection, Ion exchange, Electrolytic methods, Solvent extraction – advanced oxidation/reduction.

Selection of Treatment – Design of municipal water treatment plant units – Aerators– chemical feeding – Flocculation – clarifier – tube settling – filters – Rapid sand filters, slow sand filter, pressure filter, dual media – Disinfection – Displacement and gaseous type – Flow charts – Layouts – Hydraulic Profile, Project Information Document(PID) – construction and O&M aspects – case studies, Residue management – Upgradation of existing plants – Case study.

Design of Industrial Water Treatment Units – Selection of process – Design of softener – De mineralizer – Reverse osmosis plants – Flow charts – Layouts – Hydraulic Profile, PID-construction and O&M aspects – case studies, Residue management – Case study.

Design of municipal wastewater treatment units – screens – grit chamber – settling tanks – sludge thickening – sludge dewatering systems – sludge drying beds – Design of Industrial Wastewater Treatment Units – Equalization – Neutralization – Chemical Feeding Devices – mixers – floatation units – oil skimmer – clarifier – Flowcharts – Layouts – Hydraulic Profile, PID, construction and O&M aspects – Retrofitting – Residue management – Case study.

REFERENCES

1. Metcalf and Eddy, "Wastewater Engineering, Treatment and Reuse", Tata McGraw Hill, New Delhi, 2003.
2. Lee, C.C. and Shun dar Lin, “Handbook of Environmental Engineering Calculations”, McGraw Hill, New York, 1999**.**
3. Qasim, S.R., Motley, E.M. and Zhu.G., “Water works Engineering – Planning, Design and Operation”, Prentice Hall, New Delhi, 2002.
4. Hendricks, D. “Water Treatment Unit Processes – Physical and Chemical”, CRC Press, New York, 2006.
5. David Hendricks, "Fundamentals of Water Treatment Process", CRC Press, New York, 2011.

STANDARDS:

1. Spellman F.R. , "Handbook of Water and Wastewater Treatment Plant operations", CRC Press, New York, 2009.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the conceptual theories of physico–chemical treatment and their need.
2. Identify various physico-chemical treatment units with their significance and types.
3. Learn the criteria for adaptation of the physico-chemical treatment with their advantages.
4. Design physico-chemical treatment units for water and wastewater.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓				
CO2		✓	✓	✓			
CO3		✓	✓	✓			
CO4					✓	✓	✓

ENVP107	ENVIRONMENTAL PROCESS MONITORING LABORATORY	L	T	P
		0	**0**	**3**

COURSE OBJECTIVES:

To conduct laboratory studies on

- Water and wastewater samples.
- Monitoring Air Pollution and Noise Level.
- Microscopic examination for water and waste water.

LIST OF EXPERIMENTS

1) pH Meter - Determination of pH of Samples
2) Conductivity Meter - Determination of Specific conductance of Samples
3) Turbidity Meter - Determination of turbidity (NTU) of Samples
4) Jar test apparatus - Determination of the optimum dosage of coagulant
5) Determination of Chemical Oxygen Demand (COD) of samples
6) Determination of Biochemical Oxygen Demand (BOD_5) of samples

7) Determination of Solids in the samples

   a) Suspended solids
      Settleable solids
      Non-settleable solids
   b) Dissolved solids
      Volatile solids
      Fixed solids

8) Determination of Hardness of samples (EDTA method)
9) Determination of chloride of samples (Mohr's method)
10) Determination of Dissolved Oxygen of samples (Winkler's method)

Air Pollution & Noise Level Monitoring

11) Estimation of:

NO_x, SO_x, SPM, HC, CO

12) Noise level

13) Environmental Microbiology

General techniques of microbiology: Media preparation, sterilization, inoculation, cultivation, isolation, purification and enumeration. (plate count, membrane filtration method). Kinetics of bacterial growth: Bacterial growth curve, estimation of number of generations, generation time. Determination of microbial quality of water: standard plate count, standard coliform test, determination of coliform density by MPN method fecal coliform test, fecal streptococcal plate count, Morphological identification of various common soil fungi, Microscopic examination of different algae of water and wastewater

ENVC201	PRINCIPLES AND DESIGN OF BIOLOGICAL TREATMENT SYSTEMS	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To understand the principles, significance and the design process of various biological treatment systems involved in water and waste water treatment.
- To educate the students on the principles and process designs of various treatment systems of water and wastewater.
- To develop competency in the process employed in design of treatment systems .
- To select specific biological process knowing their advantages and overcome their disadvantages.

Objectives of biological treatment – significance – aerobic and anaerobic treatment kinetics of biological growth – Factors affecting growth – attached and suspended growth Determination of Kinetic coefficients for organics removal – Biodegradability assessment - selection of process- reactors-batch-continuous type-kinetics.

Design of sewage treatment plant units –Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters-Bio Tower-RBC-Moving Bed Reactors- fluidized bed reactors, aerated lagoons, waste stabilization ponds – nutrient removal systems – natural treatment systems, constructed wet land – Disinfection – disposal options – reclamation and reuse – Flow charts, layout, Project Information Document(PID), hydraulic profile-recent practices – DWATS.

Attached and suspended growth, Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal – Nutrient removal systems – Flow chart, Layout and Hydraulic profile – recent practice – Immobilization techniques.

Design of sludge management facilities, sludge thickening, sludge digestion, biogas generation, sludge dewatering – centrifuge - Layout, PID, hydraulics profile – upgrading existing plants – ultimate residue disposal – recent advances.

Construction and Operational Maintenance problems – Trouble shooting – Planning, Organization and control of plant operations – capacity building - Retrofitting Case studies – sewage treatment plants – sludge management facilities - carbon footprints.

REFERENCES

1. Metcalf & Eddy, Inc.,"Wastewater Engineering – Treatment and Reuse", Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
2. Qasim, S.R., "Wastewater Treatment Plant, Planning, Design & Operation", Technomic Publications, New York, 1994.
3. Arceivala, S.J., "Wastewater Treatment for Pollution Control", TMH, New Delhi, Second Edition, 2000.
4. F.R. Spellman, "Hand Book of Water and Wastewater Treatment Plant operations", CRC Press, New York, 2009.
5. David Hendricks, "Fundamentals of Water Treatment Process", CRC Press, New York, 2011.

STANDARDS:

1. Manual on "Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Learn the principles, theories and significance of biological treatment systems for waste water treatment.
2. Design biological treatment systems for waste water.
3. Develop conceptual schematics required for biological treatment of wastewater.
4. Translate pertinent criteria into biological treatment system requirements.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓				
CO2	✓	✓	✓	✓			
CO3			✓	✓		✓	
CO4					✓	✓	✓

ENVC 202	SOLID WASTE MANAGEMENT	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To create a better understanding on the differences those exist between solid, liquid and gaseous waste.
- To understand the functional elements of solid waste management, prevailing issues and challenges arising due to quantity, quality and heterogeneity of the solid waste.
- To impart theoretical knowledge on various terminologies used in SWM, the 1egal framework and requirements in India.
- To know various methods available for processing / treatment and the options available for ultimate disposal of waste, recent advancement in recycling and reuse, waste to energy generation and the role of Integrated solid waste management.

Introduction - definition of the term solid waste – goals and objectives of solid waste management - types and sources of solid wastes – legal and regulatory requirements - present scenario in India – waste generation – functional elements of solid waste management - solid waste sampling - composition and characterization – problems and issues in existing waste management practices - participatory waste management – sustainable waste management.

Handling and segregation of waste at source - storage – specific storage plan for various buildings - community storage – collection – types – methods – optimizing the routes for collection -collection frequency – transfer and transport – transfer stations – types and design requirements. Volume reduction – Mechanical treatment - Processing and materials recovery – selection of suitable processing techniques – biological – chemical – thermal processing –

incineration –pyrolysis – conventional gasification – plasma arc gasification – energy recovery - recycling and reuse.

Secured Landfills – concept and challenges - types – criteria for site selection – methods - machineries involved - reactions – control of gas movement and leachate control – design - post closure monitoring – environmental monitoring – TSDF – landfill remediation - cost consideration. Composting and bio gasification – types – methods – product quality - environmental effects – cost considerations.

REFERENCES

1. George Technobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid waste Management", McGraw Hill Publishers, New York, 1993.
2. Howard. S.Peavy, Donald R. Rowe & George Technobanoglous, "Environmental Engineering" McGraw Hill Publishers, New York, 1985.
3. Bhide A.D and Sundaresan, B.B, "Solid Waste Management Collection, Processing and Disposal", 2000.
4. Manual on Municipal Solid waste Management", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.
5. Frank Kreith and George Technobanoglous, Hand book of Solid Waste Management, Mc Graw Hill, 2002.
6. Haggerty, D.J., Solid Waste Management, Von Nostrand Renihold Company, New York, 1973.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the present scenario of solid waste management in India, framework and regulatory requirements applicable in India.
2. Gain good knowledge on composition and characterization of waste based on which a recommendation can be made on how to handle the given waste.
3. Demonstrate the concept of waste to wealth.
4. Device a better strategy to adopt the principle of cradle to grave to dispose waste.
5. Apply knowledge for recycling and reuse of waste in their respective fields.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓				
CO2	✓	✓	✓	✓			
CO3			✓	✓		✓	
CO4				✓	✓		
CO5					✓	✓	✓

ENVC 203	INDUSTRIAL WASTE MANAGEMENT	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To insist the importance in maintaining the quality of the environment for sustainable living.
- To characterize the industrial effluents, its impact on the environment, possible preventive measures against generation of wastes and treatment and reuse option for the generated wastewater.

Introduction: Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management.

Industrial Pollution Prevention: Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Pollution Prevention of Assessment - Material balance - Evaluation of Pollution prevention options – Cost benefit analysis – payback period - Waste minimization Circles.

Wastewater Reuse And Residual Management: Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse , Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

Hazardous waste management rules, classification of hazardous wastes, storage and handling requirements, risk assessment, on-site and off-site emergency preparedness planning.

Hazardous waste treatment and disposal practices, stabilization and solidification, incineration, land filling, deep-well injection, underground disposal, encapsulation; site remediation.

Case Studies: Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining – Pharmaceuticals – Sugar and Distilleries.

REFERENCES

1. Eckenfelder, W.W., "Industrial Water Pollution Control", Mc-Graw Hill Publishers, 2000.
2. Nelson Leonard Nemerow, "Industrial waste treatment – contemporary practice and vision for the future", Elsevier, Singapore, 2007.
3. Frank Woodard, "Industrial waste treatment Handbook", Butterworth Heinemann, New Delhi, 2001.
4. World Bank Group, "Pollution Prevention and Abatement Handbook – Towards Cleaner Production", World Bank and UNEP, Washington D.C., 1998.
5. Paul L. Bishop, "Pollution Prevention: - Fundamentals and Practice", Mc-Graw Hill International Publishers, Boston, 2000.

COURSE OUTCOMES:

1. Characterize the wastewater generated from a specific industry and understand the possible impacts on the environment.
2. Identify the means and methods to reduce the quantity of generation of wastewater from an industrial premise by performing source reduction techniques and waste audit.
3. Probe the possible recycling and reuse opportunities for the generated wastewater and residuals by employing suitable treatment units.
4. Understand the feasibility and benefits of individual, common and joint treatment of industrial wastewater.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2	✓	✓	✓	✓			
CO3			✓	✓		✓	
CO4				✓	✓		

ENVC204	ENVIRONMENTAL IMPACT AND RISK ASSESSMENT	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To expose the students to the need, methodology, documentation and usefulness of Environmental Impact Assessment.
- To develop the skill to prepare Environmental management plan.

- To provide knowledge related to the broad field of Environmental Impact Assessment, important processes that control contaminant transport and tools that can be used in predicting and managing human health risks.

Introduction: Concept of EIA – Legal Aspects – Limitations – EIA process in India – Projects requiring Environmental clearance – Types of EIA – State and central level agencies – EIA team – EIA process – screening – scoping – setting – analysis – Terms of Reference (TOR) in EIA, Identification – Assessment and Prediction – documentation – Draft presentation – Public participation in EIA – public hearing process in India – Compliance Schedules – Final presentation – EIA consultant Accreditation.

Impact Identification and Prediction: Assessment methods – simple methods – Matrices – Networks – checklists – software packages – Expert systems – Models for impact prediction – Assessment and prediction of Air – Water – Soil and Noise Environment.

Social Impact Assessment and Environmental Management plan: Assessment and prediction of Biological – Cultural – Visual Impact on Environment – Assessment and prediction of socio Economic Environment – Documentation of EIA findings – Organization of information and visual display – Draft Report – EMP – preparation – Implementation of mitigation aspects – policy & guidelines for planning and monitoring programme – post project audit – Ethical and quality aspects of EIA – Case Studies.

Environmental risk analysis / assessment – Hazard identification – Dose response evaluation - - Exposure assessment – Tools for environmental risk assessment – HAZOP and FEMA methods – Event tree and Fault tree analysis –Risk characterization - Risk communication – Emergency preparedness plan – Design of risk management programs.

REFERENCES

1. Canter L.W., "Environmental Impact Assessment", McGraw Hill Publishers, New York, 1996.
2. Raghavan K.V. and Khan A.A., "Methodologies in Hazard Identification and Risk Assessment", Manual by CLRI 1990.
3. Lawrence, D.P., "Environmental Impact Assessment – Practical solutions to recurrent problems", Wiley- Inter science, New Jersey, 2003.
4. World Bank - Source book on EIA.
5. Noble, B.F., "Introduction to Environmental Impact Assessment: A Guide to principles and practice", 3rd Edition, Oxford University Press, 2015.
6. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
7. Jain, R.K., "Environmental Impact Assessment", McGraw Hill Publishers, New York, 2002.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the necessity of the impacts and risks that will be caused by projects or industries and the methods to overcome these impacts.
2. Know about the legal requirements of Environmental Impact and Risk Assessment for projects.
3. Gain good knowledge on environmental impact assessment procedures and techniques adopted in the field.
4. Understand EIA as a technical, social process used for environmental governance.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2	✓	✓					
CO3		✓	✓			✓	
CO4				✓	✓		✓

ENVP207	UNIT OPERATIONS & PROCESS LABORATORY	L	T	P
		-	-	3

COURSE OBJECTIVE

To conduct laboratory studies on water and wastewater treatment units.

LIST OF EXPERIMENTS

1) Coagulation and Flocculation.
2) Batch studies for sedimentation.
3) Characteristics of Filter media.
4) Studies on Filtration.
5) Water softening.
6) Adsorption studies / Kinetics.
7) Silt Density Index.
8) Reverse Osmosis.
9) Kinetics of suspended growth process (activated sludge process).
10) Kinetics of attached growth process (Rotating Biological Contactors).
11) Sludge volume Index.
12) Anaerobic Reactor systems / Kinetics.
13) Advanced Oxidation Processes.
14) Chlorine Demand Estimation.

REFERENCES

1.Metcalf & Eddy, Inc. 'Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi 2003.
2.Lee, CC & Shun dar Lin, Hand book of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
3.Casey T.J. Unit treatment processes in water and wastewater engineering, John Wileys Sons, London, 1993.

Computer Aided Modeling Laboratory

Computer programmes with reference to Environmental problems. Each student should develop and execute a minimum of 15 programmes and submit in the form a record

ENVS208	SEMINAR	L	T	P
		0	**0**	**2**

COURSE OBJECTIVES:

- To work on a technical topic related to Environmental Engineering and acquire the ability of written and oral presentation
- To acquire the ability of writing technical papers for Conferences and Journals

The students will work for two periods per week guided by student counselor and a seminar will be conducted for not less than fifteen minutes and not more than thirty minutes on any technical topic of student's choice related to relevant subject. The students will defend their presentation and interact with audience. A brief copy of their presentation also should be submitted. Evaluation will be done by the student counselor based on the technical presentation and the report and also on the interaction shown during the seminar.

COURSE OUTCOMES:

1. The students will be getting the training to face the audience and to interact with the audience with confidence.
2. To tackle any problem during group discussion in the corporate interviews.

ENVT303	THESIS PHASE-I	L	T	P
		0	**4**	**0**

COURSE OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Take up any challenging practical problems and find solution
2. Learn to adopt systematic and step-by-step problem solving methodology

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓	✓	✓		✓
CO2		✓	✓	✓	✓	✓	

ENVI304	INDUSTRIAL TRAINING	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To train the students in the field of Environmental Engineering and enrich practical knowledge to carry out the relevant works in the field.
- To train and develop skills in solving problems during execution of certain works related to the field of specialization.

The students individually undergo a training program in reputed concerns in the field of Environmental Engineering during the summer vacation (at the end of second semester for full – time / fourth semester for part – time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training obtained, within ten days from the commencement of the third semester for Full-time / fifth semester for part-time. The students will be evaluated by a team of staff members nominated by head of the department through a viva-voce examination.

COURSE OUTCOMES:

1. The students can face the challenges in the practice with confidence.
2. The student will be benefited by the training with managing the situation arises during the execution of works.

ENVT401	THESIS PHASE-II	L	T	P
		0	**8**	**0**

COURSE OBJECTIVES

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.

- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

1. Take up any challenging practical problems and find solution.
2. Learn to adopt systematic and step-by-step problem solving methodology.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓	✓	✓	✓	
CO2		✓	✓	✓	✓		✓

PROFESSIONAL ELECTIVES

ENVE* **	**NOISE POLLUTION AND CONTROL ENGINEERING**	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To give students an overview of noise pollution including methods of prevention, control, measures and management of pollution.
- To apply the theory of noise pollution to practical engineering situations.
- To use engineering instrumentation and principles to undertake a laboratory investigation in noise pollution.

Sources of Noise: Industry, Road traffic, Rail traffic, Air traffic, Construction and Public Works, Indoor Sources, Public Gatherings

Effects of Noise: Human hearing mechanism, Interference with Communication, Hearing Loss, Disturbance of sleep, Stress, annoyance, Effects of performance, Miscellaneous effects, Exposure limits

Basic Concepts of Sound: Propagation of Sound Wave Sound Intensity and Sound Power, Sound level and decibel, equivalent and continuous sound pressure level

Sound Measurement: Sound level meters, Types, Components, Community Noise Measurement, Procedure

Noise Pollution Control: Community and Industrial Noise, Control Measures, Control at Source, Control of sound transmission, Reduction in Length of exposure, Education of Public and Workers, Ear Protection, Noise Pollution Control Legislation

REFERENCES

1. "Environmental Health Criteria – 12", Noise, World Health Organisation Publication, Geneva, 1980.
2. Patrick, C.F., "Environmental Noise Pollution ", John Wiley and Sons, 1977.
3. Burs, W., Lippin Cott., " Noise and Man", Philadelphia, 1969.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Overview noise pollution including methods for prevention and control.
2. Use engineering instrumentation and principles to undertake a laboratory investigation in noise pollution.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2	✓	✓		✓		✓	✓

ENVE***	AIR POLLUTION METEOROLOGY AND MODELING	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To enlighten the students in the various aspects of Air pollution and associated Meteorology particularly for dispersion.
- To have the exposure of fundamentals Planetary Boundary Layer Characteristics.
- To understand the different approaches of pollutant transport theories.
- To learn the popular Gaussian Plume Model used widely for regulatory purposes.
- To provide numerical dispersion modeling for the advancement towards research and development.

Air pollution micrometeorology–primary and secondary measurement – projection-Sources of meteorological data

Planetary Boundary Layer (PBL) – Introduction and definition–Earth and atmosphere Exchange process-Thermodynamic variables and their vertical distribution in the PBL-Atmospheric stability –lapse rate- stability classes. Conservation laws-Atmospheric dynamics – Large scale inviscid and small scale viscous flows- Application. Scales of Atmospheric

motion –Macro, synoptic, meso and Micro scale system and dispersion - Characteristic plume shapes – Inversion breakup and shoreline fumigation.

Gradient Transport Theories – Eulerian approach to describe diffusion-Mass conservation and diffusion equations- Molecular diffusion-Turbulent diffusion constant K (Fickian Diffusion) theory- Variable K-theory-Limitations and experimental verification of gradient transport theories –Application of K-theories to atmospheric dispersion

Statistical Theories of Diffusion-Lagrangian approach to describing diffusion-Statistical theory of absolute diffusion-Plume diffusion from continuous sources- Statistical theory of relative diffusion-Puff diffusion from Instantaneous Release – Fluctuating Plume Models-Experimental Verification of Statistical Theories-Application to Atmospheric Dispersion and Limitation.

Gaussian Plume Model- assumptions and approximation-Diffusion experiments- Pasquill Stability classes-Empirical dispersion parameterization schemes – Pasquill-Gifford-Brookhaven National Laboratory-Tennessee Valley Authority-Briggs Urban Dispersion-Maximum Ground Level Concentration-Model evaluation – Tracer release experiments. Plume rise theory-Briggs- Plume Concentrations for differing sampling time averaging-Gravitational Settling of Particles-Dry Deposition

Numerical Dispersion Models-Introduction-Short range gradient transport Models-Turbulent Kinetic Energy (TKE) models- Higher order closure models. Urban and regional Air Quality Models-Introduction_ Components of an air quality model – Urban Diffusion and air quality models-Regional air quality models- Applications.

REFERENCES

1. S.Pal Arya., “Air Pollution Meteorology And Dispersion”, Oxford University Press, 1999.
2. Arthur C. Stern., “Air Pollution” (Third Edition) Volume I- Air Pollutants, Their Transformation and Transport, Academic Press (An imprint of Elsevier), 2006.
3. Roland.B. Stull., “An Introduction to Boundary Layer Meteorology”, Kluwer Academic Press, London, 1993.
4. J.R. Garratt, “ The Atmospheric Boundary Layer”, Cambridge University Press, 1999.
5. D.Bruce Turner, “Workbook of Atmospheric Dispersion Estimates”, Lewis Publishers, London, 1994.
6. Lyons, T.J., and Scott, W.D., **“**Principles of Air Pollution Meteorology”, CBS Publishers and Distributors (P) Ltd., New Delhi, 1992.
7. James R. Holton, “An Introduction to Dynamic Meteorology”, Academic Press Inc., London, 1989.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Investigate the spatial and temporal air pollution problems.
2. Model the transport, diffusion and dispersion of pollutants by either Gaussian or numerical methods with better air pollution meteorological background.
3. Develop new site specific air quality model codes and to investigate the present existing regulatory model codes under practice globally.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2		✓	✓			✓	✓
CO3				✓		✓	✓

ENVE***	CLIMATE CHANGE AND ADAPTATION	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To understand the earth's climate change and its system classification.
- To introduce the observed changes in the climate and concept of modeling and Institutional arrangements existing for monitoring this phenomenon.

Earth's Climate System: Introduction – Climate in the spotlight - The Earth's Climate Machine – Climate Classification – Global wind systems – Trade Wind Systems– Trade Winds and the Hadley Cell – The Weserlies – Cloud formation and Monsoon Rains – Storms and Hurricanes – The Hydrological Cycle – Global Ocean Circulation – EI Nino and its Effect – Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.

Observed Changes and Its Causes: Observation of Climate Change – Changes in pattern of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large Scale Variability – Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol – UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – Climate Change modeling.

Impacts Of Climate Change: Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water resources – Human Health – Industry, Settlement and Society – Methods and Scenarios – Projected Impacts for different

regions – Uncertainties in the Projected Impacts of Climate Change – Risk of irreversible changes.

Climate Change Adaptation and Mitigation Measures: Adaptation Strategy/options in various sectors – Water – Agriculture – Infrastructure and Settlement including coastal zones. Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and practices – Energy supply – Transport – Buildings – Industry – Agriculture – Forestry – Carbon sequestration – Carbon Capture and Storage (CCS) – Waste (MSW & Biowaste, Biomedical, Industrial waste – International and Regional co-operation.

Clean Technology and Energy: Clean Development Mechanism – Carbon Trading – Examples of future Clean Technology – Biodiesel – Natural Compost – Eco-friendly Plastic – Alternate Energy – Hydrogen – Bio-fuels – Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding

REFERENCES

1. Al core 'Inconvenient Truth" – video form
2. Dash Sushil Kumar, "Climate Change – An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.
3. IPCC Fifth Assessment Report – www.ipcc.ch
4. Jan C. van Dam, "Impacts of Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press, 2003.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the earth's climate change and its system classification.
2. Introduce the observed changes in the climate and concept of modelling and Institutional arrangements existing for monitoring the phenomenon.
3. Show the impact of climate change on various sectors and its irreversibility.
4. Prepare the adaptation and mitigation measures of climate change on various sectors.
5. Choose the clean Technology for the Fuel and energy through natural and eco friendly techniques.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2		✓	✓				
CO3		✓		✓	✓		
CO4						✓	✓
CO5				✓		✓	✓

ENVE***	ENVIRONMENTAL MANAGEMENT	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To expose the students to the need, methodology, documentation and usefulness of Environmental management.
- To provide knowledge related to the broad field of Environmental audit, important processes that control tools that can be used in predicting and managing human health risks.

Introduction – pollution control agency – aims and objectives – executive powers – legislative background – relevance to the constitution – cost benefit analysis in environmental problems

Component environment land, water and air – natural quality – pollution – sources – degree of pollution – tolerance limits based on scientific data – standards and their criteria – efforts to prevent/ control pollution, social objectives – health objectives – economic aspects protection of environment – planning approaches

Water quality management – concepts – riparian rights – components of water quality management – water uses – monitoring programmes – technology transfer – common effluent treatment concept

Air quality management – emission inventory – ambient air quality in the region – spotting of violations – corrective measures – technology transfer

Solid waste management – land pollution from solid and liquid wastes – spotting of violations – corrective measures – technology transfer

Environmental law – provisions in the law for initiating action – categories of penalties – categories of violations – pollution control enforcement strategies – inspections – procedures for serving notice – code of practice applicable to new industries – phasing of effecting controls – compliance schedule

Environmental audit – role of auditing – history – definitions audit methodology – evaluation audit results – audit reports – case studies

REFERENCES

1. Canter L.W., “Environmental Impact Assessment”, McGraw Hill, New York, 1996.
2. Lawrence, D.P., “Environmental Impact Assessment – Practical solutions to recurrent problems”, Wiley-Inter Science, New Jersey, 2003.
3. Mekee and Welf, “Water quality criteria”, The Resources agency of California, State water quality control Board, California, 1963.

4. Suess, “Manual on urban air quality management”, WHO Geneva, 1979.
5. Suriyakumaran, “Environmental Analysis and Assessment”, UNEP/UNAPDI, Bangkok, 1979.
6. Background materials on environmental audit, Confederation of Indian Industry, New Delhi.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the necessity to study the environmental management that will be caused by projects or industries.
2. Know about the legal requirements of Environmental management and auditing.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓		✓		
CO2		✓	✓		✓	✓	✓

ENVE***	TRANSPORT OF WATER AND WASTEWATER	L	T	P
		4	**0**	**0**

COURSE OBJECTIVE:

- To educate the students in detailed design concepts related to water transmission mains, water distribution systems, sewer networks and storm water drain.
- To learn computer applications of design.

Principles of hydraulics: fluid flow, continuity principle, energy principle. Loss of head – major loss - minor losses -pumping of fluids - types of pumps, selection of pumps - flow measurement - pipe flow, open channel flow.

Water transmission and distribution: planning factors-transmission mains – design & Economizing of transmission mains – water hammer analysis - Upsurge and Down surge – pipe materials-water distribution pipe network-analysis, design of network & optimization - Laying and maintenance of pipelines. Pipe appurtenances – corrosion prevention – minimization of water losses and leak detection.

Storm water drainage: combined and separate system, quantity estimation – rainfall data analysis – storm water drain design – storm water harvesting and roof water harvesting

Wastewater collection and conveyance: planning factors – design of sanitary sewer – economics of sewer design - Pumps and Pumping stations – sewer appurtenances – material, construction, inspection and maintenance of sewer, recent trends - Vacuum sewer system.

Software applications: Water distribution- LOOP, BRANCH and EPANET- Sewer design – SEWER.

REFERENCES

1. Bhave, P. R., "Analysis of flow in water distribution Networks", Technomic publishing Co., U.S.A.,1991.
2. Ven Te Chow, David R Maidment, Larry W. Mays "Applied Hydrology", McGraw Hill Book Co., 1988.
3. "Manual on sewerage and sewage treatment", CPHEEO, Ministry of Urban affairs and employment, GOI, New Delhi, 2001.
4. "Manual on water supply and treatment", CPHEEO, Ministry of Urban affairs and Employment GOI, New Delhi, 2001.
5. "Manual on water supply maintenance and management", CPHEEO, Ministry of Urban affairs and Employment, GOI, New Delhi.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand and apply the principles of hydraulics in water transportation and distribution and wastewater collection and conveyance.
2. Design water supply mains, distribution networks and sewers for various field conditions.
3. Analyze a water supply distribution network.
4. Estimate the quantity of storm drainage and design a proper storm drainage for speedy draining of storm water from the city area.
5. Troubleshoot in water and sewage transmission.
6. Use various computer software for the design of water and sewage networks.
7. Design a sewer network for the proper disposal of the sewage generated from the city limits to treatment plant.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2		✓	✓				
CO3			✓	✓	✓		
CO4		✓		✓		✓	
CO5		✓		✓	✓		
CO6						✓	✓
CO7				✓		✓	✓

ENVE***	WATER QUALITY MODELING	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To provide a fundamental understanding of water quality models.
- To provide students direct exposure to models currently used in environmental engineering practice for predicting water quality in rivers and lakes.
- To equip the students to apply such models to solve simple wasteload allocation problems.
- To instruct as to how water quality data can be analyzed and interpreted.
- To show how water quality models may be calibrated, verified, and applied to environmental engineering problems, such as total maximum daily loads or fate and transport modeling of toxic organic chemicals.

Introduction, Water Quality-Fundamental Quantities-Mathematical models, Historical Development of Water-Quality Models. Basic modeling concepts – Finite difference approximations to differential equations - Reaction Kinetics-Reaction fundamentals-Analysis of Rate Data-Temperature Effects

Transport phenomena – Advection, diffusion, dispersion- simple transport models –Diffusive transport: Diffusion and Fick's first law, Calculation of molecular diffusion coefficients Plug flow models- Application of PFR and MFR model - Steady state and time variable solutions-completely mixed systems, concept and models in Completely Stirred Tank Reactors, mass balance equations, loading types, feed forward vs. feedback reactor systems.

Water quality modeling 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 modeling in flowing water

Groundwater flow and mass transport of solutes, Degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion – basic concepts and modeling –Mathematical model of the discharge of wastewater into a marine environment

Exposure to surface water and groundwater quality modeling software‟s – MIKE 21, QUAL2E and MODFLOW Models and their application, Case studies

REFERENCES

1. Steven C.Chapra, "Surface Water Quality Modelling", The McGraw-Hill Companies, Inc., New Delhi, 1997.
2. Benedini, Marcello, Tsakiris, George, "Water Quality Modelling for Rivers and Streams", Springer, Netherlands, 2013.
3. Jacob Bear, A. H.-D. Cheng, "Modeling Groundwater Flow and Contaminant Transport", Springer Science & Business Media, 2010.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the context of water quality management and engineering.
2. Apply mass balance principles to develop and solve simple water quality models.
3. Understand eutrophication, the principal biochemical and physical factors affecting algae growth, management problems and solutions.
4. Identify modelling approaches and their limitations.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2		✓	✓				
CO3		✓		✓	✓		
CO4						✓	✓

ENVE***	OPERATION AND MAINTENANCE OF ETP SYSTEMS	L	T	P
		4	0	0

COURSE OBJECTIVE:

- To educate the student on the various Operation & Maintenance aspects of Water treatment systems, sewer systems, sewage treatment plants and Effluent Treatment Plants.

Elements of operation and maintenance: Strategy for Good Operation and Maintenance- Knowledge of process and equipment- 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 - Corrosion prevention and control –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- management of residues from plant maintenance.

Operation and maintenance of water intakes and supply systems: 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- Maintenance of Lined and Unlined Canals- Problems in Transmission Mains- Maintenance of Pipelines and Leakage Control- Repair Method for Different types of Pipes- Preventive and corrective maintenance of water pumps – Algal Control - O&M of Service Reservoirs - Problems in the water Distribution System and remedies- Water Quality Monitoring and Surveillance- Water Meters, Instrumentation, Telemetry & Scada- Computerised Water Billing System

Operation and maintenance of sewer systems: Components and functions of sewer system – Conduits or pipes – Manholes – Ventilating shaft – 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 -Case Studies.

Operation and maintenance of Physico-Chemical Treatments: Operation and maintenance in screen chamber, Grit Chamber and clarifiers- - Operation issues, trouble shooting 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- Case Studies.

Operation and Maintenance of Biological Treatment: 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- Trouble shooting guidelines – Interaction with other Treatment Processes - Planning, Organizing and Controlling of plant operations – capacity building, case studies of Retrofitting- Case studies.

REFERENCES

1. CPHEEO, Manual on operation and maintenance of water supply systems, Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, Government of India, 2005.
2. Ministry of Drinking Water and Sanitation, operation and maintenance manual for rural water supplies, Government of India, 2013.
3. Metcalf & Eddy, Inc., G. Tchobanoglous, H. D. Stensel, R. Tsuchihashi, and F. L.Burton. "Wastewater Engineering: Treatment and Resource Recovery"5th edition). McGraw Hill Company, 2014.
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.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Acquire knowledge required to operate and maintain water treatment plants.
2. Gain knowledge on wastewater treatment plants including trouble shooting.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2		✓	✓				

ENVE***	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P
		4	**0**	**0**

COURESE OBJECTIVES:

- To study the living organisms of microscopic size, which include bacteria, fungi, algae, protozoa and the infectious agents and their form, structure,

reproduction, physiology, metabolism and classification.

- To study their distribution in nature, their relationship to each other and to other organisms, their effects on human beings and on other animals and plants, their abilities to make physical and chemical changes in our environment, and their reactions to physical and chemical agents.

Cellular structure of microorganism, classification and study of microorganisms, nutrition of microorganisms and metabolism, enzymes, photosynthesis, protein, fat and carbohydrate metabolism, respiration sterilization theory, growth kinetics and enzyme kinetics, modelling aspects of microbial growth and metabolism

Ecology and ecosystem, spoilage and product manufacture by spontaneous mixed cultures, microbial participation in the natural cycles of matter

General features of the organic and inorganic pollutants

Bacteriology of water, sewage, air, soil and milk - Algae in water supply and its control, microbiology of waste water treatment - Bio-methanation processes

Agricultural applications for sludge and wastewaters – process design schemes for treatment of wastewater – dumping of refuge and sludge – exhaust gas purification

Some case studies of treatment of effluents from distillery, refinery, fertilizer, tannery textile, pulp and paper and metal processing industries

REFERENCES

1. Atlas, R.A. and Bartha, R. "Microbial Ecology- Fundamentals and Application", Benjamin Cummings, New York, 2000.
2. Grant, Wd. And Long, PL., "Environmental Microbiology", Blackie Glasgow, London, 1981.
3. Grerard J. Tortora, Berdell R. Funke, Christine and L. Case, "Microbiology: An Introduction", Benjamin Cummings, U.S.A. 2004.
4. Pelczar Jr. MJ, Chan ECS and Krieg, NR., "Microbiology", McGraw Hill Inc., NewYork, 1993.
5. Prescott, L.M., Harley, J.P. and Klein, D.A., "Microbiology", McGraw Hill, New York, 2006.
6. H.J. Rehm and G.Reed., "A Comprehensive treatise in Biotechnology" Vol. No.8., Verlag Chenie, Wein Heim, 1983.
7. M.J.Pelczar, R.D. Reid and F.C.S. Chan, "Microbiology", Tata Mcgraw Hill Publishing Co., 1977.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the characteristics and structure of microbes.
2. Isolate and identify different microbes present in various sources.
3. Acquire knowledge on soil, aquatic and air microbiology.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2		✓	✓				
CO3		✓		✓	✓		

ENVE***	MARINE POLLUTION AND CONTROL	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To educate about the Coastal and Marine Environment.
- To expose the concepts of ocean dynamics.
- To find sources of marine pollution and methods for monitoring, modeling and control.

Marine and Coastal Environment: Seas and oceans, Continental area, Coastal zone, Properties of sea water, Principles of Marine Geology, coastal features – Beaches, Estuaries, Lagoons–The oceans and climate

Ocean Hydrodynamics: 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 Niño effect.

Marine Pollution sources and effects: Sources of Marine Pollution – Point and non-point sources, Pollution caused by Oil Exploration, Dredging, Offshore Structures, Agriculture Impacts of pollution on water quality and coastal ecosystems – Marine discharges and effluent standards.

Marine Pollution Monitoring: Basic measurements - Sounding boat, lead lines, echo sounders – current meters - tide gauge - use of GPS – Measurement of coastal water characteristics – sea bed sampling – Modeling of Pollutant transport and dispersion - Oil Spill Models - Ocean Monitoring satellites – Applications of Remote Sensing and GIS in monitoring marine pollution

Coastal Management: Pollution Control strategies – Selection of optimal Outfall locations - National and International Treaties, Coastal Zone Regulation – Total Maximum Daily Load applications – Protocols in Marine Pollution – ICZM and Sustainable Development

REFERENCES

1. R.B. Clark, C. Frid and M Atttrill, "Marine Pollution", Oxford Science Publications, 5th Edition, 2005.
2. Tobias N. Hofer, "Marine Pollution: New Research", Nova Publishers, 2008
3. Dr.P. C.Sinha , "Marine pollution", Anmol Publications Pvt. Ltd, 1998.
4. Laws, E.A., "Aquatic pollution", John Wiley and Sons, Inc., New York, 2000.
5. Michael J. Kennish, "Practical Handbook of Estuarine and Marine Pollution", Volume 10 of CRC Marine Science, CRC Press, 1996.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Know about marine environment and learn the physical concepts lying behind the oceanic currents and natural processes of various activities happening over the marine environment.
2. Acquire knowledge on the marine pollution and the effect of the same on the ecology.
3. Understand remote sensing and various other techniques for measuring and monitoring oceanic environment parameters.
4. Learn the significance of control of marine pollution and sustainable development.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓			✓		
CO2		✓	✓				
CO3				✓	✓	✓	
CO4		✓			✓	✓	✓

		L	T	P
ENVE***	**MEMBRANE SEPARATION FOR WATER AND WASTEWATER TREATMENT**	**4**	**0**	**0**

COURSE OBJECTIVE:

- To introduce the concept and principles of membrane separation and its applications in water and wastewater treatment.

Membrane Filtration Processes: Solid Liquid separation systems- Theory of Membrane separation – mass Transport Characteristics - Cross Flow filtration - Membrane Filtration- Flux and Pressure drop -Types and choice of membranes, porous, non porous, symmetric and asymmetric – Plate and Frame, spiral wound and hollow fibre membranes – Liquid Membranes

Membrane Systems: Microfiltration principles and applications – Ultra filtration principles and applications - Nano Filtration principles and applications – Reverse Osmosis: Theory and design of modules, assembly, plant process control and applications – Electro dialysis : Ion exchange membranes, process design- Pervaporation – Liquid membrane – Liquid Pertraction – Supported Liquid Membrane and Emulsion Liquid membrane - Membrane manufactures – Membrane Module/Element designs – Membrane System components – Design of Membrane systems - pump types and Pump selection – Plant operations – Economics of Membrane systems

Membrane Bioreactors: Introduction and Historical Perspective of MBRs, Biotreatment Fundamentals, Biomass Separation MBR Principles, Fouling and Fouling Control, MBR Design Principles, Design Assignment, Alternative MBR Configurations, Commercial Technologies, Case Studies

Pretreatment Systems: Membrane Fouling – Control of Fouling and Concentration Polarization-Pretreatment methods and strategies – monitoring of Pretreatment – Langlier Index, Silt Density Index, Chemical cleaning , Biofoulant control

Case Studies: Case studies on the design of membrane based water and wastewater treatment systems – zero Liquid effluent discharge Plants – Desalination of brackish water.

REFERENCES

1. Anthony Wachinski, “Membrane Processes for water reuse”, McGraw-Hill, USA, 2013.
2. WEF, “Membrane Bioreactors”, WEF manual of Practice No.36, Water Environment Federation, USA, 2012.
3. Symon Jud, "Principles and application of MBR in water and wastewater treatment", Elservier, 2006.
4. Yamamoto K and Urase T., "Membrane Technology in Environmental management", special issue, Water Science and technology, Vol.41, IWA Publishing, 2000.
5. Jorgen Wagner, "Membrane Filtration handbook, Practical Tips and Hints”, 2nd Edition, Revision-2, Osmonics Inc., 2001.
6. Baker, R.W., "Membrane technology and applications", 2nd, John Wiley, 2004.
7. Noble, R.D. And Stern, S.A., "Membrane Separations Technology: Principles and Applications", Elsevier, Netherlands, 1995.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the membrane processes, principles, separation mechanisms, and applications.
2. Identify the selection criteria for different membrane processes.
3. Know the principles of the most common membrane applications.
4. Design projects for particular membrane technology applications.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓				
CO2		✓	✓				
CO3	✓	✓		✓	✓		
CO4		✓			✓	✓	✓

ENVE***	LANDFILL ENGINEERING & REMEDIATION	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To understand the important characteristics and design principles of the waste containment and remediation industry.
- To know the relevant regulations and engineering design requirements of landfills and contaminated site remediation.

Landfill: Waste management Hierarchy- Need for landfills –Environmental Protection by Landfills- Landfill Classification – Sanitary and Secure Landfills - Components and Configuration - Legal framework for landfilling – Landfill Site investigation- Regional Landfills- Environmental control using site design –- Landfill Design Tasks

Landfill Liners and cover systems: Landfill barrier system components – Design of Compacted clay liners: Factors affecting hydraulic conductivity , Water content-density criteria, Thickness, Desiccation - Geo synthetic Clay Liners and Geomembranes; types, manufacturing, handling, seaming and testing - Asphalt Barriers and Capillary barrier - Composite Liner system design- liner construction and quality control- Leakage through Liners- vapor transmission and chemical compatibility - Installation of Geo membranes - Liner Leakage Mechanism – Diffusion - Controls on advection through liners - Single phase flow-advection-diffusion- Landfill cover systems- Design of Cover Systems – Daily Cover – Intermediate Cover – Final Cover - Flow through Landfill Covers- Design and Analysis of Slope Stability- Anchor Trenches- Access ramps - Erosion control

Leachate and Landfill Gas Management: Waste decomposition in landfills - Factors affecting leachate and landfill gas generation – Factors affecting Leachate Quantity in active and post closure conditions- Hydrologic Evaluation of *Landfill* Performance (HELP) model – Leachate Drainage Layer – Geotextile and Geonet design – Leachate Collection and Removal systems-Temporal trends in leachate composition – Design of Landfill gas collection and removal systems- Gas condensate issues & knockouts - Leachate treatment methods (biological and physico-chemical)- Leachate re-circulation & bioreactor landfills- monitoring and control of leachate and Landfill gas- Landfill Settlement

Landfill Operation and Closure: Landfill Construction and Operational Controls – Fill Sequencing Plans – Cell Construction- Dozer and Compactor operations-Selection of Landfill Equipment- Landfill Administration-Record Keeping - Topographic mapping-Environmental Controls – Odour, Vector and Litter Control – Landfill Safety - Fire Control – Ground and Surface water Monitoring – Methane Gas monitoring - Audits of landfill environmental performance and management – Post Closure care and use of landfills – Landfill Economics-landfill construction and operational cost estimation – establishing tipping fees

Contaminated Site Remediation Contaminated sites - Fate and behaviour of toxics and persistent substances in the environment – Engineering Issues in Site Remediation - Site Characterization - Framework for risk assessment at landfill sites - Remediation Principles: Source Control and Management of Migration Covers, Cut-off Walls, Solidification / Stabilization - Pump-and-Treat Systems - Solvent Vapor Extraction, Air Sparging, Soil Flushing – Bioremediation - Natural Attenuation - Remedy Selection and Risk Assessment – Geotechnical Aspects of In Situ Remediation Technology - Specific case studies in contaminated site remediation – Rehabilitation of Open dumps- Landfill Mining

REFERENCES

1. Robert M. Koerner and Donald H Gray "Geotechnical aspects of Landfill Design and Construction", Prentice Hall, New Jersy, 2002.
2. Neal Bolton P.E “The Handbook of Landfill Operations”, Blue Ridge Services Inc., Atascadro, CA, 1995.
3. David E Daniel and Robert M. Koerner “Waste Containment Facilities –Guidance for construction Quality Assurance and Construction Quality Control of Liner and Cover Systems”, American Society of Civil Engineers, ASCE Press, 2007.
4. Donald L Wise and Debra J Trantolo, “Remediation of Hazardous Waste Contaminated Soils”, Marcel Dekker Inc., New York, 1994.
5. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management”, Mc-Graw Hill International edition, New York, 1993.
6. Hari D Sharma and Krishna R. Reddy, “Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies”, John Wiely, New Jersy, 2004.
7. Oweis, I.S. and Khera, R.P, “Geotechnology of Waste Management”, 2nd Edition, PWS Publishing Co., Boston, MA, 1998.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Have an overview of the Indian and International landfill regulations and guidelines for the design, construction, operation and management of landfills.
2. Understand the methods for management and treatment of landfill gas and leachate.
3. Have an in-depth understanding of the key pollutants in leachate and gas, their potential environmental impacts and the engineering design and performance of control systems used to manage and treat pollutant and waste emissions from sites.
4. Apply a risk based assessment of contaminated sites and implement site remediation technologies.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		✓					
CO2	✓	✓	✓				
CO3	✓	✓		✓	✓		
CO4						✓	✓

ENVE***	COMPUTING TECHNIQUES IN ENVIRONMENTAL ENGINEERING	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To educate the students on computing techniques.
- To develop the different numerical techniques.
- To educate students on aspects of data management.
- To develop the model Applications for monitoring and management of Environment.

Computing Principles: Introduction to Computing techniques – Algorithms and Flowcharts, Numerical methods - Solution to ordinary and partial differential equation using Finite difference and Finite element method , Numerical integration and differentiation, Design of digital models for Environmental applications.

Artificial Intelligence: Knowledge based Expert system concepts - Principle of Artificial Neural Network (ANN) – Neural Network Structure – Neural Network Operations – ANN Algorithm - Application of ANN Model to Environmental field – Genetic Algorithms

Fuzzy Logic: Fuzzy sets, fuzzy numbers, fuzzy relations, fuzzy measures, fuzzy logic and

the theory of uncertainty and information; applications of the theory to inference and control, clustering, and image processing - Network analysis models.

Data Management: Data base structure - Data acquisition - Data warehouse - Data retrieval-Data format Attribute - RDBMS - Data analysis - Network data sharing - Statistical Analysis (SYSTAT) - Regression - factor analysis - histogram - scatter diagram - Goodness of fit.

Environmental Modelling using MATLAB: Introduction to MATLAB Software – Environmental modeling principles and MATLAB Applications – Pollutants transport, decay and degradation modeling using MATLAB. Case studies

REFERENCES

1. Aliev R. A, and Aliev Rashad, "Soft Computing and its Applications", World Scientific Publications Co. Pte. Ltd., Singapore, 2014.
2. Chepra S. C. and Canele R. P., "Numerical Methods for Engineers", McGraw-Hill, New York, 6th Edition 2014.
3. "Data -Driven Modeling: Using MATLAB in Water Resources and Environmental Engineering", Springer, 2014.
4. Kotteguda, N.T., and Renzo Resso, "Probability and Reliability for Civil and Environmental Engineers", McGraw Hill Companies Inc., New York, 2008.
5. Mathews J. H. and Fink K.D., "Numerical methods using MATLAB", Pearson Education, 2010.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understand the computing techniques.
2. Apply the principle of soft computing for solving Environmental problems.
3. Assess the Environmental Impacts using ANN and Fuzzy logic.
4. Employ modern advanced computing tools in environmental studies.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓				
CO2		✓	✓	✓			
CO3		✓		✓	✓		
CO4				✓		✓	✓

ENVE***	ENVIRONMENT, HEALTH AND SAFETY FOR INDUSTRIES	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To understand safety practices and environmental issues in construction.
- To identify the potential hazards and prepare a risk assessment report for highly polluting industries.

Introduction: Need for developing Environment, Health and Safety systems in work places-Status and relationship of Acts, Regulations and Codes of Practice-Role of trade union safety representatives and International initiatives-Ergonomics and work place.

Occupational health and hygiene: Definition of the term occupational health and hygiene-Categories of health hazards-Exposure pathways and human responses to hazardous and toxic substances-Advantages and limitations of environmental monitoring and occupational exposure limits-Hierarchy of control measures for occupational health risks-Role of personal protective equipment and the selection criteria-Effects on humans, control methods and reduction strategies for noise, radiation and excessive stress, OHSAS ISO 18001 certification.

Workplace safety and safety systems: Features of the satisfactory design of work premises HVAC, ventilation-Safe installation and use of electrical supplies-Fire safety and first aid provision – construction safety management – environmental issues in management- construction safety provision at site – significance of human factors in the establishment and effectiveness of safe systems-Safe systems of work for manual handling operations.

Techniques of environmental safety: Elements of a health and safety policy and methods of its effective implementation and review-Functions and techniques of risk assessment, inspections and audits-Investigation of accidents- Principles of quality management systems in health and safety management-Relationship between quality manuals, safety policies and written risk assessments-Records and other documentation required by an organization for health and safety-Industry specific EHS issues.

Safety Practices in Construction: Construction accidents, Construction safety management, Environmental issues in construction, Occupational and safety hazard assessment, Job site assessment, Safety in hand tools, Construction safety provision at site, operations of machineries, Hoisting apparatus and conveyors, Safety in the use of mobile cranes, Safety in demolition work, Fire hazards and preventing methods.

Education and training: Requirements for and benefits of the provision of information,

instruction, training and supervision-Factors to be considered in the development of effective training programmes-Principles and methods of effective training-Feedback and evaluation mechanism.

REFERENCES

1. Bill Taylor, "Effective Environmental, Health, and Safety Management Using the Team Approach", Culinary and Hospitality Industry Publications Services, 2005.
2. Nicholas P. Cheremisinoff and Madelyn L. Graffia, "Environmental and Health and Safety Management", William Andrew Inc. NY, 1995.
3. Brian Gallant, "The Facility Manager's Guide to Environmental Health And Safety", Government Inst Publ., 2007.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Describe environmental hazards in communities and occupational health and hygiene in work place.
2. Understand safety practices and environmental issues in construction.
3. Identify potential hazards and prepare a risk assessment report for highly polluting industries.
4. Comply with work place safety acts and rules and establish safety systems for any industry.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		✓	✓				
CO2	✓	✓	✓				
CO3		✓		✓	✓		
CO4					✓	✓	✓

ENVE***	FUNDAMENTALS OF SUSTAINABLE DEVELOPMENT	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To gain knowledge in sustainable principles and fundamentals and apply them in environmental pollution control and management.
- To gain knowledge for design of environmental sustainable systems.

Principles of Sustainable Development: History and emergence of the concept of Sustainable Development – Definitions – Environmental issues and crisis – Resource degradation – green house gases – desertification – social insecurity – Industrialization – Globalization and Environment.

Indians Judiciary System and Sustainable Development: Judicial System in India – Induction of sustainability concepts through legal systems – concepts – principles – doctrines – case laws.

Sustainable Development and International Contribution: Components of sustainability – Complexity of growth and equity – International Summits – Conventions – Agreements – Transboundary issues – Action plan for implementing sustainable development – Moral obligations and Operational guidelines.

Socio-Economic Sustainable Development Systems Hours: Socio-economic policies for sustainable development – Strategies for implementing Eco development programmes – Sustainable development through trade – Economic growth – Carrying Capacity – Public participation.

Agenda for Future Global Sustainable Development Hours: Role of developed countries in the sustainable development of developing countries – Demographic dynamics and sustainability – Integrated approach for resource protection and management.

REFERENCES

1. Kirkby, J., O' Keefe, P. and Timberlake, "Sustainable Development", Earthscan Publication, London, 1996.
2. Mackenthun, K.M., "Basic Concepts in Environmental Management", Lewis Publication, London, 1998.
3. Bowers, J., "Sustainability and Environmental Economics – an alternative text", Longman, London, 1997

COURSE OUTCOMES:

At the end of the course students will be able to

1. Apply the gained knowledge in the design of sustainable management systems.
2. Visualize the practical issues and solve complex problems applying sustainable principles and design.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓	✓	✓		✓		
CO2					✓	✓	✓

OPEN ELECTIVES

ENVE***	REMOTE SENSING AND GIS FOR ENVIRONMENTAL APPLICATIONS	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To learn the principles and applications of spatial information technologies namely remote sensing, GPS and GIS in the context of Environmental Engineering.
- To realize the importance of remote sensing and GIS in solving the spatial problems in Environmental Engineering.

Concepts of Remote Sensing – Principles of remote sensing - Energy sources and radiation principles, Energy interactions with atmosphere, Energy interactions with earth surface features - Spectral reflectance of some earth features- Data acquisition and interpretation – Aerial photography – Visible, Infra Red and Microwave sensing-Thermal and Multispectral remote sensing.

Classification of sensing system - Active and Passive- Remote sensing platforms-Sun synchronous and Geosynchronous - Image interpretation - Visual Image Interpretation - Digital Image Processing – Image rectification, enhancement classification-Supervised and Unsupervised - satellite data Products-Concepts of GPS.

GIS- Definition- basic components of GIS-standard GIS packages-Maps-Mapping process-projections, coordinate systems-Spatial data –spatial data model-spatial relationship-topology-spatial data structure: Raster, Vector – attribute data- database-database management systems-database models: Hierarchical, network, relational, object oriented models-data input, editing-integrated GIS database.

Thematic mapping - measurement in GIS: length, perimeter and areas - Query analysis - Reclassification-Buffering-Neighborhood functions-Integrating data: map overlay, overlay functions, vector overlay and raster overlay – Interpolation-Network analysis-Data output types- Output devices-Error- Types of errors -Digital Elevation Modeling (DEM).

Application of Remote sensing - Management and monitoring of Environment, conservation of resources, coastal zone management – Limitations – urban storm water studies – Solid waste management – optimal routing – wetland studies – non point source pollution -water Quality, monitoring and management.

REFERENCES

1. Lillesand, T.M. and Kiefer, R.W., "Remote Sensing and Image Interpretation", John Wiley and Sons, New York, 2004.
2. Burrough, P.A. and McDonnell, R.A., "Principles of Geographic Information Systems", Oxford University Press, New York, 2001.
3. Lintz, J. and Simonet, "Remote Sensing of Environment", Addison Wesley Publishing Company, New Jersey, 1998.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Obtain the complete knowledge on Remote sensing, GIS and GPS.
2. Apply the various methods of Visual Interpretation and Digital image interpretation.
3. Understand various methods of Mapping process, Thematic map, Map overlay and DEM.

MAPPING PROGRAMME OUTCOMES WITH COURSE OUTCOMES							
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	✓				✓		
CO2		✓		✓	✓		✓

ENVE* **	**RESEARCH METHODOLOGY**	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To introduce concepts of research process in hydrology and water resources and water management.
- To enable students to get basic understanding of scientific research methods.
- To develop capacity to independently analyze and define a research problem.

Scope**:** Objectives and types of research – Identification of research problem – Research process – Research design – Bibliography.

Sample: Sampling theory and sampling design – Types of samples – Sources of data – Qualitative and quantitative data – Data collection methods.

Data: Measurement levels and scaling – Types of errors – Sampling adequacy – Data collection and editing – Coding of data – Analysis and statistical inference.

Report: Report preparation – Structure of report – graphs and illustration tools – Tables and charts – Draft – Finalising research report.

Design of a Research Project a mini project design

REFERENCES

1. Pannerselvam. R, "Research Methodology", Prentice-Hall of India Private Ltd., New Delhi, 2007.
2. Upagade. V and A.Shende, "Research Methodology", S.Chand & Co., New Delhi, 2010.

COURSE OUTCOMES:

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

1. Understand applied research methods in Science and Engineering.
2. Define and formulate a research problem independently.

ENVE***	ENVIRONMENTAL SOCIOLOGY	L	T	P
		4	**0**	**0**

COURSE OBJECTIVES:

- To provide knowledge and scholarship of sociological basis of environment and society interface.
- To impart social skills in environmental concerns in order to understand the human suffering.
- To provide knowledge of the debate on environment and development.
- To focus on the environmental issues in the perspective of environmental sociology.

Introduction: Environment – Environmental Sociology - Emergence and development of Environmental Sociology – Sociological Approaches to Environment

Environmental Issues pertaining to population, water, Sanitation, Pollution, Energy, Housing and Urban Development – Social Impact Assessment of Environmental Issues.

Social Consequences of Environmental Disruption: Body, Health and Environment – Environmental Management of Water, Air, Soil and Land - Solid waste management – Tackling social Awareness Programme.

Nature Vs Nurture debate – Systemic causes of Environmental Disruption: Risk, Technology and Society.

Development, displacement, Relocation and Environmental Problems.

REFERENCES

1. King, Leslie and Deborah Mecarthy, "Environmental Sociology: From analysis to action", Rowman & Littlefield Publishers, Inc., 2009.
2. Riley, E. Dunlap, "Handbook of Environmental Sociology", William Michelson (eds.), Rawat, 2008.

3. Jules Pretty, Andrew S Ball, Ted Benton, Julia S Guivant, "Handbook of Environmental Sociology", Sage, 2006.
4. Mahesh Rangarajan., "Environmental Issues in India: A Reader", Pearson, Longman, Section V, Global issues, New Delhi, 2007.
5. Mohan,I., "Environmental Issues and Programmes", Asia Publishing house, New Delhi, 1989.
6. Verma, Manish Kumar, "Development, Displacement and Resettlement", Rawat Publication, Jaipur, 2004.
7. Rohan D'Souza, 'Environment, Technology and Development: Critical and Subversive Essays", Orient Blacksman, 2012.
8. Archana Prasad, "Environment, Development and Society in Contemporary India. An Introduction", Macmillan India, Part Four: Global Environmental Issues, New Delhi.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Develop critical skills and thinking.
2. Apply a sociological lens to Environmental research and other sources of information (e.g., newspapers).
3. Take up Career training and/or entry-level positions in environment related fields.
4. Develop a deeper understanding of themselves and their role in society.
5. Obtain a position in the applied social sciences outside of academia.
6. Understand the ethical dimensions of the field and follow ethical practices within all areas of their work.
7. Contribute to the administrative functioning of their work unit and/or to the administrative functioning of professional organizations.

		L	T	P
ENVE* **	**ENVIRONMENTAL INSTRUMENTATION**	**4**	**0**	**0**

COURSE OBJECTIVE:

- To understand different instrumentation techniques for measurement of environmental parameters.

Introduction: Necessity of instrumentation & control for environment, sensor requirement for environment. Instrumentation methodologies: Ultraviolet analyzers, total hydrocarbon analyzers using flame ionization detector, Gas chromatography in environmental analysis, photo ionization, portable & stationary analytical instruments.

Quality of water: Standards of raw & treated water, sources of water & their natural quality, effects of water quality. Water quality parameters: Thermal conductivity, detectors, Opacity monitors, pH analyzers & their application, conductivity analyzers & their application. Water treatment: Requirement of water treatment facilities, process design.

Sedimentation & flotation: General equation for settling or rising of discrete particles, hindered settling, effect of temperature, viscosity, efficiency of an ideal settling basin , reduction in efficiency due to various causes, sludge, storage & removal, design criteria of settling tank, effect of temperature on coagulation. Ground water monitoring: Level measurement in ground water monitoring wells, laboratory analysis of ground water samples, instrumentation in ground water monitoring, instrumentation in assessment of soil & ground water pollution. Rain water harvesting: necessity, methods, rate of NGOs municipal corporation, Govt., limitations. Quality assurance of storage water.

Waste water monitoring: Automatic waste water sampling, optimum waste water sampling locations, and waste water measurement techniques. Instrumentation set up for waste water treatment plant. Latest methods of waste water treatment plants.

Air pollution: definitions, energy environment relationship, importance of air pollution, air pollution from thermal power plant, their characteristics & control. Air sampling methods & equipments, analytical methods for air pollution studies. Control of air pollution - Air monitoring: measurement of ambient air quality. Flow monitoring: Air flow measurement, gas flow, non-open channel flow measurement, open channel waste water flow measurement.

REFERENCES

1. H.H. Willard, Merrit and Dean, "Instrumental Methods of Analysis", 5th Ed., 1974.
2. R.K. Jain, "Fundamentals of Mechanical and Industrial Instrumentation", 1985.
3. S.P. Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill, 1985.
4. G. N. Pandey and G.C. Carney, "Environmental Engineering", Tata McGraw-Hill, 1989.
5. Wark and Warner, "Air pollution control technology", 2004
6. Randy D Dwon, "Environmental Instrumentation & Analysis Handbook", 2001.

COURSE OUTCOME:

At the end of the course students will be able to

1. Understand spectral methods, methods for water quality, air quality, sound and soil pollution.

		L	T	P
ENVE* **	**ENERGY ENGINEERING**	**4**	**0**	**0**

COURSE OBJECTIVES:

- To explain concept of various forms of Non-renewable and renewable energy
- To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications
- To analysis the environmental and cost economics of using renewable energy sources compared to fossil fuels.

COMMERCIAL ENERGY: Coal, Oil, Natural Gas, Nuclear power and Hydro - their utilization pattern in the past, present and future projections of consumption pattern - Sector-wise energy consumption – environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India.

SOLAR ENERGY: Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

WIND ENERGY: Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy – Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept.

BIO-ENERGY: Biomass resources and their classification - types of biogas Plants - applications - alcohol production from biomass – bio diesel production –History of usage of Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae - Process and chemistry.

OTHER TYPES OF ENERGY: Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plants - ocean wave energy conversion - tidal energy conversion – small hydro – geothermal energy - geothermal power plants – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.

REFERENCES

1. Sukhatme, S.P., Solar Energy, Tata McGraw Hill, 1984.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd., 1986.
3. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill,2007
4. Kreith, F and Kreider, J. F., Principles of Solar Engineering, McGraw-Hill, 1978.
5. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 1990
6. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, 1980.
7. Bent Sorensen , Renewable Energy, Elsevier, Academic Press, 2011

COURSE OUTCOMES:

At the end of the course students will be able to

1. Understanding of commercial energy and renewable energy sources
2. Knowledge in working principle of various energy systems

3. Capability to do basic design of renewable energy systems

ENVE***	CLEANER PRODUCTION AND ENVIRONMENTAL MANAGEMENT	L	T	P
		4	0	0

COURSE OBJECTIVES:

- To understand the importance of Material Science as a subject that revolutionized modern day technologies.
- To understand the significance of material science in the development of new materials and devices for all branches of Engineering.

Introduction: Sustainable Development – Indicators of Sustainability – Sustainability Strategies Barriers to Sustainability – Industrial activity and Environment – Industrialization and sustainable development – Industrial Ecology – clean development mechanism, Cleaner Production (CP) in Achieving Sustainability – Prevention versus Control of Industrial Pollution – Environmental Polices and Legislations – Regulations to Encourage Pollution Prevention and Cleaner Production – Regulatory versus Market-Based Approaches.

Principles Cleaner Production: Definition – Importance – Historical evolution – Benefits – Promotion – Barriers – Role of Industry, Government and Institutions – Environmental Management Hierarchy – Source Reduction Techniques – Process and equipment optimization, reuse, recovery, recycle, raw material substitution – Internet Information & Other CP Resources.

Cleaner Production Project Development and Implementation: Overview of CP Assessment Steps and Skills, Preparing for the Site, Visit, Site, Visit, Information Gathering, and Process Flow Diagram, Material Balance, CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives - Total Cost Analysis – CP Financing – Establishing a Program – Organizing a Program – Preparing a Program Plan – Measuring Progress – Pollution Prevention and Cleaner Production Awareness Plan – Waste audit – Environmental Statement, carbon credit, carbon sequestration, carbon trading.

Life Cycle Assessment and Environmental Management Systems: Elements of LCA – Life Cycle Costing – Eco Labeling – Design for the Environment – International Environmental Standards – ISO 14001 – Environmental audit, Green building & green energy concepts and management

Case Studies: Industrial applications of CP, LCA, EMS and Environmental Audits, green energy and green process management.

REFERENCES

1. Modak, P., “Waste Minimization: A guide to cleaner production and Enhanced profitability”, Centre for Environmental Education, Ahmedabad, 1996.

2. Modak, P., C. Visvanathan and Mandar Parasnis “Cleaner production Audit, Environmental systems Reviews”, Asian Institute of Technology, Bangkok, 2005.
3. Paul L Bishop, “Pollution Prevention: Fundamentals and Practice”, McGraw Hill International, 2000.
4. World Bank Group, “‘Pollution Prevention and Abatement Handbook – Towards Cleaner Production”, World Bank and UNEP, Washington D.C., 2005.

COURSE OUTCOMES:

At the end of the course students will be able to

1. Apply the acquired knowledge under the cleaner practices in industrial, production systems
2. Gain knowledge on environmental management systems.
3. Prepare environmental assessment and preparation of reports under cleaner production and environmental management.