PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

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Criterion 1 – Curricular Aspects

Key Indicator	1.1	Curriculum Design and Development
Metric	1.1.2	Percentage of Programmes where syllabus revision was carried out during the 2022-23

DEPARTMENT OF CIVIL ENGINEERING

S. No.	Programme Code	Programme name	Year of Introduction	Year of revision	Percentage of Syllabus content added or replaced
1.	254	M.Tech (Environmental Engineering) Full Time	2008-09	2022	24.7%

S.No	Contents
1.	Minutes of Board of Studies
2.	Extracts of minutes of the Academic Council Meeting
3.	Curriculum and Syllabus of the programme – Before Revision
4.	Curriculum and Syllabus of the programme – After Revision

Legend : Highlighted Color - Red – Indicates courses which are removed from syllabus before revision

Highlighted Color - Green – Indicates courses which are removed from syllabus after revision

1. Minutes of Board of Studies

Department of Civil Engineering

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PERIYAR MANIAMMAI

BOARD OF STUDIES MEETING

For M.Tech. ENVIRONMENTAL ENGINEERING (FULL TIME) PROGRAMME

Minutes of Meeting

Date: 28.06.2022 **Time: 10.00AM** **Venue: Smart Class Room**

The Board of Studies meeting was held on 28.06.2022 for framing the M. Tech. Environmental Engineering (Full Time) Curriculum and syllabi (I to VI semester) of Regulation 2022.

Members present:

Table I Members of the BoS

Sl.No.	Name	Designation	Representing	Signature
1	Dr. V. A. Shanmugavelu	Associate Professor & Head Department of Civil Engineering, Periyar Maniammai Institute of Science and Technology.	Chair person	
2	Dr. C. Lakshumanan	Professor Department of Remote Sensing, Bharathidasan University, Trichy.	Member (Academic Expert)	
3	Dr. P. Mariappan	Executive Engineer, TWAD Board, Dindigul.	Member (Industry Representation)	
4	Dr. S. Senthamilkumar	Dean FET Professor, Department of Civil Engineering, Periyar Maniammai Institute of Science and Technology.	Member	
5	Dr. R. Jayanthi	Professor, Department of Civil Engineering, Periyar Maniammai Institute of Science and Technology.	Member	

6	Dr. S. Suppiah	Professor (Adjunct) Dept. of Civil Engg., PMIST	Member	28/06/2022
7	Dr. B. Anupriya	Associate Professor Dept. of Civil Engg., PMIST	Member	
8	Dr. D. Thayalnayaki	Assistant Professor(SS) Dept. of Civil Engg., PMIST	Member	
9	Dr. J. Santhosh	Assistant Professor Dept. of Civil Engg.,PMIST	Member	

A. FEEDBACK ON CURICULLAR ASPECTS

The feedback were collected and analyzed during 2019-20, 2020-21 and 2021-22 from the following stake holders

1. Teachers
2. Employers
3. Alumni students
4. Students

In addition the feedback from Academic Expert, Industry Expert, Teachers, Alumni and students who participated in Department Advisory Committee Meeting (**DAC**) were presented. The action taken for the feedbacks are given as "Remarks" column in the point "C".

B. PRESENTATION OF CURICULLUM AND SYLLABUS

All the courses of M.Tech. Environmental Engineering programme prepared by the faculty member of the Department of Civil Engineering are presented individually. The deletion, addition and introduction of new courses related details are tabulated for all courses in the following table.

Table II: Discussions on courses with actions as remarks

Sl. No	Sem	Course Name	Course content Deleted	Course Content Added	% of Change	Remarks
1	I	YEN101 Environmental Chemistry	Microbiology Portion Removed	Aquatic Chemistry, Atmospheric Chemistry, Emerging Areas	60%	Previously the course framed as combination of Chemistry & Microbiology. Now it is split into two courses as suggested by feedback received from the students
2	I	YEN102 Environmental Microbiology	Nil	Fully changed	100%	
3	I	YEN103 Principles and Design of Physico-Chemical Treatment Systems	Nil	Nil	0%	Only Course Title reframed as suggested by BoS Experts

4	I	YEN106 Environmental Quality Measurements Laboratory	Nil	Experiments related to Air, Soil and Noise	40%	Feedback given by DAC members and BoS Subject experts
6	I	YEN109 Microbiology Laboratory	Nil	Nil	0%	
7	II	YEN201 Transport of Water and Waste water	Nil	Nil	0%	
8	II	YEN202 Biological Treatment of Wastewater	Nil	Nil	0%	
9	II	YEN203 Environmental Impact Assessment	Nil	Nil	0%	Professional Elective course is changed as core course as suggested by BoS Subject experts
19	II	YEN206 Environmental Engineering Processes Laboratory	Nil	Nil	0%	Only Course Title reframed as suggested by DAC Members
11	II	YEN207 Mini Project	Nil	Nil	0%	
12	III	YEN302 Dissertation Phase – I	Nil	Nil	0%	
13	IV	YEN401 Dissertation Phase – II	Nil	Nil	0%	
14	I	YEN104A Energy and Environment	Nil	Nil	0%	
15	I	YEN104B Environmental Economics	Nil	Nil	0%	
16	I	YEN104C Air Pollution and Control	Nil	Nil	0%	
17	I	YEN105A Instrumental Methods and Analysis of Environmental Pollutants	Nil	Nil	0%	
19	I	YEN105B Theory and Practice of Industrial Wastewater Treatment	Nil	Nil	0%	
20	I	YEN105C Noise Pollution and Control Engineering	Nil	Added Newly	100%	Introduced as new elective course as suggested by BoS Experts
21	II	YEN204A Environmental Biotechnology	Nil	Nil	0%	
22	II	YEN204B Environmental Geotechnology	Nil	Nil	0%	
23	II	YEN204C Solid and Hazardous Waste Management	Nil	Nil	0%	

24	II	YEN205A Operation and Maintenance of Water and Wastewater Treatment Systems	Nil	Added Newly	100%	Introduced as new elective course as suggested by BoS Experts
25	II	YEN205B Ground Water Contamination and Transport Modeling	Nil	Nil	0%	
26	II	YEN 205C Simulation and Modeling in Environmental Systems	Nil	Nil	0%	
27	III	YEN302A Remote sensing and GIS for Environmental Applications	Nil	Nil	0%	Only Course Title reframed as suggested by BoS Experts
28	III	YEN302B Sustainable Engineering	Nil	Added Newly	100%	Replaced the existing course based on the feedback given by DAC members
29	III	YEN 302C Membrane Technologies for water and Wastewater Treatment	Nil	Nil	0%	

C. LIST OF NEWLY INTRODUCED COURSES IN REGULATION 2022

1. YEN105C Noise Pollution and Control Engineering
2. YEN205A Operation and Maintenance of Water and Wastewater Treatment Systems
3. YEN301B Sustainable Engineering

D. LIST OF COURSES REMOVED

Table III Table of courses removed with remarks

S.No	Course Code and Name	Remarks
1.	YEN 101 Chemistry and Microbiology for Environmental Engineers	Previously the course framed as combination of Chemistry & Microbiology. Now it is split into two courses as suggested by feedback received from the student and BoS Members
2.	Environmental Policies and Legislation	The two courses were added and framed as a new course title on Sustainable Engineering
3.	Sustainable Urban development Concepts and Strategies	

E. PERCENTAGE CHANGE IN THE SYLLABUS

Number of new courses added = **3 Electives** = 9 credits
Number of courses removed = 3 = 9 credits
% change = (18/73) x 100 = 24.7%

F. NOTES ON BENCHMARKING WITH UGC/AICTE/CoA/NCTE/World Top Universities MODEL CURRICULUM

1. The AICTE model syllabus was also presented in the BoS. The members compared the designed curriculum and discussed the following
   a. The credits of the both the curriculum was found to be same.
   b. The courses in the AICTE curriculum are present in the designed curriculum either as core course or discipline specific elective.
2. Courses on Indian Ethos and Business ethics are added for **national needs**.
3. A specialization stream focusing on Environmental Management system is present. This will help the **local needs** of Thanjavur and Trichy ரஜ ம ன .
4. Major areas of knowledge an M.Tech. Environmental Engineering graduate to acquire knowledge defined by UGC & AICTE. The defined attributes was discussed. Important aspects pertaining to **international needs** are taken into account.

G. NOTES ON CREDIT DISTRIBUTION AND COMPARISION WITH AICTE GUIDELINES

Table IV: Credit distribution

AICTE Course Title	I	II	III	IV	PMIST Total	AICTE recommendation	Deviation
Professional Core Course - PCC	10	9	-	-	19	12	7
Professional Elective Course - PEC	6	6	3	-	15	15	0
Professional Core Course Lab PCC-L	4	4	10	16	34	36	-2
Open Elective Course OEC	-	-	3	-	3	3	0
AICTE- Mandatory Course	2	-	-	-	2	2	0
AICTE – Audit	0	0	-	-	0	0	0
	22	**19**	**16**	**16**	**73**	**68**	

H. COURSES ON EMPLOYABILITY/ENTREPRENEURSHIP/SKILL DEVELOPMENT

The curriculum focus of including 96.07% of courses with either /and employability / entrepreneurship / skill development. The courses are given below:

Table V Categorization of courses

Sem	Category	Course Code & Course Name	Category
I	PCC	YEN101 Environmental Chemistry	Skill Development
I	PCC	YEN102 Environmental Microbiology	Skill Development
I	PCC	YEN103 Principles and Design of Physico-Chemical Treatment Systems	Employability & Entrepreneurship
I	PEC	YEN104*Elective - I	Skill Development
I	PEC	YEN105*Elective – II	Skill Development
I	PCC-L	YEN106 Environmental Quality Measurements Laboratory	Employability
I	AICTE Mandatory Course	YRM107Research Methodology and IPR	Skill Development
I	AICTE-Audit	YEGOE1English for Research Paper Writing	Skill Development
I	PCC-L	YEN109 Microbiology Laboratory	Employability
II	PCC	YEN201 Transport of Water and Waste water	Skill Development
II	PCC	YEN202 Biological Treatment of Wastewater	Skill Development
II	PCC	YEN203 Environmental Impact Assessment	Employability & Entrepreneurship
II	PEC	YEN203*Elective – III	Skill Development
II	PEC	YEN204*Elective – IV	Skill Development
II	PCC-L	YEN206 Environmental Engineering Processes Laboratory	Employability
II	PCC-L	YEN207 Mini Project	Employability
II	AICTE-Audit	YPSOE1Constitution of India	Skill Development
III	PEC	Elective -V	Skill Development
III	PCC-L	YEN302 Dissertation Phase – I	Entrepreneurship & Skill Development
III	OEC	YEN301*Open Elective	Skill Development
IV	PCC-L	YEN401 Dissertation Phase – II	Skill Development

I. DISCUSSION ON PROGRAMME ARTICULATION MATRIX (PO COVERAGE BY ALL COS)

The existing POs and ~~PSO was~~ were presented. The members agreed that there need not be any changes in the PSO and PO. It is found that the curriculum covers all POs with small deviations.

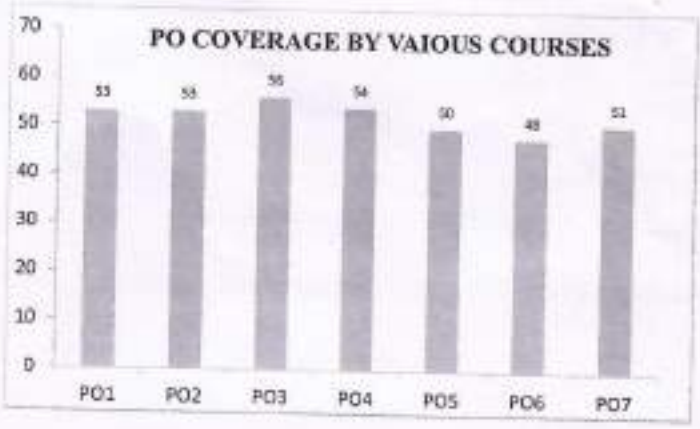

Figure 1 PO coverage by various courses

The BoS members recommended to submit the outcome of this meeting in the forthcoming Academic council meeting for approval.

HoD/Civil
(Dr.V.A Shanmugavelu)

Dean (FET)
(Dr.S.Senthamil Kumar)

Dean (Academic)
(Dr. A.George)

2 **Extracts of minutes of the Academic Council Meeting**

Civil Engineering with specialization in GIS and Remote Sensing programme (Regulation 2021, Revision 1: Full time mode). The courses pertaining to the specialization and their credits (in addition to the courses in B.Tech – Civil Engineering Curriculum and Syllabi, Regulation 2021).

FET M.Tech-EE 40.3.4

TO CONSIDER AND APPROVE the Curriculum and Syllabi from I to IV semester for M.Tech – Environmental Engineering programme under Full-Time (Regulation 2022).

Notes:

The Board of Studies of the Department of Civil Engineering recommended the Curriculum and Syllabi from I to IV Semesters of M.Tech.-Environmental Engineering under Full-Time (Regulation 2022).

Curriculum and Syllabus is in line with AICTE proposed guidelines 2022 with 24.7% revision from previous syllabus. The syllabus revision included feedback on curricular aspects from students, teachers, employers and alumni. The syllabus has 96% courses having focus on employability/entrepreneurship/skill development. The complete curriculum and syllabi with details are given in the Board of Studies minutes document attached as Annexure-I.

-The new courses of Regulations 2022 offered by the department are

Sl.No	Name of the Course
1	Noise Pollution and Control Engineering
2	Operation and Maintenance of Water and Wastewater Treatment Systems
3	Sustainable Engineering

The matter is placed before the Academic Council for approval.

Resolution

RESOLVED TO APPROVE the Curriculum and Syllabi from I to IV semester for M.Tech – Environmental Engineering programme under Full-Time (Regulation 2022).

3 **Curriculum and Syllabus of the programme – Before Revision**

M.TECH ENVIRONMENTAL ENGINEERING (Full-Time)

SEMESTER I

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
YEN101	Core I	Chemistry and Microbiology for Environmental Engineers	3	0	0	3
YEN102	Core II	Unit Operation and Processes in Environmental Systems	3	0	0	3
YEN103	Programme Elective	Elective - I	3	0	0	3
YEN104	Programme Elective	Elective – II	3	0	0	3
YEN105	Core Lab I	Environmental Quality Measurements Laboratory - I (Water & Wastewater)	0	0	2	2
YEN106	Core Lab II	Microbiology Laboratory	0	0	2	2
YRM107	MLC	Research Methodology and IPR	2	0	0	2
	Audit I	Audit Course- 1	2	0	0	0
		TOTAL	**16**	**0**	**4**	**18**

SEMESTER II

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
YEN201	Core III	Transport of Water and Wastewater	3	0	0	3
YEN202	Core IV	Biological Treatment of Wastewater	3	0	0	3
YEN203	Programme Elective	Elective - III	3	0	0	3
YEN204	Programme Elective	Elective – IV	3	0	0	3
YEN205	Core Lab III	Environmental Quality Measurements Laboratory - II (Air, Noise and Solidwaste)	0	0	2	2
YEN206	Core Lab IV	Unit Operation Laboratory	0	0	2	2
YEN207	Core	Mini Project	0	0	4	2
	Audit 2	Audit Course - 2	2	0	0	0
		TOTAL	**14**	**0**	**8**	**18**

SEMESTER III

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
YEN301	Programme Elective	Elective – V	3	0	0	3
	Open Elective	Open Elective	3	0	0	3
YEN303	Dissertation	Dissertation Phase - I	0	0	20	10
		TOTAL	**6**	**0**	**20**	**16**

SEMESTER IV

Sub. Code	Category	Name of the Course	Hours per week			C
			L	T	P	
YEN401	Dissertation	Dissertation Phase - II	0	0	32	16
		TOTAL	**0**	**0**	**32**	**16**

TOTAL CREDITS - 68

Note:

1. HOD concerned has to provide options for selecting the relevant MOOC courses or any elective paper which are offered.

2. The credit distribution is followed as per the guidelines given by AICTE/UGC.

PROFESSIONAL ELECTIVE COURSES

ELECTIVE I

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEN103A	Energy and Environment	3	0	0	3
YEN103B	Environmental Economics	3	0	0	3
YEN103C	Air Pollution and Control	3	0	0	3

ELECTIVE II

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEN104A	Instrumental Methods and Analysis of Environmental Pollutants	3	0	0	3
YEN104B	Theory and Practice of Industrial Wastewater Treatment	3	0	0	3
YEN104C	Environmental Policies and Legislation	3	0	0	3

ELECTIVE III

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEN203A	Environmental Biotechnology	3	0	0	3
YEN203B	Sustainable Urban development Concepts and Strategies	3	0	0	3
YEN203C	Solid and Hazardous Waste Management	3	0	0	3

ELECTIVE IV

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEN204A	Remote sensing and GIS	3	0	0	3
YEN204B	Environmental Geotechnology	3	0	0	3
YEN204C	Simulation and Modeling in Environmental Systems	3	0	0	3

ELECTIVE V

Sub. Code	Name of the Course	Hours per week	C

		L	T	P	
YEN301A	Ground Water Contamination and Transport Modeling	3	0	0	3
YEN301B	Environmental Impact Assessment	3	0	0	3
YEN301C	Membrane Separation for Water and Wastewater	3	0	0	3

AUDIT COURSES

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEGOE1	English for Research Paper Writing	2	0	0	0
YPSOE1	Constitution of India	2	0	0	0

OPEN ELECTIVES

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YCOOE1	Business Analytics	3	0	0	3
YMEOE1	Industrial Safety	3	0	0	3
YMAOE1	Operations Research	3	0	0	3
YCOOE2	Cost Management of Engineering Projects	3	0	0	3

Semester	Course Code	Course Name	L	T	P	C
I	YEN101	Chemistry and Microbiology for Environmental Engineers	3	0	0	3

COURSE CONTENT

UNIT I FUNDAMENTALS ON ANALYTICAL CHEMISTRY 12

oxidation and reduction reactions, balancing equation by electron method -Colloids – Redox potentials – partition co-efficient – Beer – Lambert's Law – Limitations – Electrode potential – Applications of potentiometry – pH measurements, glass electrodes, ion selective electrodes – Instrumentations- Atomic spectroscopy – Flame photometry – Atomic Adsorption Spectrophotometry – principle- UV–visible spectrophotometer -Application in determination of mercury, lead and cadmium in water samples. Chromatography – Gas chromatography – simple instrumentation – Application in measuring SO_2, NO_2& H_2S by spectrophotometry.

UNIT II DEGRADATION OF CHEMICALS 6

Transport and transformation of chemicals – DO, BOD and COD – Photo catalysis - Degradation of foodstuffs, detergents, pesticides and hydrocarbons

UNIT III SOIL CHEMISTRY 9

Soil properties, clay minerals - acid-base and ion-exchange reactions in soil - salt affected soil and its remediation

UNIT IV MICROORGANISMS AND NUTRITIONAL REQUIREMENTS 9

Basic principles of microbiology- structure and function of microbial cell-pure and mixed cultures-metabolism-Aerobic and Anaerobic pathways- Microbial growth and growth kinetics-Classification and morphological aspects of Bacteria, Fungi, Protozoa and algae. Microbial Nutrition –Growth of micro-organism in different media, growth curve, methods of enumeration of micro-organisms, sterilization and disinfection.

UNIT V MICROBIOLOGY IN WASTE WATER 9

Biological methods to treat waste water- Microbiology in air pollution control (biofilter and bio scrubber), biodegradation of toxic pollutant. Practical: culture, identify and explain microorganisms in environmental cultures

L	T	P	Total
45	0	0	45

TEXT BOOKS

1. Sawyer,C.N., MacCarty, P.L. and Parkin, G.F., Chemistry for Environmental Engineering and Science, Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Colin Baird 'Environmental Chemistry', Freeman and company, New York, 2011.
3. Pelczar, Jr, M.J., E.C.S., Krieg, R.Noel., and Pelczar Merna Foss. "Microbiology 5th edition.
4. Tata McGraw Hill Publishing Company Limited, New Delhi-2001
5. Maeir, R.M., I.L.Pepper and C.P. Gerba, " Environmental Microbiology", Academic Press, New York, 2008

REFERENCES

1. Des W. Connell, "Basic Concepts of Environmental Chemistry", CRC Press, 2nd Edition, 2005
2. Gary W VanLoon, Stephen J Duffy," Environmental Chemistry: A Global Perspective", Oxford University Press, 2010

Semester	Course Code	Course Name	L	T	P	C
II	YEN104C	Environmental Policies and Legislation	3	0	0	3

COURSE CONTENT

UNIT I INTRODUCTION **8**

Basics of jurisprudence – Environmental law relation with other disciplines - Criminal law – Common Law – Relevant sections of the Code of Civil Procedure, Criminal Procedure Code – Indian Penal Code.

UNIT II INDIAN CONSTITUTION AND ENVIRONMENT **10**

Introduction – Fundamental Rights – Directive Principles of State Policy – Article 48 (A) and 51-A(g) Judicial enforceability – Constitution and Resources management and pollution control – Indian Forest Policy (1990) – Indian Environmental Policy (1992).

UNIT III ADMINISTRATIVE REGIME & LEGAL REGIME **9**

Administrative regulations – constitution of Pollution Control Boards Powers, functions, Accounts, Audit etc. – Formal Justice Delivery mechanism Higher and Lower of judiciary – Constitutional remedies writ jurisdiction Article 32, 226 136 special reference to Mandamus and Certiorari for pollution abatement – Equitable remedies for pollution control

UNIT IV POLLUTION CONTROL LAWS **9**

Administrative regulation under recent legislations in water pollution control. Water (prevention & control of pollution) Act 1974 as amended by Amendment Act 1988. Water (prevention and control of pollution) Rules 1975 Water (prevention & control or Pollution) cess Act. 1977 as amended by Amendment Act 1987 and relevant notifications.

UNIT V ENVIRONMENTAL (PROTECTION) ACT 1986 **9**

Relevant notifications in connection with Hazardous Wastes (management and handling) Biomedical wastes (management and handling), Noise pollution, Eco-labeling, and E.I.A.

L	T	P	Total
45	0	0	45

TEXT BOOKS

1. Constitution of India Eastern Book Company Lucknow 12th Edn. 1997.
2. Constitutional Law of India – J.N. Pandey 1997 (31st Edn.) Central Law Agency Allahabad.
3. Administrative Law U.P.D. Kesari 1998. Universal Book Trade Delhi.

4. Environmental Law H.N. Tiwari, Allahabad Law. Agency 1997

REFERENCES

1. Environmental, A., Divan and Noble M. Environmental Law and Policy in India (cases, Materials and Statutes) 1991 Tripathi Bombay.
2. Environmental Policy. Forest Policy. Bare Acts – Government Gazette Notification

Semester	Course Code	Course Name	L	T	P	C
III	YEN203B	Sustainable Urban development Concepts and Strategies	3	0	0	3

COURSE CONTENT

UNIT I **Introduction** **9**

Introduction to sustainable development –Energy Resources-Renewable Non – conventional energy sources-Energy needs-Conserving natural resources

UNIT II **Environmental Protection** **9**

Environmental protection in urban areas-Co ordination and enforcement – Legislative aspects-Population control-Technological aspects-Application of EIA-Methodology to urban development programme

UNIT III **Urban Landscape** **9**

Principles of urban landscape- Landscape design for front areas and other functional areas in urban development -Develict areas-Reclamation of derlict areas

UNIT IV **Community Development** **9**

Community involvement in developing settlement – Developmental programs related to urban and rural society—Impact of programme on social development

UNIT V **Development Management** **9**

Socio economic factors in the development of urban and rural settlements-Legal administrative and financial frame works –Development management and control

L	T	P	Total
45	0	0	45

TEXT BOOKS

1. Neil S. Grigg., " Urban Water Infrastructure Planning - Management and Operations ", John Wiley and Sons, 1986.
2. Overtens D.E. and Meadows M.E., " Storm Water Modelling ", Academic Press, NewYork, 1976.

REFERENCES

1. Environmental, A., Divan and Noble M. Environmental Law and Policy in India(cases, Materials and Statutes) 1991 Tripathi Bombay.
2. Environmental Policy. Forest Policy. Bare Acts – Government Gazette Notification

4 **Curicullum and Syllabus of the programme – After Revision**

SEMESTER-WISE STRUCTURE OF CURRICULUM

REGULATIONS – 2022

(Applicable to the students admitted from the Academic year 2022-2023)

SEMESTER I

Category	Sub. Code	Name of the Course	Hours per week			C	H
			L	T	P		
PCC	YEN101	Environmental Chemistry	3	0	0	3	3
PCC	YEN102	Environmental Microbiology	3	0	0	3	3
PCC	YEN103	Principles and Design of Physico-Chemical Treatment Systems	3	1	0	4	4
PEC	YEN104*	Elective - I	3	0	0	3	3
PEC	YEN105*	Elective – II	3	0	0	3	3
PCC-L	YEN106	Environmental Quality Measurements Laboratory	0	0	4	2	4
AICTE Mandatory Course	YRM107	Research Methodology and IPR	2	0	0	2	2
AICTE-Audit	YEGOE1	English for Research Paper Writing	2	0	0	0	2
PCC-L	YEN109	Microbiology Laboratory	0	0	4	2	4
	TOTAL		**19**	**1**	**8**	**22**	**28**

SEMESTER II

Category	Sub. Code	Name of the Course	Hours per week			C	H
			L	T	P		
PCC	YEN201	Transport of Water and Waste water	3	0	0	3	3
PCC	YEN202	Biological Treatment of Wastewater	3	0	0	3	3
PCC	YEN203	Environmental Impact Assessment	3	0	0	3	3
PEC	YEN204*	Elective – III	3	0	0	3	3
PEC	YEN205*	Elective – IV	3	0	0	3	3
PCC-L	YEN206	Environmental Engineering Processes Laboratory	0	0	4	2	4
PCC-L	YEN207	Mini Project	0	0	4	2	4
AICTE-Audit	YPSOE1	Constitution of India	2	0	0	0	2
	TOTAL		**17**	**0**	**8**	**19**	**25**

SEMESTER III

Category	Sub. Code	Name of the Course	Hours per week			C	H
			L	T	P		
PEC	YEN301*	Elective –V	3	0	0	3	3
PCC-L	YEN302	Dissertation Phase – I	0	0	20	10	20
OEC		Open Elective	3	0	0	3	3
	TOTAL		**06**	**0**	**20**	**16**	**26**

SEMESTER IV

Category	Sub. Code	Name of the Course	Hours per week			C	H
			L	T	P		
PCC-L	YEN401	Dissertation Phase – II	0	0	32	16	32
	TOTAL		**0**	**0**	**32**	**16**	**32**

TOTAL CREDITS - 73

PCC – Professional Core Course
PEC- Professional Elective Course
OEC – Open Elective Course
PCC-L – Professional Core Course - Lab

Note:

1. HOD concerned has to provide options for selecting the relevant MOOC courses or any elective paper which are offered.

2. The credit distribution is followed as per the guidelines given by AICTE/UGC.

PROFESSIONAL ELECTIVE COURSES

Elective I

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEN104A	Energy and Environment	3	0	0	3
YEN104B	Environmental Economics	3	0	0	3
YEN104C	Air Pollution and Control	3	0	0	3

Elective II

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	

YEN105A	Instrumental Methods and Analysis of Environmental Pollutants	3	0	0	3
YEN105B	Theory and Practice of Industrial Wastewater Treatment	3	0	0	3
YEN105C	Noise Pollution and Control Engineering	3	0	0	3

Elective III

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEN204A	Environmental Biotechnology	3	0	0	3
YEN204B	Environmental Geotechnology	3	0	0	3
YEN204C	Solid and Hazardous Waste Management	3	0	0	3

Elective IV

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEN205A	Operation and Maintenance of Water and Wastewater Treatment Systems	3	0	0	3
YEN205B	Ground Water Contamination and Transport Modeling	3	0	0	3
YEN205C	Simulation and Modeling in Environmental Systems	3	0	0	3

Elective V

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEN301A	Remote sensing and GIS for Environmental Applications	3	0	0	3
YEN301B	Sustainable Engineering	3	0	0	3
YEN301C	Membrane Technologies for water and Wastewater Treatment	3	0	0	3

AUDIT COURSES

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YEGOE1	English for Research Paper Writing	2	0	0	0
YPSOE1	Constitution of India	2	0	0	0

OPEN ELECTIVES

Sub. Code	Name of the Course	Hours per week			C
		L	T	P	
YCOOE1	Business Analytics	3	0	0	3
YMEOE1	Industrial Safety	3	0	0	3
YMAOE1	Operations Research	3	0	0	3
YCOOE2	Cost Management of Engineering Projects	3	0	0	3

Table 3 Distribution of credits and course types

S.No	Course Type	Symbol	Credits
1.	Professional Core Course	PCC	19
2.	Professional Elective Course	PEC	15
3.	Open Elective Course	OEC	3
4.	Professional Core Course - Lab	PCC-L	6
5.	Project	Proj	28
5.	AICTE Course - Audit	AICTE–Audit	0
6.	AICTE Course - Mandatory	AICTE– Mandatory	2
Total			**73**

Semester	Course Code	Course Name	L	T	P	C
I	YEN101	Environmental Chemistry	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Students will gain competency in solving environmental issues of chemicals based pollution

CO2 Ability to determine chemicals mobility in aquatic systems

CO3 Ability to identify contaminating chemicals in air and their fate

CO4 Understand the type of soil contaminants and provide remediation

CO5 Identify emerging environmental contaminants including speciation

COURSE CONTENT

UNIT I **INTRODUCTION** **9**

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product(Ksp), heavy metal precipitation, amphoteric hydroxides, CO2 solubility in water and species distribution –Chemical kinetics, First order, Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation

UNIT II **AQUATIC CHEMISTRY** **9**

Water quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals-Metals, complex formation, oxidation and reduction, Eh – pH diagrams, redox zones, Fe – sorption- Chemical speciation

UNIT III **ATMOSPHERIC CHEMISTRY** **9**

Atmospheric structure –-chemical and photochemical reactions – photochemical smog. Ozone layer depletion, greenhouse gases and global warming, CO2 capture – Acid rain - origin and composition of particulates. Air quality parameters-effects and determination

UNIT IV **SOIL CHEMISTRY** **9**

Nature and composition of soil-Clays- cation exchange capacity-acid base and ion-exchange reactions in soil. Reclamation of contaminated land.

UNIT V EMERGING AREAS **9**

Principles of green chemistry, Atom economy, mass index - Nano materials, CNT, titania, composites, environmental applications.

TEXT BOOKS

1. Sawyer,C.N., MacCarty, P.L. and Parkin, G.F., Chemistry for Environmental Engineering and Science, Tata McGraw – Hill, Fifth edition, New Delhi 2003.
2. Colin Baird 'Environmental Chemistry', Freeman and company, New York, 2011.
3. Manahan, S.E., "Environmental Chemistry", Ninth Edition, CRC press, 2009.
4. Ronald A. Hites ,"Elements of Environmental Chemistry", Wiley, 2nd Edition,2012.

REFERENCES

1. Des W. Connell, "Basic Concepts of Environmental Chemistry", CRC Press, 2nd Edition, 2005
2. Gary W VanLoon, Stephen J Duffy," Environmental Chemistry: A Global Perspective", Oxford University Press, 2010

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3		1				
CO2		3	2		1	2	1
CO3			3			1	1
CO4	2		3	1			1
CO5	2		2	1			1
Total	**2**	**1**	**3**	**2**	**1**	**1**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	YEN102	Environmental Microbiology	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Explain the basic importance and functional elements of environmental microbiology including the potential applications in the environment

CO2 Understand and describe the type of microorganisms in the environment, their importance in water supplies and the role of microorganisms in the cycling of nutrients in an ecosystem.

CO3 Understand the metabolic processes on carbohydrates, protein and lipids, importance of enzymes, production of energy and the various additional metabolic processes.

CO4 Select and apply appropriate methods for assessing the water, air and soil borne pathogens, their health implications, importance of microbes in aerobic and anaerobic cycles and deterioration of water bodies

CO5 Conduct testing and research on toxicology, understand the importance of test organisms, environmental applications such as biomagnifications, biomonitoring and in developing risk based standards.

COURSE CONTENT

UNIT I **FUNDAMENTALS OF MICROBIOLOGY** **9**

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

UNIT II **MICROBIAL ECOLOGY AND METABOLISM** **9**

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.

UNIT III **SOIL MICROBIOLOGY** **9**

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

UNIT IV AQUATIC MICROBIOLOGY 9

Hydrological cycle – Marine, Brackish and Fresh water ecosystems – Water borne bacterial diseases – Biological indicators of water pollution – Quality checking of potable water – Algae in water supplies – problems and control – Microbiology of sewage treatment.

UNIT V ATMOSPHERIC MICROBIOLOGY 9

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

TEXT BOOKS

1. Pelczar Jr. MJ, Chan ECS and Krieg, NR., "Microbiology", McGraw Hill. Inc, New York, 1993.
2. Prescott, L.M., Harley, J.P. and Klein, D.A., "Microbiology", McGraw Hill, New York, 2006.Stanley E. Manahan, "Environmental Science and Technology", Lewis Publishers, 200
3. Atlas, R.A. and Bartha, R., "Microbial Ecology – Fundamentals and Application", Benjamin Cummings, New York, 2000.

REFERENCES

1. Egbert Boeker and Rienk Vangrondella, "Environmental Science", John Wiley & Sons Ltd., USA, 2001.
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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3				1		
CO2		3					
CO3		3	3				
CO4			2	3			
CO5				3		2	1
Total	**1**	**2**	**1**	**2**	**1**	**1**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	YEN103	Principles and Design of Physico-Chemical Treatment Systems	3	1	0	4

Course Outcome: After the completion of the course, students will be able to

CO1 Evaluate various physical and chemical treatment options for treatment of water and wastewater

CO2 Explain the mechanism behind the treatment processes and their advantages and disadvantages

CO3 Design the treatment scheme for municipal water and wastewater

CO4 Analyse the specific needs on residue management and up gradation of existing plants

CO5 Gain knowledge on operation and maintenance of various treatment units

COURSE CONTENT **Hours**

UNIT I **INTRODUCTION** **9**

Pollutants in water and wastewater–characteristics, standards for performance-significance of physico-chemical treatment–Selection criteria-types of reactor-reactor selection-batch-continuous type-kinetics

UNIT II **PHYSICAL TREATMENT** **12**

Physical treatment - screening – mixing, equalization –sedimentation – filtration – evaporation– incineration–gas transfer–mass transfer coefficient adsorption – isotherms – membrane separation, Reverse Osmosis, Nanofiltration, Ultrafiltration and Electrodialysis, Distillation– Stripping and Crystallization – Recent advances.

UNIT III **CHEMICAL TREATMENT** **9**

Principles of Chemical treatment– Coagulation - flocculation–Precipitation – flotation - solidification and stabilization–Disinfection, Ion exchange, Electrolytic methods, Solvent extraction–advanced oxidation/reduction– recent trends

UNIT IV **DESIGN OF MUNICIPAL WATER TREATMENT PLANTS** **15**

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 filter – disinfection flow charts–layouts –construction and O&M aspects–case studies, residue management –

upgradation of existing plants – recent trends.

UNIT V DESIGN OF WASTEWATER TREATMENT PLANTS 15

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 - flowcharts – layouts -construction and O&M aspects – case studies, retrofitting - residue management – upgradation of existing plants – recent trends.

TEXT BOOKS

1. Metcalf Eddy ,Inc. George Tchobanoglous, Franklin Burton H, David Stensel," Wastewater Engineering", Tata McGraw-Hill Education ,2002
2. Hendricks," Water Treatment Unit Processes: Physical and Chemical," CRC, 2006.
3. Qasim.S.R., Guang Zhu., "Wastewater Treatment and Reuse" – Volume 1& 2 2018.
4. Ajey Kumar Patel, Achanta Ramakrishna Rao," Aeration Systems for Wastewater Treatment", Lap Lambert Academic PublishinG,-2011

REFERENCES

1. Lee, C.C. and Shun dar Lin, "Handbook of Environmental Engineering Calculations", McGraw Hill, New York, 1999.
2. CPHEEO manual – "Manual for sewerage and sewage treatment systems" – Part A,B,C, Ministry of Urban development, New Delhi, 2013.
3. CPHEEO manual – "Manual for water supply and treatment" –Ministry of Urban Development, New Delhi, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3			2	1	3
CO2	2	2	3		2	1	1
CO3		3		3	3	1	3
CO4				3	2	1	2
CO5	3	2		3		3	2
Total	**2**	**2**	**1**	**2**	**2**	**2**	**3**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course name	Course Code	L	T	P	C
I	**YEN106**	**Environmental Quality Measurements Laboratory**	**0**	**0**	**4**	**2**

Course Outcome: After the completion of the course, students will be able to

CO1 Calibrate and standardize the equipments

CO2 Explain the operation and mechanism of different analytical equipments and their advantages and limitations

CO3 Relate the theoretical knowledge of sampling and analysis into lab practice

CO4 Estimate the concentration of various parameters in water, wastewater, and ambient air

CO5 Perform field oriented testing of Solid waste water, wastewater and soil

List of Experiments:

1. Good Laboratory Practices, Quality control, calibration of Glassware

a) Water

a. Determination of pH, Turbidity and Electrical conductivity
b. Determination of Alkalinity
c. Determination of Acidity
d. Determination of Chlorides
e. Determination of Total Hardness
f. Determination of iron
g. Determination of Sulphates
h. Determination of Fluorides
i. Determination of Residual chlorine
j. Test on Dissolved Oxygen

b) Wastewater

a. BOD
b. COD
c. Total Solids, Suspended Solids, Volatile Solids, Non Volatile Solids
d. Determination of Ammoniacal Nitrogen

c)Air

a. Determination of Ambient Air Quality Parameters- SPM, CO, NO_x and SO_x

d) Soil

a. Soil Analysis – pH and Conductivity

e) Noise

b. Determination of Noise

c.

f) Solid waste

a. Composition of Municipal Solid waste
b. Proximate and Ultimate Analysis

TEXT BOOKS

1. APHA, "Standard Methods for the Examination of Water and Wastewater", 22nd Edition, Washington, 2012.
2. "Laboratory Manual for the Examination of water, wastewater soil Rump", H.H. and Krist, H. – Second Edition, VCH, Germany, 3rd Edition, 1999.
3. "Methods of air sampling & analysis" ,James P.Lodge J (Editor) 3rd Edition, Lewis publishers, Inc, USA,1989. Standard Methods for the Examination of Water and Wastewater, 20th Edition.
4. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1				3			
CO2	3					3	3
CO3	2	2					1
CO4			2	2	3	3	
CO5	2			3	3	3	2
Total	**2**	**1**	**1**	**2**	**2**	**2**	**2**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	YEN109	Microbiology Laboratory	0	0	4	2

Course Outcome: After the completion of the course, students will be able to

CO1 Explain the basic importance and functional elements of environmental microbiology including the types of microorganisms in air, water and soil.

CO2 Understand and describe the type of microorganisms in the environment, their importance and the method of culturing of microorganisms in the laboratory.

CO3 Understand the basic biochemical method of identification of microorganisms and to identify them using microscopial tool.

CO4 Select and apply appropriate methods for detection in the water, air and soil borne pathogens, their health implications, importance of microbes in our daily life.

CO5 Conduct testing and research on toxicology, the importance of test organisms, environmental applications of such microorganisms in toxicological studies and in developing risk based standards.

List of Experiments

1. Preparation of culture media
2. Isolation, culturing and Identification of Microorganisms
3. Microorganisms from polluted habitats (soil, water and air)
4. Measurement of growth of microorganisms
5. Biodegradation of organic matter in waste water Analysis of air borne microorganisms
6. Staining of bacteria.
7. Effect of pH, temperature on microbial growth
8. Pollutant removal using microbes from industrial effluent.
9. Bacteriological analysis of wastewater (Coliforms, *E.coli*, *Streptococcus*) – MPN
10. Bacteriological analysis of wastewater (Coliforms, *Streptococcus)* - MF techniques
11. Detection of Anaerobic Bacteria (*Clostridium* sp.)
12. Bioreactors (cultivation of microorganisms)

TEXT BOOKS

1. Benfield, L.D.; Weand, B.L.; Judkins, J.F. (1982) Process chemistry for water and wastewater. Prentice Hall Inc Englewood Cliffs New Jersey.
2. Weber Jr., W.J. (1972) Physico-chemical Process for Water Quality Control. Wiley Inc. Newyork.
3. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. Environmental Engineering, McGraw Hills, New York, 1985.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2				3	
CO2	2	3				1	
CO3	2		2				
CO4	1		3	3		2	
CO5	1			3	2	1	1
Total	**2**	**1**	**1**	**2**	**1**	**2**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	**YEN201**	**Transport of Water and Wastewater**	**3**	**0**	**0**	**3**

Course Outcome: After the completion of the course, students will be able to

CO1 Understand general hydraulics and need for proper collection and conveyance of water and wastewater

CO2 Design economic diameters of gravity and pumping mains and storage reservoirs

CO3 Design and analysis of water distribution networks and apply computer softwares

CO4 Design sewer networks for various flow conditions

CO5 Estimate the quantity of storm drainage and design proper storm drainage for speedy draining of storm water from the city area.

COURSE CONTENT **HRS.**

UNIT I **TRANSPORT OF WATER** **9**

Water Storage and Transmission, Storage- requirements, impounding reservoirs- intakes, pressure conduits, hydraulics - pumps and pumping units, capacity - selection of water pumps -economic design of pumps and economic design of gravity and pumping mains

UNIT II **MATERIALS FOR PIPES** **9**

Specification for pipes, merits and demerits, pipe appurtenances, types of loads and stresses, water hammer, causes and prevention, control devices, laying, jointing and Testing of pipes.

UNIT III **DISTRIBUTION SYSTEM** 9

Principles of design, analysis of distribution networks, Hardy Cross, equivalent pipe and Newton Raphson methods, computer applications in distributions network analysis, optimal design of networks, maintenance of distribution systems, methods of control and prevention of corrosion, storage, distribution and balancing reservoirs – EPANET – WaterGEM

UNIT IV **STORM DRAINAGE**

Necessity - combined and separate system; Estimation of storm water run-off Formulation of rainfall intensity duration and frequency relationships- Rational methods – Empirical Method

UNIT V **SANITARY SEWERAGE** **9**

Sanitation technology selection - sanitary sewage flow estimation - sewer materials and appurtenances - hydraulics of flow in sanitary sewers - partial flows - sewer design - sewer layouts- LOOP.

TEXT BOOKS

1. G.S.Bridie & J.S. Bridie, Water Supply and Sanitary Engineering, Dhanpat Rai and Sons, New Delhi, 2010.
2. Hammer, M.J. Water & Waste water Technology, John Wiley & Sons, New York, 7TH edition, 2012.
3. Garg, S.K., "Environmental Engineering I & II", Khanna Publishers, New Delhi 2007
4. Manual on Water Supply and Treatment, CPHEEO, Government of India, New Delhi, 2000
5. Manual on Sewage and Sewerage system, CPHEEO, Government of India, New Delhi, 2000

REFERENCES

1. 'Water supply and wastewater Removal' Vol.I. John Wiley and Sons Manual on Water Treatment, CPHEEO, Government of India, New Delhi, 2010
2. Hussain S.K. A Text book of water supply and sanitary Engineering, Oxford and IBH

Publishing Co., New, 2010.
3. Larry W. Mays, Mays Larry." Water Distribution System Handbook, "McGraw-Hill Professional Publishing, 1999.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	3			1
CO2		3	3	2	3		2
CO3	2	2	3	3	3	2	3
CO4	2	2	3	3	3	2	3
CO5	1	1	3	3	3	2	2
Total	**2**	**2**	**3**	**3**	**3**	**2**	**3**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	**YEN202**	**Biological Treatment of Wastewater**	**3**	**0**	**0**	**3**

Course Outcome: After the completion of the course, students will be able to

CO1 Understand the principles and significance of various biological treatment systems involved in water and waste water treatment.
CO2 Design various treatment systems of water and wastewater.
CO3 Develop conceptual schematics required for biological treatment of wastewater.
CO4 Translate pertinent criteria into biological treatment system requirements.
CO5 Gain knowledge on operation and maintenance of various treatment units

COURSE CONTENT

UNIT I **INTRODUCTION** **9**

Objectives of biological treatment – significance – Principles of 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

UNIT II **AEROBIC TREATMENT OF WASTEWATER** **9**

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, PID, hydraulic profile, recent trends

UNIT III ANAEROBIC TREATMENT OF WASTEWATER 9

Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal – Nutrient removal systems – Flow chart, Layout and Hydraulic profile – Recent trends.

UNIT IV SLUDGE TREATMENT AND DISPOSAL **9**

Design of sludge management facilities, sludge thickening, sludge digestion, biogas generation, sludge dewatering(mechanical and gravity) Layout, PID, hydraulics profile – upgrading existing plants – ultimate residue disposal – recent advances.

UNIT V OPERATION AND MAINTENANCE **9**

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

TEXT BOOKS

1. Arceivala, S.J., "Wastewater Treatment for Pollution Control", Tata Mcgraw Hill, New Delhi, III Edition, 2006.
2. David Hendricks, "Fundamentals of Water Treatment Unit Process", CRC Press, New York, 2010
3. F.R. Spellman, "Hand Book of Water and Wastewater Treatment Plant operations", CRC Press, New York, III, Edition, 2013.

REFERENCES

1. Manual on "Sewerage and Sewage Treatment" CPHEEO, Ministry of Urban Development, Government of India,New Delhi, 1999.
2. Metcalf & Eddy, INC, "Wastewater Engineering – Treatment and Reuse", Fourth Edition, Tata Mc Graw-Hill Publishing Company Limited, New Delhi, 2003.
3. Qasim, S.R. "Wastewater Treatment Plant, Planning, Design & Operation", Technomic Publications, New York, II Edition, 1998.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	2		1	1	2
CO2	2	3	2	3	3	2	3
CO3	1	2	1		3	1	2
CO4	1		2	2	2	1	2
CO5	3	1	1	3	2	1	2
Total	**3**	**2**	**2**	**2**	**3**	**2**	**3**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
III	YEN203	Environmental Impact Assessment	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Understand the necessity of the impacts and risks that will be caused by projects or industries and the methods to overcome these impacts.

CO2 Know about the legal requirements of Environmental Impact and Risk Assessment for projects.

CO3 Gain good knowledge on environmental impact assessment procedures and techniques adopted in the field.

CO4 Understand EIA as a technical, social process used for environmental governance.

CO5 Analyse the environmental impacts of the proposed projects

COURSE CONTENT

UNIT I UNIT I-INTRODUCTION TO EIA 9

Environmental Impact Assessment (EIA)- Environmental Impact Statement – Environmental Risk assessment –Legal and Regulatory aspects in India – Types and limitations of EIA – Terms of reference in EIA – Issues in EIA – National – Cross sectoral – social and cultural.

UNIT II METHODOLOGIES 9

Methods of EIA –Check lists – Matrices – Networks – Cost-benefit analysis – Analysis of alternatives – Case Studies.

UNIT III PREDICTION AND ASSESSMENT 9

Assessment of Impact on land, water and air, noise, social, cultural flora and fauna; Mathematical models; public participation – Rapid EIA.

UNIT IV ENVIRONMENTAL MANAGEMENT PLAN 9

Plan for mitigation of adverse impact on environment – options for mitigation of impact on water, air and land, flora and fauna; Addressing the issues related to the Project Affected People – ISO 14000

UNIT V CASE STUDIES 9

EIA for infrastructure projects – Bridges – Stadium – Highways – Dams – Multi-

storey Buildings – Water Supply and Drainage Projects

TEXT BOOKS

1. Canter, L.W., "Environmental Impact Assessment", McGraw-Hill, New York. 2006.
2. Lawrence, D.P., "Environmental Impact Assessment – Practical solutions to recurrent problems", Wiley-Interscience, New Jersey 2003.
3. Petts, J., "Handbook of Environmental Impact Assessment", Vol., I and II, Conwell Science London. 2009.

REFERENCES

1. Biswas, A.K. and Agarwala, S.B.C., "Environmental Impact Assessment for Developing Countries", Butterworth Heinemann, London. 2004.
2. The World Bank Group, "Environmental Assessment Source Book Vol. I, II and III. The World Bank, Washington. 2001.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2			2	3	2	3
CO2	3					2	2
CO3	3		2	2			
CO4	2		1	2	3	2	1
CO5	1	3	3	2	3	2	1
Total	**3**	**1**	**2**	**2**	**2**	**2**	**2**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	**YEN206**	**Environmental Engineering Processes Laboratory**	**0**	**0**	**4**	**2**

Course Outcome: After the completion of the course, students will be able to

CO1 Perform common environmental experiments relating to water and wastewater quality, and know which tests are appropriate for given environmental problems.

CO2 Demonstrate and analyze basic reactor types and kinetics.

CO3 Determine the quantity of Sludge

CO4 Demonstrate and analyze basic environmental engineering processes (physical/chemical) for treatment of contaminants, including gas transfer and adsorption.

CO5 Analyse the basic methods of environmental parameters.

List of Experiments

1. Coagulation and Flocculation
2. Studies on Filtration- Characteristics of Filter media
3. Disinfection for Drinking water (Chlorination
4. Water Softening – Lime and Caustic Soda Process
5. Sludge volume Index
6. Sedimentation – Settling Column Analysis of Flocculating Particles
7. Adsorption – Colour Removal by Adsorption
8. Heavy Metal Precipitation
9. Kinetics of Activated Sludge Process

TEXT BOOKS

1. Standard Methods for the Examination of Water and Wastewater, 20th Edition.
2. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2000.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3		2		3
CO2		3	3		2		3
CO3		3			3		1
CO4	3	3	3	2	3		2
CO5			3	3	2	3	2
Total	**2**	**3**	**3**	**1**	**3**	**1**	**3**

Semester	Course Code	Course Name	L	T	P	C
II	**YEN207**	**Mini Project**	**0**	**0**	**4**	**2**

Course Outcome: After the completion of the course, students will be able to

CO1 Define and discuss an existing problem in Environmental Engineering Systems and summarize the solutions.

CO2 Discover various tools and mathematical/Engineering methods behind the solutions

CO3 Present the problem, objectives, literature and analyze various solutions.

CO4 Solve the problem using existing method by proper tools and produce the results.

CO5 Conclude, compare, report and present the solution proposed and the results obtained.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3			2	1	3
CO2			3	3	1	2	2
CO3		3			3	1	3
CO4	3	3	3		2	2	3
CO5					3	1	3
Total	**2**	**2**	**2**	**1**	**3**	**2**	**3**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	**YEN302**	**Dissertation Phase – 1**	**0**	**0**	**20**	**10**

Course Outcome: After the completion of the course, students will be able to

CO1 Identify problems and contemporary tools to solve them efficiently.

CO2 Survey recent solutions proposed and outline the objectives and methods.

CO3 Explain the project ideas, findings and demonstrate the same

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	3	3		2	3	1
CO2	1	3			3	3	3
CO3	1	2	3	3	3	2	3
Total	**1**	**2**	**2**	**1**	**2**	**2**	**2**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
IV	**YEN401**	**Dissertation Phase – II**	**0**	**0**	**32**	**16**

Course Outcome: After the completion of the course, students will be able to

CO1 Identify, Estimate, Track and cost the human and physical resources required, and make plans to obtain the necessary resources

CO2 Conclude, compare, report and present the solution proposed and the results obtained.

CO3 Extend the findings and develop a research article without any plagiarism and present

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				3	3	3	2
CO2	1	1	1	3	3	3	3
CO3	1	1	1	3	3	3	3
Total	**1**	**1**	**1**	**2**	**2**	**2**	**2**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

ELECTIVES

Semester	Course Code	Course Name	L	T	P	C
I	**YEN104A**	**Energy and Environment**	**3**	**0**	**0**	**3**

Course Outcome: After the completion of the course, students will be able to

CO1 Understand the waste generation and processing Philosophy

CO2 Identify the various types of waste recovery materials

CO3 Gain knowledge on separation and recycling of waste Materials

CO4 Demonstrate the Waste handling and storage processes

CO5 Gain knowledge on instrumentation for ensuring operation and safety

COURSE CONTENT **Hours**

UNIT I GENERAL **9**

Trends in waste generation-Processing Philosophy- Typical waste composition and its uses-Waste recovery methods-Waste recycling methods-Energy recovery methods

UNIT II RECOVERY OF WASTE MATERIAL **9**

Recovery of waste materials-Plastic recovery –Energy recovery-Metal recovery-Glass recovery-Non ferrous metals recovery-Composting-Check list

UNIT III RECYCLING OF WASTE MATERIAL **9**

Separation and recycling of waste – Principles – separation-Air classifier – Screening-Hammer mill-Products of recycling-Recycling applications-Case histories-House hold waste recycling –Scrap fragmentation Process

UNIT IV WASTE HANDLING SYSTEMS **9**

Waste handling and storage-Supply and demand-Compacting and storage-Storage hoppers-Waste handling systems-Access and safety –Compactors

UNIT V DISOPAL OF WASTE **9**

Waste disposal-Management- Conveyance – Specific examples- Refractories-Development-Chimneys-Control and instrumentation-Operation and safety.

TEXT BOOKS

1. Vaish Troloki, Enery, Environment and Ecology, Vayu Education of India, New Delhi, 2001
2. Salvato, “Environmental Sanitation”, John Wiley & Sons, NewYork, 1982
3. David Kut and Gerard Hare**, ”**Waste recycling for energy recovery”, Architectural Press, 1981.

REFERENCES

1. Metcalf & Eddy, “Wastewater Engineering Treatment Disposal Reuse”, Tata McGraw-Hill, New York, 2003.
2. Arcievala S.J., Wastewater treatment and Disposal – Engineering and Ecology in pollution control, Marcel Dekker. Inc., New York, 1981.
3. Chandra and Adab,”Rubber and plastic Waste”,Cbs,2004.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3						
CO2	2	3	2	3			
CO3		2	3	3			
CO4	2		2	3			
CO5	2			3	1	1	1
Total	**2**	**1**	**2**	**3**	**1**	**1**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	**YEN104B**	**Environmental Economics**	**3**	**0**	**0**	**3**

Course Outcome: After the completion of the course, students will be able to

CO1 Understand the Nature and significance of environmental economics

CO2 Evaluate environmental damages for land, water, air and forest.

CO3 Provide solutions to the environment problems

CO4 Adopt the strategies for Prevention, control and abatement of pollution

CO5 Formulate the environmental policy

COURSE CONTENT

UNIT I THEORY AND CONCEPT **9**

Nature and significance of environmental economics – definition and scope of environmental economics – basic theory – market system and the environment – welfare and environment – the economics of externalities.

UNIT II ENVIRONMENT AND ECONOMICS **9**

Environment – economy linkage – environment as a necessity and luxury – population and environment linkage – environmental use as an allocative problem – environment as a public good – valuation of environmental damages: land, water, air and forest.

UNIT III ENVIRONMENTAL PROBLEMS **9**

Economic development and environmental problems – air pollution – water pollution – sound pollution – energy use and environment problem – pollution and urbanization – global warming and greenhouse effect – health, urbanization, transport and technology – environmental degradation.

UNIT IV POLLUTION CONTROL **9**

Prevention, control and abatement of pollution – choice of policy instruments in developing countries – environmental law – sustainable development – indicators of sustainable development – environmental planning – environmental accounting.

UNIT V POLICY MEASURES **9**

Basic approach – design of environmental policy – Indian environment policies and performance – pollution control boards and their function.

TEXT BOOKS:

1. M. Karpagam (1993), Environmental Economics, Sterling Publishers, New Delhi.
2. S. Sankaran(1994) Environmental Economics, Margham , Madras
3. N.Rajalakshmi and DhulasiBirundha (1994), Environomics, Economic analysis of Enviroment, Allied publishers, Ahmedabad.
4. S.Varadarajan and S. Elangovan(1992), Environmental economics, Speed, Chennai.

REFERENCES:

1. Singh G.N (Ed.) (1991) Environmental Economics, Mittal Publications, New Delhi.
2. Garge, M.R. (Ed.) (1996), Environmental Pollution and Protection, Deep and Deep Publications, New Delhi.
3. Lodha, S.L (Ed.) (1991), Economics of Environment, Publishers, New Delhi. 8. The Hindu survey of Environment: Annual Reports.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3			3			
CO2		2	2	3			3
CO3		3	3	3			
CO4			2	3		3	3
CO5				3	1	3	3
Total	**1**	**1**	**2**	**3**	**1**	**2**	**2**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	YEN104 C	Air Pollution and Control	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Classify the types and sources of air pollutants and to understand their effects on human health and the broader environment

CO2 Differentiate and design various air pollution control technologies for particulates and gaseous pollutants

CO3 Choose appropriate technologies for removal of selective pollutants

CO4 Establish and implement air quality management components

CO5 Understand the sources and causes of Indoor Air Quality Problems

COURSE CONTENT

UNIT I INTRODUCTION TO AIR POLLUTANTS 9

Air resource management system – Air quality management – Scales of air pollution problem – Sources and classification of pollutants and their effect on human health vegetation and property – Global implications of air pollution – Meteorology Fundamentals – Atmospheric stability – Micrometeorology – Atmospheric turbulence – mechanical and thermal turbulence – Wind profiles – Atmospheric Diffusion – Atmospheric diffusion theories – Steady-state atmospheric diffusion equation – Plume rise – Diffusion models – Ambient air quality and emission standards – Air pollution indices – Air Quality Sampling and Monitoring.

UNIT II CONTROL OF PARTICULATE CONTAMINANTS 9

Settling chambers – Filters, gravitational, Centrifugal – multiple type cyclones, prediction of collection efficiency, pressure drop, wet collectors, Electrostatic Precipitation theory – ESP design – Operational Considerations – Process Control and Monitoring – Case Studies.

UNIT III CONTROL OF GASEOUS CONTAMINANTS 9

Absorption – principles – description of equipment-packed and plate columns – design and performance equations – Adsorption – principal adsorbents – Equipment descriptions – Design and performance equations – Condensation – design and performance equation – Incineration – Equipment description – design and performance equations – Biological Air Pollution Control Technologies – Bio-Scrubbers, Biofilters – Operational Considerations – Process Control and Monitoring – Case Studies.

UNIT IV EMERGING TRENDS 9

Process Modification – Automobile Air Pollution and its control – Fuel Modification – Mechanical Particulate Collectors – Entrainment Separation – Internal Combustion

Engines – Membrane Process – Ultraviolet Photolysis – High Efficiency Particulate Air Filters – Technical & Economic Feasibility of selected emerging technologies for Air pollution control

UNIT V INDOOR AIR QUALITY **9**

Sources and Causes of Indoor Air Quality Problems- Risk due to Indoor Air pollutants- sources of indoor Air pollutants- Indoor Air Quality Regulations- Indoor Air Quality Models- Indoor Air Quality Control- Case Studies

TEXT BOOKS

1. Noel de Nevers, Air Pollution Control Engineering, Mc Graw Hill, New York, 2010.
2. Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, Air Pollution Control Engineering, Tokyo, 2004.
3. Anjaneyulu. Y, 'Air Pollution and Control Technologies', Allied Publishers (P) Ltd., India, 2002

REFERENCES

1. David H.F. Liu, Bela G. Liptak 'Air Pollution', Lewis Publishers, 2000.
2. Arthur C.Stern, ' Air Pollution (Vol.I – Vol.VIII)', Academic Press, 2006.
3. Wayne T.Davis, 'Air Pollution Engineering Manual', John Wiley & Sons, Inc., 2000

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2	3		1			
CO2	2	2	2	2		1	
CO3		3	3	3	1	2	1
CO4			3	3		3	2
CO5	3				2		
Total	**2**	**2**	**2**	**2**	**1**	**2**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	YEN105A	Instrumental methods and analysis of environmental pollutants	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Analyse the principles of volumetric and instrumental analytical methods in Environmental monitoring

CO2 Use statistical methods for evaluating and interpreting data of environmental interest

CO3 Discriminate various electrochemical methods

CO4 Summarize various material characterization techniques and its principles

CO5 Demonstrate the analysis through Non – dispersive infra-red (NDIR) analyzer

COURSE CONTENT

UNIT I INTRODUCTION **9**

Instrumental Methods, Selection of method, Precision and Accuracy, Errors in measuring signals, Noise/signal ratio, base line drift, Indicator tubes.

UNIT II SPECTROSCOPIC METHODS **9**

Electromagnetic radiation, matter radiation interactions; Colorimetry and Spectrophotometry, Fluorimetry, Nephelometry and Turbidimetry, flame photometry Atomic Absorption Spectrometry (AAS), Atomic Emission Spectrometry (AES) – Inductively coupled plasma (ICP) and Direct Current Plasma (DCP) spectrometry. ICP – MS (Mass spectrometry).

UNIT III CHROMATOGRAPHIC METHODS **9**

Classical methods, Column, Paper and thin layer chromatography (TLC), Gas Chromatrography (GC), GC-MS, High performance liquid chromatography (HPLC) and Ion Chromatrography (IC).

UNIT IV ELECTRO AND RADIO ANALYTICAL METHODS **9**

Conductometry, Potentiometry, Coulometry, Amperometry Polarography, Neutron Activation Analysis (NAA), X-ray Fluorescence (XRF) and X-ray Diffraction (XRD) methods.

UNIT V CONTINUOUS MONITORING INSTRUMENTS **9**

Non – dispersive infra-red (NDIR) analyzer for CO, Chemiluminescent analyzer for Nox, Fluorescent analyzer for SO_2, Auto analyzer for water quality using flow injection analysis; permeation devices.

TEXT BOOKS

1. Willard. H., Merritt, L., Dean, D.A. and Settle. F.A. 'Instrumental methods of analysis, 7th Edn. Words Worth, New York, 2004.
2. Eckman D.P. "Industrial Instrumentation", Wiley Eastern Ltd., 1989.
3. Considine D M and Considine G D "Process Instruments Controls" Handbook 3rd Edition , McGraw – Hill Book Co., NY, 1990.
4. Scborg D E,.Edgar T.F and Mellichamp D.A, "Process Dynamics and Control" John Wiley 1989

REFERENCES

1. Fribance, "Industrial Instrumentation Fundamentals" ,Mc Graw Hill Co. Inc. New York 1985
2. Ewing 'Instrumental Methods of Chemical Analysis, 5th Edn., McGraw-Hill, New York, 1995.
3. Ernest Doebelin, Measurement systems, McGraw – Hill Book, Co., NY, 1975.
4. Astrom K.J., Bjon wittenmark, Computer controlled systems, Prentice- Hall of India, New Delhi 1994.
5. Cartis Johnson, Process Control Instrumentation Technology, Prentice-Hall of India, New Delhi 1993.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	1	3	3	3	3		1
CO2	2	3	2	3	3	1	3
CO3	3		3	2	2		3
CO4	2		3	2	2	2	2
CO5	2	2	2	3	2	3	3
Total	**2**	**2**	**3**	**3**	**3**	**2**	**3**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	YEN105B	Theory and practice of industrial waste water treatment	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Characterize the wastewater generated from a specific industry and understand the possible impacts on the environment.

CO2 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

CO3 Probe the possible recycling and reuse opportunities for the generated wastewater and residuals by employing suitable treatment units.

CO4 Understand the feasibility and benefits of individual, common and joint treatment of industrial wastewater.

CO5 Design waste treatment flow sheets for industries.

COURSE CONTENT

UNIT I INTRODUCTION 9

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.

UNIT II INDUSTRIAL POLLUTION PREVENTION 9

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.

UNIT III INDUSTRIAL WASTEWATER TREATMENT 9

Equalization – Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors – Chemical oxidation – Ozonation – carbon adsorption – Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.- Treatability studies.

UNIT IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT **9**

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

UNIT V CASE STUDIES **9**

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.

TEXT BOOKS

1. Eckenfelder, W.W., 'Industrial Water Pollution Control', Mc-Graw Hill, 2000.
2. Nelson Leonard Nemerow, "Industrial waste treatment – contemporary practice and vision for the future", Elsevier, Singapore, 2007
3. Paul L. Bishop, 'Pollution Prevention: - Fundamentals and Practice', Mc-Graw Hill International, Boston, 2000.

REFERENCES

1. Nemerow, N.I, Butterworth-Heinemann, "Theories of practice of Industrial Waste Treatment", 2006.
2. Gurnham, C.F., "Principles of Industrial Waste Treatment "CRC Press, 1999.
3. Frank Woodard, 'Industrial waste treatment Handbook', Butterworth Heinemann, New Delhi, 2001

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	2		1		1
CO2	1	2	2	3	1		
CO3	1	2	2	3	2	1	1
CO4	2	1		2		1	1
CO5	1	2	3	3	2		3
Total	**2**	**2**	**2**	**3**	**2**	**1**	**2**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	YEN105C	Noise Pollution and Control Engineering	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Overview noise pollution including methods for prevention and control.

CO2 Apply the theory of noise pollution to practical engineering situations.

CO3 Gain knowledge on concepts of sound wave propagation and its intensity

CO4 Use engineering instrumentation and principles to undertake a laboratory investigation in noise pollution.

CO5 Know about the legal requirements for Noise pollution Control and Management

COURSE CONTENT

UNIT I **SOURCES OF NOISE** **9**

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

UNIT II **EFFECTS OF NOISE** **9**

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

UNIT III **BASIC CONCEPTS OF SOUND** **9**

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

UNIT IV **SOUND MEASUREMENT** **9**

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

UNIT V **NOISE POLLUTION CONTROL** **9**

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

TEXT BOOKS

1. "Environmental Health Criteria – 12", Noise, World Health Organisation Publication, Geneva, 1980.
2. Patrick, C.F., "Environmental Noise Pollution ", John Wiley and Sons, 1977.

Burs, W., Lippin Cott., " Noise and Man", Philadelphia, 1969.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	1				
CO2		2	2	2		1	
CO3	3						
CO4		3	3	2		2	
CO5		2	2		3	1	1
Total	**2**	**2**	**2**	**1**	**1**	**1**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	**YEN204A**	**Environmental Biotechnology**	**3**	**0**	**0**	**3**

Course Outcome: After the completion of the course, students will be able to

CO1 Understand the characteristics and structure of microbes.

CO2 Explain the mechanisms of detoxification and biodegradation of solid wastes

CO3 List out the different methods for bioremediation of environment and to design biological system for the removal of nutrients

CO4 Evaluate the benefit of microorganisms in degrading organic contaminants and to choose suitable microorganism for biodegradation of selected compounds.

CO5 Select suitable assessment methods for bioremediation

COURSE CONTENT

UNIT I INTRODUCTION **5**

Principles and concepts of environmental biotechnology—usefulness to mankind, current status.

UNIT II DETOXIFICATION OF ENVIRONMENTAL POLLUTANTS 8

Degradation of high concentrated toxic pollutants—halogenated, non-halogenated, petroleum hydrocarbons, metals. Mechanisms of detoxification-oxidation, dehalogenation, biotransformation of metals, biodegradation of solid wastes.

UNIT III MICROBIAL TECHNOLOGY FOR WASTE TREATMENT 12

Biotechnological remedies for environmental pollution—decontamination of groundwater systems, subsurface environment—reclamation concepts—bioremediation. Production of proteins – biofertilizers. Physical, chemical and microbiological factors of composting – health risk – pathogens – odour management – Microbial cell/enzyme technology – adapted microorganisms – biological removal of nutrients – algal biotechnology and applications in agriculture – role of extracellular polymers. Biogas technology – case studies.

UNIT IV RECOMBINANT DNA TECHNOLOGY AND GENETIC APPLICATION 10

Concept of rDNA technology – expression vectors – cloning of DNA – mutation – construction of microbial strains, radioactive probes, protoplast fusion technology – applications.

UNIT V ETHICAL AND REGULATORY ISSUES 10

Environmental effects and ethics of microbial technology – safety of genetically engineered organisms – microbial containment – Risk assessment

TEXT BOOKS

1. Chaudhury, G.R. 'Biological degradation and Bioremediation of toxic chemicals', Dioscorides Press, Oregon, 1994.
2. Martin.A.M, 'Biological degradation of wastes', Elsevier Applied Science, London, 1991.
3. Sayler, Gray S. Robert Fox and James W. Blackburn Environmental Biotechnology for Waste Treatment, Plenum Press, New York, 1991.
4. Blaine Metting.F (Jr.,) Soil Microbiology Ecology, Marcel Dekker Inc., 1993.

REFERENCES

1. Wainwright, M, An Introduction to Environmental Biotechnology, 1999.
2. Old, R.W., and Primrose, S.B., Principles of Gene Manipulation 3rd Ed. Blackwell Sci. Publ., Cambridge, 1985.
3. Bruce E. Rittmann, Eric Seagren, Brian A.Wrenn and Albert J. Valocchi, Chittaranjan Ray, Lutgarde Raskin, Insitu Bioremediation (2nd Edition) Nayes Publication, U.S.A, 1991

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2			1		
CO2		2	2		1		
CO3	3	2	2				
CO4		3	3	3		2	
CO5	2	2	2	2		2	1
Total	**2**	**3**	**2**	**1**	**1**	**1**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	**YEN204B**	**Environmental Geotechnology**	**3**	**0**	**0**	**3**

Course Outcome: After the completion of the course, students will be able to

CO1 Identify the origin, nature, and extent of contamination in field.

CO2 Predict the retention and flow properties of contaminants.

CO3 Adopt suitable sampling techniques for geoenvironmental characterization

CO4 Suggest the remediation techniques for decontamination

CO5 Gain knowledge on advanced soil characterization techniques

COURSE CONTENT

UNIT I SOIL PROFILE

Soil as a multiphase system; Soil – environment interactions; Properties of water in relation to porous media; Water cycle with special reference to soil medium.

UNIT II SOIL MINERALOGY

Soil mineralogy; significance of mineralogy in determining soil behavior; Mineralogical characterization

UNIT III MECHANISMS OF SOIL-WATER INTERACTIONS

Diffuse double layer models; Force of attraction and repulsion; Soil- Water contaminant interaction; Theories of Ion exchange; Influence of organic and inorganic chemical interaction.

UNIT IV WASTE & ITS TRANSPORT IN SOIL

Concepts of waste containment facilities; desirable properties of soil; contaminant transport and retention; contaminated site remediation

UNIT V REMEDIAL TECHNIQUES

Introduction to advanced soil characterization techniques; volumetric water content; gas permeation in soil; electrical and thermal properties; pore –size distribution; contaminant analysis

TEXT BOOKS

1. Geotechnical and Geo-environmental Engineering Handbook, Rowe R. K, Kluwer Academic Publishers 2001
2. Fundamentals of Soil Behavior, Mitchell J.K and Soga K., John Wiley and Sons Inc. 2012
3. Introduction to Environmental Geotechnology, Fang, H.Y., CRC press 1997
4. Geotechnical Practice for Waste Disposal, Daniel D.E, Chapman and Hall 1993

REFERENCE

1. Clay Barrier Systems for Waste Disposal Facilities, Rowe J.R., Quigley R.K., R.M. and Booker, Chapman and Hall 1995
2. Geoenvironmental Engineering: Principles and Applications, Reddi L.N. and Inyang H.F, Marcel Dekker Inc 2000
3. Waste Containment Systems, Waste Stabilization And Landfills: Design and Evaluation, Sharma H. D. And Lewis S.P, John Wiley & Sons Inc 1994

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2	2					
CO2		2	3	3			
CO3		3	3	3		2	
CO4		2	3	3	2		
CO5	3					3	2
Total	**1**	**2**	**2**	**2**	**1**	**1**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	YEN204C	Solid and Hazardous Waste Management	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Understand the present scenario of solid waste management in India, framework and regulatory requirements applicable in India.

CO2 Explain the various functional elements involved in waste management system

CO3 Gain good knowledge on composition and characterization of waste based on which a recommendation can be made on how to handle the given waste

CO4 Knowledge on 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.

CO5 Device a better strategy to adopt the principle of cradle to grave to dispose waste.

COURSE CONTENT

UNIT I SOURCES, CLASSIFICATION AND REGULATORY FRAMEWORK 9

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management – Elements of integrated waste management and roles of stakeholders - Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, lead acid batteries, electronic wastes , plastics and fly ash – Financing waste management.

UNIT II WASTE CHARACTERIZATION AND SOURCE REDUCTION 9

Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – waste sampling and characterization plan - Source reduction of wastes –Waste exchange - Extended producer responsibility - Recycling and reuse

UNIT III STORAGE, COLLECTION AND TRANSPORT OF WASTES 9

Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations Optimizing waste allocation– compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport

UNIT IV WASTE PROCESSING TECHNOLOGIES 9

Objectives of waste processing – material separation and processing technologies –

biological &chemical conversion technologies – methods and controls of Composting - thermal conversion technologies, energy recovery – incineration – solidification & stabilization of hazardous wastes- treatment of biomedical wastes

UNIT V WASTE DISPOSAL 9

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps – landfill remediation

TEXT BOOKS

1. George Techobanoglous et al, "Integrated Solid Waste Management", McGraw - Hill, 2014.
2. Manual on Municipal Solid waste Management, CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi, 2000.
3. Techobanoglous Thiesen Ellasen; Solid Waste Engineering Principles and Management, McGraw - Hill 1997.

REFERENCES:

1. R.E.Landrefh and P.A.Rebers," Municipal Solid Wastes-Problems & Solutions" ,Lewis, 1997.
2. Blide A.D.& Sundaresan, B.B,"Solid Waste Management in Developing Countries", INSDOC, 1993.
3. Georges E. Ekosse, Rogers W'O Okut-Uma, Pollution control & Waste management in Developing Countries, Commonwealth Publishers, New Delhi, 2000.
4. B. B. Sundaresan, A. D. Bhide – Solid Waste Management, Collection, Processing and Disposal, Mudrashilpa Offset Printers, 2001.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	2	1				1
CO2	2	3	2	2		2	1
CO3	3	3	3	3	1		1
CO4	2	3	2	2	3	2	1
CO5	1		2	3	3	3	2
Total	**3**	**3**	**2**	**2**	**2**	**2**	**2**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	YEN205A	Operation and Maintenance of Water and Wastewater Treatment Systems	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Acquire knowledge required to operate and maintain water treatment plants

CO2 Gain knowledge on wastewater treatment plants including trouble shooting.

CO3 Understand the preventive and corrective maintenance of sewage pumps

CO4 Identify the hazards in Chemical Handling processes

CO5 Understand the construction, Operation and Maintenance aspects of Biological Treatment processes

COURSE CONTENT

UNIT I 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.

UNIT II 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 - Computerised Water Billing System

UNIT III 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.

UNIT IV OPERATION AND MAINTENANCE OF PHYSICO-CHEMICAL TREATMENTS

Operation and maintenance in screen chamber, Grit Chamber and clarifiers- Operation issues, troubleshooting guidelines and record keeping requirements for clarifier, Equalization basins, Neutralization unit - Chemical storage and mixing equipment - Chemical metering equipment - Flash mixer –Filters, thickeners and centrifuges- Filter Press - Start-up and maintenance inspection - Motors and Pumps - Hazards in Chemical Handling – Jar Test - Chlorination Equipment - Membrane process systems- SDI and LSI determination- Process Chemistry and Chemical dosage calculations- Case Studies.

UNIT V 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.

TEXT BOOKS

1. 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.
2. Ananth S Kodavasal, The STP Guide-Design, Operation and maintenance, Karnataka State Pollution Control Board, Bangalore, 2011.
3. Frik Schutte, Handbook for the operation of water Treatment Works, The Water Research Commission, The Water Institute of Southern Africa, TT265/06, 2006.

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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2				2	
CO2		2	2	3		2	
CO3		2	3	2		3	
CO4	3	2	2	2	2	1	
CO5	2	3	3	2	2	3	2
Total	**2**	**3**	**2**	**2**	**1**	**3**	**1**

Note:	Total	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
III	YEN205B	Ground Water Contamination and Transport Modeling	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Develop flow and transport model for contaminant in subsurface water

CO2 Apply mass balance principles to develop and solve simple water quality models.

CO3 Differentiate various numerical techniques for solving flow and transport equations

CO4 Develop reactive transport model for reactive species

CO5 Apply the software packages to develop contaminant transport model for field condition

COURSE CONTENT

UNIT I INTRODUCTION TO TRANSPORT PHENOMENA 9

Transport phenomenon, diffusion, dispersion, advection, adsorption, conservative and non-conservative pollutants, sources and sinks- point and nonpoint.

UNIT II FLOW AND TRANSPORT EQUATIONS 9

Governing Equations for flow and transport in surface and subsurface waters, chemical and biological process models, simplified models for lakes, streams, and estuaries.

UNIT III MODEL COMPLEXITY 9

Selection and development, model resolution, coupled and uncoupled models, Linear and nonlinear models, solution techniques, data requirements for calibration, application and evaluation of environmental control.

UNIT IV NUMERICAL MODELS 9

FDM, FEM and Finite volume techniques, explicit vs. implicit methods, numerical errors, and stability, High resolution techniques.

UNIT V SOFTWARE MODELLING 9

Stream quality modeling and Groundwater transport modeling using software.

TEXT BOOKS

1. Alexander H.-d Cheng, Jacob Bear, "Modeling Groundwater Flow and Contaminant Transport", springer 02, 2011.

2. PascualHoracio Benito," Approaches to Modeling Contaminant Transport in Porous Media: Pore-Scale to Regional Scale Investigations,"Proquest, Umi Dissertation Publishing, 09-2011.
3. Mark Goltz, Junqi Huang," Analytical Modeling of Solute Transport in Groundwater: Using Models to Understand the Effect of Natural Processes on Contaminant Fate and Transport I",John *Wiley & Sons, Aug 2010.*

REFERENCES

1. Rafael Antonio PrietoPiedrahita," Treatment of Contaminated Sediments Using Reactive Cap Technology: Characterization and Modeling of Geotechnical, Hydraulic and Contaminant Transport", Proquest, Umi Dissertation Publishing, Sep 2011.
2. ChunmiaoZheng, Gordon D. Bennett," Applied Contaminant Transport Modeling", Wiley-Interscience, February 2002.
3. Shahar Shlomi,"Combining Geostatistical Analysis and Flow-And-Transport Models to Improve Groundwater Contaminant Plume Estimation, "Proquest, Umi Dissertation Publishing,2011.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2	1	3	3		1	2
CO2		2	2	3		1	2
CO3	2	3	3	3		3	3
CO4		3	2	3	1	3	3
CO5		3	3	2		3	3
Total	**1**	**3**	**3**	**3**	**1**	**3**	**3**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	YEN205C	Simulation and Modeling in Environmental Systems	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 To develop contaminant transport model for natural systems

CO2 To predict the quality of water in river, lakes and estuaries using specific models

CO3 To solve the transport equation using numerical techniques

CO4 To estimate the concentration of pollutant in ambient air using dispersion models

CO5 Developed conceptual schematics required for system analysis and an ability to translate pertinent criteria into system requirements

COURSE CONTENT

UNIT I **9**

Scope of Environmental modeling – transport phenomena – advection - diffusion – sediment transport – lake dispersion calculation – simple transport models – equilibrium chemical model – equilibrium principles – numerical solution techniques – redox reactions in equilibrium models .

UNIT II **9**

Eutrophication of lakes – conventional pollutants in rivers – toxic organic chemicals – modeling trace metals – mass balance and waste load allocation for rivers – study state model for metals in lakes – metals migration in soils .

UNIT III **9**

Groundwater contamination – Darcy's law – flow equations – contaminant solute transport equation – biotransformations - biofilms and bio availability – remediation – numerical methods.

UNIT IV **9**

Atmospheric deposition and biogeochemistry – genesis of acid deposition – neutralizing capacities – biogeochemical models – ecological effects – critical loads – case studies –metal deposition.

UNIT V **9**

Global change and Global cycles – Climate change and general circulation models – global carbon box model – nitrogen cycle – Global sulfur cycle – trace gases.

TEXT BOOKS

1. Environmental Modelling by Gerald .L. Schnoor, John Wiley and sons, Inc.
2. Process Dynamics in Environmental Systems by Walter .J. Weber,Jr and Francis ,John Wiley and sons, Inc.

3. Transport Modelling for Environmental Engineers and Scientists by Mark .M. Clark, John Wiley and Sons, Inc.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3				2		2
CO2		3	3	3	2	1	
CO3		2	2		1	2	
CO4		2	3	1		1	
CO5		3	3	2		2	2
Total	**1**	**2**	**3**	**2**	**1**	**2**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	**YEN301A**	**Remote Sensing and GIS for Environmental Applications**	**3**	**0**	**0**	**3**

Course Outcome: After the completion of the course, students will be able to

CO1 Summarize the basic spectral mechanism behind remote sensing and GIS techniques

CO2 Explain different software for data creation, analysis and modeling

CO3 Understand geo database development and geo-spatial analysis for environmental applications

CO4 Apply the image processing techniques for various environmental problems

CO5 Apply the Waste Management and monitoring of pollution index using GIS Techniques

COURSE CONTENT

UNIT I FUNDAMENTALS OF REMOTE SENSING **9**

Definition, Physics of Remote Sensing, Electromagnetic Radiation and its interactions with atmosphere, Spectral reflectance of earth materials and vegetation

UNIT II PLATFORMS AND SENSORS 9

Aerial Photographs, Active and passive sensors, Data products, Various satellite in orbit and their sensors.

UNIT III DATA PROCESSING 9

Data analysis - Visual Interpretation and Digital Image Processing – classification

UNIT IV GIS 9

Introduction to GIS, concepts and Data base structure, various GIS software.

UNIT V REMOTE SENSING AND GIS APPLICATIONS 9

Management and monitoring of land, air, water and pollution studies, conservation of resources, Identification of site for waste disposal – optimization of Route for collection of MSW

TEXT BOOKS

1. Anji Reddy.M," Textbook of Remote Sensing and GIS", BPB Publications,2006
2. T. M. Lillesand and R.W.Kiefer, "Remote Sensing and Image Interpretation" , Wiley,2011
3. E. T. Engman and R. J. Curney," Remote Sensing in Hydrology," Chapman & Hall,1990

REFERENCES

1. Lillies and T.M. and Kiefer, R.W., "Remote Sensing and Image Interpretation ", John Wiley and Sons, 1994.
2. Burrough, P.A. and McDonnell, R.A., "Principles of Geographical Information Systems", Oxford University Press, 1998. 3. Lintz, J. and Simonet, " Remote Sensing of Environment ", Addison Wesley Publishing Company, 1994.
3. David Martin," Geographic Information Systems", Routledge,1995.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3				2		
CO2		3	3	2			
CO3	2	1	2	1	2	1	
CO4		2	3	1	2	1	2
CO5	2	2	3	3	3	2	2
Total	**2**	**2**	**3**	**2**	**2**	**1**	**1**

Note:	Total	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
II	YEN301B	Sustainable Engineering	3	0	0	3

Course Outcome: After the completion of the course, students will be able to

CO1 Understand the relevance and the concept of sustainability and the global initiatives

CO2 Explain the different types of environmental pollution problems and their sustainable solutions

CO3 Discuss the environmental regulations and standards

CO4 Outline the concepts related to conventional and non-conventional energy

CO5 Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

COURSE CONTENT

UNIT I SUSTAINABILITY

Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).

UNIT II ENVIRONMENTAL POLLUTION

Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.

UNIT III ENVIRONMENTAL MANAGEMENT STANDARDS

ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis

(LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

UNIT IV RESOURCES AND ITS UTILISATION

Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.

UNIT V SUSTAINABILITY PRACTICES

Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.

TEXT BOOKS

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998

REFERENCES

1. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
2. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional
3. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
4. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3				2		2
CO2		2	2	2	1	1	
CO3	3				2	2	2
CO4	3					2	
CO5		2	2	2	2	2	1
Total	**2**	**1**	**1**	**1**	**2**	**2**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
III	**YEN301C**	**Membrane Separation for Water and Wastewater**	**3**	**0**	**0**	**3**

Course Outcome: After the completion of the course, students will be able to

CO1 Differentiate various membrane processes, principles, separation mechanisms and its applications

CO2 Explain the selection criteria for different membrane processes

CO3 Design membrane bioreactors

CO4 Develop synthetic membranes by various preparation techniques

CO5 Recommend the pollution control methods for specific industries

COURSE CONTENT

UNIT I MEMBRANE FILTRATION PROCESSES 10

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

UNIT II MEMBRANE SYSTEMS 10

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

UNIT III MEMBRANE BIOREACTORS 9

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

UNIT IV PRETREATMENT SYSTEMS 8

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

UNIT V CASE STUDIES 8

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

TEXT BOOKS

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. Symon Jud, MBR Book – "Principles and application of MBR in water and wastewater treatment", Elservier, 2006.

3. Yamamoto K. and Urase T, "Membrane Technology in Environmental management", special issue, Water Science and technology, Vol.41, IWA Publishing, 2000.

REFERENCES

1. Jorgen Wagner, "Membrane Filtration handbook, Practical Tips and Hints, 2nd Edition, Revision2, Osmonics Inc., 2001.

2. 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", Elservier,Netherlands,1995.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2				
CO2	3	2	1	2			
CO3		2	3	2	2	1	1
CO4		2	1	1	1	2	2
CO5		3			3	2	1
Total	**2**	**3**	**2**	**1**	**2**	**1**	**1**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	**YRM107**	**Research Methodology and IPR**	**2**	**0**	**0**	**2**

Course Outcome: After the completion of the course, students will be able to

CO1	Understand the Characteristics of a research problem	Cognitive	Understanding
CO2	Carryout Effective literature studies	Affective	Applying
CO3	Gain knowledge on Nature of Intellectual Property	Cognitive	Understanding
CO4	Understand the Patent Rights and Licensing	Cognitive	Understanding
CO5	Understand the New Developments in IPR	Cognitive	Understanding

UNIT I **6**

Meaning of research problem, Sources of research problem, Criteria-Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II **6**

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT III **6**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT IV **6**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT V **6**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

LECTURE	TUTORIAL	TOTAL
30	0	30

REFERENCES

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
5. Mayall, “Industrial Design”, McGraw Hill, 1992.
6. Niebel, “Product Design”, McGraw Hill, 1974.
7. Asimov, “Introduction to Design”, Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.
9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2		1	3		2	2
CO2	3					3	3
CO3	2	2					1
CO4			2	2	3	3	
CO5	2			3	3	3	2
Total	**2**	**1**	**1**	**2**	**2**	**3**	**2**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	**YEGOE1**	**English for Research Paper Writing**	**2**	**0**	**0**	**0**

Course Outcome: After the completion of the course, students will be able to			
CO1	Understand Structuring Paragraphs and Sentences	Cognitive	Understanding
CO2	Understand the Paraphrasing and Plagiarism	Cognitive	Understanding
CO3	Carry out the Review of the Literature	Affective	Organisation
CO4	Gain knowledge on key skills writing an Introduction and Literature review	Cognitive	Understanding
CO5	Understand the Key skills for writing the results and conclusion	Cognitive	Understanding

COURSE CONTENT

UNIT I **6**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and vagueness

UNIT II **6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT III **6**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV **6**

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

UNIT V **6**

skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2	2	1	3		2	2
CO2	3		2			3	3
CO3	2	2			2		1
CO4		1	2	2	3	3	
CO5	2	1		3	3	3	2
Total	**3**	**2**	**1**	**2**	**2**	**3**	**2**

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High

Semester	Course Code	Course Name	L	T	P	C
I	YPSOE1	Constitution of India	2	0	0	0

Course Outcome: After the completion of the course, students will be able to

CO1	**To Study** History of Constitution	Cognitive	Understanding
CO2	**To Explain** the Union Executive	Cognitive	Remembering
CO3	**To Identify** the concept of Union Legislature	Cognitive	Applying
CO4	**To Analysis** the Union Judiciary	Cognitive	Analyzing
CO5	**To Explain** the Centre State Relation	Cognitive	Evaluating

COURSE CONTENT

UNIT I **6**

Constitutional History- The Constitutional Rights- Preamble- Fundamental Rights- Fundamental Duties- Directive principles of State Policy.

UNIT II **6**

The Union Executive- The President of India (powers and functions)- Vice-President of India- The Council of Ministers-Prime Minister- Powers and Functions.

UNIT III **6**

Union Legislature- Structure and Functions of Lok Sabha- Structure and Functions of Rajya Sabha- Legislative Procedure in India- Important Committes of Lok Sabha- Speaker of the Lok Sabha.

UNIT IV **6**

The Union Judiciary- Powers of the Supreme Court- Original Jurisdiction- Appelete jurisdictions- Advisory Jurisdiction- Judicial review.

UNIT V **6**

Centre State relations- Political Parties- Role of governor, powers and functions of Chief Minister-Legislative Assembly- State Judiciary- Powers and Functions of the High Courts.

REFERENCES

1. W.H.Morris Shores- Government and politics of India, NewDelhi,B.1.Publishers,1974.
2. M.V.Pylee- Constitutional Government in India, Bombay, Asia Publishing House,1977.
3. R.Thanker- The Government and politics of India, London: Macmillon, 1995.
4. A.C.Kapur- Select Constitutions S,Chand & Co.,NewDelhi, 1995

5. V.D.Mahajan- Select Modern Governments, S,Chand &Co, NewDelhi,1995.
6. B.C.Rout- Democractic Constitution of India.
7. Gopal K.Puri- Constitution of India, India 2005.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2			1			
CO2	2			1			
CO3	2			1			
CO4	2			1			
CO5	2	2		1			
Total	**2**	**1**		**1**			

Note:	**Total**	0	1-5	6-10	11-15
	Scaled value	0	1	2	3
	Relation	No	Low	Medium	High