ME (Environmental Engineering)
Curriculum Structure and Syllabus

DEPARTMENT OF CIVIL ENGINEERING

PEC UNIVERSITY OF TECHNOLOGY, CHANDIGARH

PG – Curriculum Structure as approved by Senate

Course/ Credits Distribution of ME (Environmental Engineering)

Sr. No.	Courses	Credit Structure	
		No. of Courses	Credits
1	Program Core	04	12 (3 each)
2	Open core	02	06 (3 each)
3	Program Elective	03	09 (3 each)
4	Open Elective	01	03
5	Program Lab	02	04 (2 each)
6	Case Histories and industry Experiences	01	01
7	Seminar and Technical Writing	01	01
8	Project/ Industry based Project	02	12+18=30
Total Credits			66

Program Core

Course Code	Course Name	L T P	Credits
CEN-561	Program Core-I **(**Environmental Chemistry & Microbiology**)**	3-0-0	3
CEN -562	Program Core-II **(**Physico-Chemical Processes in Environmental Engineering**)**	3-0-0	3
CEN -564	Program Core-III Biological Processes - Design for Wastewater Treatment	3-0-0	3
CEN -586	Program Core-IV Air & Noise Pollution & Control	3-0-0	3
Total			**12**

Open core

Course Code	Course Name	L T P	Credits
CEN-599	Open Core I: Numerical Methods and Optimization Techniques	3-0-0	3
ENN-505	Open core-II : Design of Experiments and Research Methodology	3-0-0	3
Total			**06**

Program Elective-I (Any One)

Course Code	Course Name	L T P	Credits
CEN – 565	Solid & Hazardous Waste Management	3-0-0	3
CEN – 572	Ecological & Ecosystem Engineering	3-0-0	3
CEN - 573	Environmental Geo-technology	3-0-0	3
CEN - 575	Environmental Biotechnology	3-0-0	3
CEN – 577	Environmental Hydraulics & Hydrology	3-0-0	3
CEN – 583	Principles & Design of Water Supply & Treatment Systems	3-0-0	3
CEN – 591	Remote Sensing & GIS in Engineering	3-0-0	3
Total			**03**

Program Elective-II (Any One)

Course Code	Course Name	L T P	Credits
CEN – 569	Environmental Systems Analysis	3-0-0	3
CEN - 570	Environmental Impact Assessment	3-0-0	3
CEN – 576	Surface & Ground water Modelling	3-0-0	3
CEN - 578	Life Cycle Analysis	3-0-0	3
CEN – 582	Fate & Transport of Contaminants in Natural Systems	3-0-0	3
CEN - 585	Environmental Impact of Disaster & Management	3-0-0	3
CEN – 588	Energy Systems & Environment	3-0-0	3
Total			**03**

Program Elective-III (Any One)

Course Code	Course Name	L T P	Credits
CEN – 568	Industrial Waste Management	3-0-0	3
CEN - 574	Indoor Air Quality	3-0-0	3
CEN – 579	Rural Water Supply & Environmental Sanitation	3-0-0	3
CEN - 580	Climate Change & Sustainable Development	3-0-0	3
CEN - 584	Environmental System Modeling	3-0-0	3
Total			**03**

Program Elective I, II & III Total	**09**

Open Elective

Course Code	Course Name	L T P	Credits
CEN - 570	Environmental Impact Assessment	3-0-0	3
CEN - 581	Clean Technology	3-0-0	3
	Total		**03**

Program Lab

Course Code	Course Name	L T P	Credits
CEN-566P	Program Lab – I (Environmental Engineering Lab I)	0-0-3	2
CEN-567P	Program Lab - II (Environmental Engineering Lab II)	0-0-3	2
Total			**04**

Case Histories and Industry Experiences

Course Code	Course Name	L T P	Credits
CEN-601	Case Histories and industry Experiences	0-0-2	01
Total			**01**

Seminar and Technical Writing

Course Code	Course Name	L T P	Credits
CEN-602	Seminar and Technical Writing	0-0-2	01
Total			**01**

Project/ Industry based Project

Course Code	Course Name	L T P	Credits
CEN- 698	Project/ Industry based Project -I	0-0-24	12
CEN -699	Project/ Industry-based Project -II	0-0-36	18
Total			**30**

CONSOLIDATED SCHEME-ME Environmental Engineering												
Sem							**Lecture Course**	**L**	**T**	**P**	**Weekly Contact**	**Credits**
I	Program Core -I Environmental Chemistry & Microbiology **CEN- 561 (LTP: 3 0 0)**	Program core-II Physico-Chemical Processes in Environmental Engineering**: CEN-562 (LTP: 3 0 0)**	(Open core I) Numerical Methods and Optimization Techniques**: CEN-599 (LTP: 3 0 0)**	Program Elective I **(see list of Electives) (LTP: 3 0 0)**	Program Elective II **(see list of Electives) (LTP: 3 0 0)**	Program Lab I Environmental Engineering **Lab I CEN-566P (LTP: 0 0 3)**	5	15	0	3	18	17
II	(Open Core II) Design of Experiments & Research Methodology : **ENN- 505 LTP: 3 0 0)**	Program Core-III Biological Processes - Design for Wastewater Treatment **CEN-564(LTP: 3 0 0)**	Program Core-IV Air & Noise Pollution & Control **CEN-586 (LTP: 3 0 0)**	Program Elective III **(see list of Electives) (LTP: 3 0 0)**	Open Elective **(LTP: 3 0 0)**	Program Lab II Environmental Engineering Lab II **CEN-567P (LTP: 0 0 3)**	5	15	0	3	18	17
III	Case Histories and Industry Experiences **:CEN- 601 (LTP: 0 0 2)**	Seminar & Technical Writing : **CEN -602 (LTP: 0 0 2)**	Project/ Industry Based Project -I :**CEN-698 (LTP: 0 0 24)**	-	-	-	-	0	0	28	28	14
IV	Project/ Industry Based Project-II: **CEN-699 (LTP: 0 0 36)**	-	-	-	-	-	-	0	0	0	36	18

PG – Curriculum Structure

M.E. (Environmental Engineering)

1st SEMESTER

Sr. No.	Course Code	Course of Study	L	T	P	C
1	CEN – 561	Program Core - I (Environmental Chemistry & Microbiology)	3	0	0	3
2	CEN – 562	Program Core - II (Physico-Chemical Processes in Environmental Engineering)	3	0	0	3
3	CEN – 599	Open Core - I (Numerical Methods & Optimization Techniques)	3	0	0	3
4		Program Elective – I	3	0	0	3
5		Program Elective – II	3	0	0	3
6	CEN – 566 P	Program Lab - I (Environmental Engineering Lab I)	0	0	3	2
		Total	**15**	**0**	**3**	**17**

2nd SEMESTER

Sr. No.	Course Code	Course of Study	L	T	P	C
1	CEN – 564	Program Core - III (Biological Processes - Design for Wastewater Treatment)	3	0	0	3
2	CEN - 586	Program core - IV (Air & Noise Pollution & Control)	3	0	0	3
3	ENN – 505	Open core – II (Design of Experiment & Research Methodology)	3	0	0	3
4		Program Elective – III	3	0	0	3
5		Open Elective	3	0	0	3
6	CEN – 567 P	Program Lab - II (Environmental Engineering Lab II)	0	0	3	2
		Total	**15**	**0**	**3**	**17**

3rd SEMESTER

Sr. No.	Course code	Course of Study	L	T	P	C
1	CEN – 601	Case Histories & Industrial Experiences	0	0	2	1
2	CEN – 602	Seminar & Technical Writing	0	0	2	1
3	CEN – 698	Project/ Industry based Project – I	0	0	24	12
		Total	**0**	**0**	**28**	**14**

4th SEMESTER

Sr. No.	Course code	Course of Study	L	T	P	C
1	CEN – 699	Project/ Industry based Project – II	0	0	32	18
		Total	**0**	**0**	**32**	**18**

List of Electives

Program Elective-I (Any One)

Course Code	Course Name	L T P	Credits
CEN – 583	Principles & Design of Water Supply & Treatment Systems	3-0-0	3
CEN – 565	Solid & Hazardous Waste Management	3-0-0	3
CEN – 591	Remote Sensing & GIS in Engineering	3-0-0	3
CEN – 572	Ecological & Ecosystem Engineering	3-0-0	3
CEN – 577	Environmental Hydraulics & Hydrology	3-0-0	3
CEN - 573	Environmental Geo-technology	3-0-0	3
CEN - 575	Environmental Biotechnology	3-0-0	3
Total			**03**

Program Elective-II (Any One)

Course Code	Course Name	L T P	Credits
CEN – 570	Environmental Impact Assessment	3-0-0	3
CEN – 582	Fate & Transport of Contaminants in Natural Systems	3-0-0	3
CEN – 569	Environmental Systems Analysis	3-0-0	3
CEN – 576	Surface & Ground water modeling	3-0-0	3
CEN – 588	Energy System & Environment	3-0-0	3
CEN – 578	Life Cycle Analysis	3-0-0	3
CEN – 585	Environmental Impact of Disaster & Management	3-0-0	3
Total			**03**

Program Elective-III (Any One)

Course Code	Course Name	L T P	Credits
CEN – 579	Rural Water Supply & Environmental Sanitation	3-0-0	3
CEN – 568	Industrial Wastewater Management	3-0-0	3
CEN – 584	Environmental System Modeling	3-0-0	3
CEN – 580	Climate Change & Sustainable Development	3-0-0	3
CEN – 574	Indoor Air Quality	3-0-0	3
Total			**03**
Program Elective Total		**9-0-0**	**09**

SEMESTER I

Course Name	**:**	**Environmental Chemistry and Microbiology**
Course Code	**:**	**CEN - 561**
Credits	**:**	**3**
L T P	**:**	**3 0 0**
Course Objectives:		
• To familiarize the students with the chemical and biological principles as applied to Environmental Engineering. • To apply these concepts to Water and Wastewater Treatment and Pollution Control.		

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	**Introduction** Importance of Chemistry and Microbiology in Env. Engg; The related uses and applications.	2
2	**Chemical equations** Types, solutions, activity and activity coefficients, chemical equilibria, chemical thermodynamics.	4
3	**Acid base equilibria** Equilibrium diagrams, carbonic acid system, buffering, Solubility Equilibria, effect of other solutes on salt solubility, removal of heavy metals.	8
4	**Oxidation reduction equilibria** Electrochemistry and electrochemical cells, stability diagrams measuring redox potentials.	6
5	**Water stabilization** Water softening and water conditioning, chemical precipitation, ion exchange.	2
6	Basics of quantitative chemistry, analytical methods, instrumentation: Organic pollution: BOD, COD, TOC.	4
7	**Microbiology** Classification, identification, Taxonomy, Reproduction and growth, cultures & characteristics, Enzymes, Microbial metabolism - energy production, biosynthesis, Mixed and pure culture, Growth rate; Application.	8
8	Fungi, Bacteria, molds and yeast, algae, protozoa, viruses. Control of microorganisms.	4
9	Microbiology of domestic water and wastewater, industrial microbiology. Epidemiology of infectious diseases, microbial agents of diseases.	4

Course Outcomes:
The student is able to apply the principles of Chemistry and Microbiology in Environmental Engg. practice. Analyze and interpret the Environmental Engg. systems from chemistry and microbiological point of view.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Chemistry for Environmental Engineering, Sawyer C.N., McCarty P.L., McGraw Hill Book Company, New York	2002
2	Microbiology – Concepts and applications, Pelczar M.J., McGraw Hill Book Company, New York,6th edition	1993
3	Process Chemistry for water and wastewater treatment: Benefield L.D., Judkins J.F., Weand B.L., Prentice-Hall Inc.	1982
4	Microbiology for Environmental Scientists and Engineers, Gaudy Jr. A.F. and Gaudy E.T., McGraw Hill Book Company, New York	1980
5	Standard Methods for the Examination of water and wastewater: APHA, WPCF	2005

Course Name	**:**	**Physico-Chemical Processes in Environmental Engg**
Course Code	**:**	**CEN - 562**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To introduce the concept of water quality.
- To understand the various physico-chemical unit processes and operations as applied to water and wastewater systems.

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	**Water quality** Physical, chemical and biological parameters of water- Water Quality requirement - Potable water standards -Wastewater Effluent standards -Water quality indices.	10
2	**Water purification systems in natural systems** Physical processes-chemical processes and biological processes - Primary, Secondary and tertiary treatment-Unit operations – unit processes.	8
3	**Sedimentation Types** Mixing, Clarification, Sedimentation, Types; Tube & Plate Settlers, Aeration& gas transfer; Coagulation & flocculation, coagulation processes, stability of colloids, destabilization of colloids, transport of colloidal particles, Clariflocculation.	8
4	**Filtration** Theory of granular media filtration; Classification of filters; slow sand filter and rapid sand filter; mechanism of filtration; modes of operation and operational problems; negative head and air binding; dual and multimedia filtration.	8
5	**Adsorption, adsorption equilibria** Adsorption, adsorption equilibria - adsorption isotherms, Disinfection - chlorine dioxide; chloramines; ozonation; UV radiation Ion Exchange-processes, Application Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodialysis.	8

Course Outcomes:

- The student will be able to appreciate and apply the concept of water quality.
- The student shall be capable of designing various physico-chemical unit processes and operations to achieve the desired water quality in water and wastewater systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Introduction to Environmental Engineering and Science, Masters G.M., Prentice Hall	2007
2	Environmental Engineering, Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, McGraw Hill Publishing	1985
3	Physicochemical Processes for Water Quality Control, Weber Jr. W.J., John Wiley & sons Inc.	1972
4.	I.S. 10500: 2012, Drinking Water Standards	2012

Course Name	**:**	**Numerical Methods & Optimization Techniques**
Course Code	**:**	**CEN - 599**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To understand the concept of optimization and its applications in civil engineering projects, and to learn the concept of relevant mathematical tools.

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
	RDBMS Civil Engg. Software Packages	6
2	Fundamentals of Optimization, Statistical Optimization	6
3	Linear Programming, Dynamic Programming.	7
4	Finite Difference Methods , Taylor's Series, fourier series	7
5	Different Implicit & Explicit Schemes such as Maccormack Scheme, Lambda Scheme, Preissmann Scheme etc.	8
6	Stability Analysis, Boundary Conditions, algebra of tensors.	8

Course Outcomes:

- Students will be able to make use of the software packages and their applications in solving the civil engineering project problems.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Software Engg, Roger Pressman, Mcgraw hill publishing, 7th ed.,2014	2014
2	Operations Research, D.S.Hira & P .K. Gupta ,S Chand Publishers, 6th ed., 2007	2007
3	Optimization Theory & Applications, S.S. Rao, Wiley Eastern Ltd., 1979	1979

Course Name	**:**	**Environmental Engineering Lab I**
Course Code	**:**	**CEN – 566 P**
Credits	**:**	**2**
L T P	**:**	**0 0 3**

Course Objectives:

To provide a hands on experience in environmental quality monitoring of Water and wastewater systems.

- To understand the concepts of Water quality and Waste water characteristics.
- To analyze the various parameters of water quality and Waste water characteristics.
- To interpret the result in comparison with public health considerations and standards.

The course instructor shall design a minimum of 10 practicals covering the various aspects of Analysis of Water and Wastewater; Microbial Techniques.

- Instrumental Principles & Techniques; Coagulation; Softening; Filtration; Kinetics Studies.
- Noise pollution and sound level measurement

The course shall contain at least one term project on real life problem identified

Experimental determination of water and wasterwater quality parameters viz. BOD,COD, Heavy metal ion,Alkalinity,Acidity, Breakpoint Chlorinationetc, cogulation,Softening, Filtration

Course Outcomes:

On completion of the course, the student shall be capable of making measurements and interpretation of

a) Water Pollution
b) Microbial quality of water and interpretation

The student shall be able to understand the kinetics of unit processes and operations as applied to water and wastewater systems

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publishers	Year of Publication/ Reprint
1	Chemistry for Environmental Engineering, Sawyer C.N., McCarty P.L., McGraw Hill Book Company, New York	2002
2	Standard Methods for the Examination of water and wastewater: AWWA, APHA, WPCF	2012

Semester II

Course Name	Biological Processes- Design for Wastewater Treatment
Course Code	CEN – 564
Credits	3
L T P	3 0 0

Course Objectives:

- To introduce the various biological process in wastewater treatment = the design and application

S.No	Lecture wise Break Up	No.of lectures
1	**Constituents of wastewaters**- sources –significant parameter - fundamentals of process kinetics, zero order, first order, second order reactions, enzyme reactions – bio reactors- types-classification – design principles.	2
2	**Design of wastewater treatment systems**-primary, secondary and tertiary treatments	12
3	**Evaluation of bio-kinetic parameters**-activated sludge and its process – modifications, biological nitrification and denitrification.	4
4	**Aeration** -fundamentals of gas transfer - attached growth biological treatment systems trickling filters-rotating biological contactors - activated biofilters.	8
5	**Waste stabilization ponds and lagoons -** aerobic pond, facultative pond, anaerobic ponds- polishing ponds, aerated lagoons.	8
6	**Anaerobic processes-** process fundamentals-standard, high rate and hybrid reactors, anaerobic filters-expanded/fluidized bed reactors - upflow anaerobic sludge blanket reactors, expanded granular bed reactors- two stage / phase anaerobic reactors, sludge digestion, sludge disposal.	8

Course Outcomes:

The student will be able to analyze and design the biological processes in wastewater treatment. He shall be able to trouble shoot the biological wastewater treatment systems

Suggested Books:

Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Process Chemistry for Water and Wastewater treatment, Benefield, L.D, Judkins, J.F and Weand, B.L Prentice-Hall, Inc. Eaglewood Cliffs, New Jersey	1982
2	Sawyer, C.N., McCarty, P.L. and Parkin, G.F. Chemistry for Environmental Engineering, Tata McGraw Hill, New Delhi	2003
3	Microbiology, Pelczar, M.J., Chan E.C.S. and Krieg, N.R. Tata McGraw Hill, New Delhi	1993

Course Name	Air and Noise Pollution & Control
Course Code	CEN – 586
Credits	3
L T P	3 0 0

Course Objectives:

- To familiarize the students with the basics of air pollution including atmospheric physics and chemistry
- To apply these concepts to Air and noise Pollution Control and Environmental Management

S. NO.	Lecture wise Break Up	No.of lectures
1	**Introduction to air pollution**– environmental engineering significance – global issues – units	2
2	**Effects of air pollution**– visibility – basic calculations Atmospheric composition – temperature profile	2
3	**Meteorology**- lapse rate – stability conditions	4
4	**Maximum mixing depth**– plume behaviour	2
5	**Dispersion**– modeling – engineering decisions – maxi ground level concentration - effective stack height	10
6	**Air pollution sampling**– Stack monitoring	2
7	**Engineered systems of AP** – particulates – gaseous pollutants, Vehicular AP – models – control measures **control**	10
8	**Air pollution control regulations – laws – Standards**	2
9	**Noise pollutionand control**	8

Course Outcomes:

1	Students shall be capable of understanding the importance of air and noise pollution. They shall be able to model the air and noise pollution and design control devices.

Suggested Books:

Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Air Pollution, Perkins H C ,McGraw Hill Book Company, New York	1974
2	Environmental Pollution Control Engineering, Rao, C S, New Age Pub. New Delhi,2nd ed	2006
3	Air Pollution, its origin and control, Wark, K and Warner, C F, Harper and Row Pub . New York,3rd ed	1997
4	Environmental Engineering, a design approach, Sincero, A P and Sincero, G A, Prentice Hall Pub. New Delhi	1995
5	Instrument Engineers Hand Book (Vol. I & II), Liptak, B G, Chilton Book Company, Philadelphia,4th ed.	2005

OPEN CORE - II

Course Name	Design of Experiments and Research Methodology
Course Code	ENN – 505
Credits	3
L T P	3 0 0
Course Objectives:	
• To introduce the fundamentals of statistical techniques, sampling techniques and data collection and their interpretation.	

S.No.	Lecture wise Break Up	No.of lectures
1	Basic principles of design of experiment, Error analysis in experiments	5
2	Concept of modeling, different types of models, random variables, random numbers, and analysis of variance	6
3	Estimation of parameters, residual analysis and model checking, sample size problem.	6
4	Different types of distributions, distribution tests, concept of stimulation, Monte Carlo simulations.	6
5	Geostatistics	5
6	Que model, Time series analysis, Fitting statistics	5
7	Research Methodology – Nature and objective of research, Research topic, Literature review, Formulation of problem, Research design, Sampling techniques, Data collection	5
8	Statistical and sensitive analysis of data, Interpretation of result and report writing.	4

Course Outcomes:	
1	Students will be able to make use of various research methodologies and its application in the relevant field of engineering.

Suggested Books:		
Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Probability and Statistics for Engineers and scientists, Walpole, Myers and Ye, Pearson Education. 9th ed	2006
2	Statistics in Research, Bernard Ostle and Richard N.Mensing, Oxford & IBH Pub Co., 3rd ed	1975
3	Hines, Montgomery, Goldsman and Borror, Probability and Statistics in Engineering, John Wiley & Sons. 4thed	2003
4	Federer, Experimental Design, Theory and applications, Oxford & IBH Pub Co	1995

Course Name	**Environmental Engineering Lab-II**
Course Code	**CEN – 567 P**
Credits	2
L T P	3 0 0

Course Objectives:

- To provide a hands on experience in environmental quality monitoring of Air, Soil and water systems

The course instructor shall design a minimum of 10 practicals covering the various aspects of:

- Air Quality Monitoring & Measurements, Soil Pollution Parameters & Measurements, Industrial Waste Water Characteristics, Absorption and Adsorption Kinetics Studies.

The course shall contain at least one term project on real life problem identified.

The course instructor shall design a minimum of 10 practicals covering the various aspects of:

- Air Quality Monitoring & Measurements, Soil Pollution Parameters & Measurements, Industrial Waste Water Characteristics, Absorption and Adsorption Kinetics Studies.

The course shall contain at least one term project on real life problem identified.

Course Outcomes:	
1	• The student shall be capable of making measurements and interpretation of (a) Air quality (b) Soil pollution (c) Industrial wastewater characteristics (d) Absorption and adsorption Kinetics

Suggested Books:

Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Standard methods for the Examination of water & wastewater: AWWA, APHA, WPCF	2012

Program Elective -I

Course Name	**:**	Solid and Hazardous Waste Management
Course Code	**:**	CEN - 565
Credits	**:**	3
L T P	**:**	3 0 0
Course Objectives:		
To have knowledge of solid waste and management.		

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	**Introduction to solid waste** Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management - Legislations on management and handling of municipal solid wastes, hazardous wastes, and biomedical wastes, Elements of integrated waste management.	5
2	**Waste characterization and analysis** Waste generation rates – Composition - Hazardous Characteristics – TCLP tests – waste sampling- Source reduction of wastes – Recycling and reuse.	7
3	**Management of solid waste** 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 - labeling and handling of hazardous wastes.	9
4	**Processing of waste** Waste processing – processing technologies – biological and chemical conversion technologies – Composting - thermal conversion technologies - energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes.	9
5	**Disposal on landfill** Disposal in landfills - site selection - design and operation of sanitary landfills- secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – landfill remediation.	12

Course Outcomes:
Students will be able to know processing and handling of solid waste in better way.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Integrated Solid Waste Management, George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, McGraw- Hill, New York, 1993.	1993
2	CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.	2000

Course Name	**:**	**Ecological and Ecosystems Engineering**
Course Code	**:**	**CEN - 572**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To familiarize the students with the basics of ecological systems and introduce them to the concept of ecological engineering
- To understand the concept and application of ecological modeling.

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	**Development and Evolution of ecosystems** Principles and concepts	2
2	**Energy flow and material cycling- productivity** classification of eco-technology- ecological engineering.	8
3	**Classification of systems** Structural and functional interactions of environmental systems- Mechanisms of steady- state maintenance in open and closed systems.	8
4	**Modeling and eco-technology** Classification of ecological models- Applications- Ecological economics- Self – organizing design and processes- Multi seeded microcosms.	8
5	**Interface coupling in the ecological systems** concepts or energy- determination of sustainable loading of ecosystems.	8
6	**Eco-sanitation** soil infiltration systems- Wetlands and ponds- Source Separation systems- Aqua cultural systems- Agro ecosystems- Detritus based Treatment for solid wastes – marine systems- Case studies.	8

Course Outcomes:

The students shall be able to apply the concept of ecological engineering in real life environmental engineering problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Ecological Engineering: Principles and Practice, Kangas, P.C and Kangas, P., Lewis Publishers, New York.	2003
2	Ecological Engineering for Wastewater Treatment, Etnier, C. and Guterstam, B., Lewis Publishers, New York.	1996
3	Basic Ecology, E .P. Odum, H.S Publication.	1983
4	Energy and Ecological Modelling, W.J Mitch, R. W. Bosserman and Klopatek JN, Elsevier Publication.	1981

Course Name	Environmental Geo-technology
Course Code	CEN - 573
Credits	3
L T P	3 0 0
Course Objectives:	
• To know the geo-techniques used in environment.	

Total No. of Lectures- 42

Sr. No.	Lecture wise Break Up	No. of lectures
1	**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.	5
2	**SOIL MINERALOGY** Soil mineralogy; significance of mineralogy in determining soil behavior; Mineralogical characterization.	6
3	**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.	8
4	**SOIL MECHANICS** Introduction to unsaturated soil mechanics; water retention property and soil- water characteristic curve; flow of water in unsaturated soil.	6
5	**WASTE & ITS TRANSPORT IN SOIL** Concepts of waste containment facilities; desirable properties of soil; contaminant transport and retention; contaminated site remediation.	8
6	**REMEDIAL TECHNIQUES** Introduction to advanced soil characterization techniques; volumetric water content; gas permeation in soil; electrical and thermal properties; pore –size distribution; contaminant analysis.	9

Course Outcomes:	
1	Better understanding of soil science and methods to preserve it.

Suggested Books		
Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Fundamentals of Soil Behavior, Mitchell J.K and Soga K., John Wiley and Sons Inc.	2012
2	Introduction to Environmental Geotechnology, Fang, H.Y., CRC press	1997
3	Geotechnical Practice for Waste Disposal, Daniel D.E, Chapman and Hall	1993
4	Clay Barrier Systems for Waste Disposal Facilities, Rowe J.R., Quigley R.K., R.M. and Booker, Chapman and Hall	1995
5	Geotechnical and Geoenvironmental Engineering Handbook, Rowe R. K, Kluwer Academic Publishers	2001
6	Geoenvironmental Engineering: Principles and Applications, Reddi L.N. And Inyang H.F, Marcel Dekker Inc	2000
7	Waste Containment Systems, Waste Stabilization And Landfills: Design and Evaluation, Sharma H. D. And Lewis S.P, John Wiley & Sons Inc	1994

Course Name	Environmental Biotechnology
Course Code	CEN - 575
Credits	3
L T P	3 0 0
Course Objectives:	
• To have knowledge of bio-techniques on environment.	

Total No. of Lectures- 42

Sr. No.	Lecture wise Break Up	No. of lectures
1	**INTRODUCTION TO ENVIRONMENTAL BIOTECHNOLOGY** Principles and concepts - usefulness to mankind.	8
2	**DEGRADATION OF POLLUTANTS** Degradation of high concentrated toxic pollutants- halogenated, non-halogenated, petroleum hydrocarbons, metals - Mechanisms of detoxification – oxidation - dehalogenation - biotransformation of metals - biodegradation of solid wastes.	10
3	**BIOTECHNOLOGY REMEDIES** Biotechnological remedies for environmental pollution - decontamination of groundwater – bioremediation - Production of proteins – bio-fertilizers - Physical, chemical and Microbiological factors of composting – health risk – pathogens – odor management – Microbial cell/enzyme technology – adapted microorganisms – biological removal of Nutrients – algal biotechnology– extra cellular polymers - Biogas technology, Concept of rDNA technology – expression vectors – cloning of DNA – mutation – construction of microbial strains - radioactive probes - protoplast fusion technology – applications.	15
4	**IMPACT ON ENVIRONMENT** Environmental effects and ethics of microbial technology – genetically engineered organisms- Microbial containment-Risk assessment.	9

Course Outcomes:
To know the importance of biological techniques and application of them.

Suggested Books:		
Sr. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Biological Degradation and Bioremediation of Toxic Chemicals, Chaudhry G.R., Dioscorides Press	1994
2	Biological Degradation of Wastes, Martin A.M, Elsevier Applied Science	1991
3	Soil Microbiology Ecology, Blaine Metting F (Jr.), Marcel Dekker Inc	1993

Course Name	**:**	**Environmental Hydraulics & Hydrology**
Course Code	**:**	**CEN - 577**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To familiarize the students with the basics of hydrology and introduce them to the concept of hydraulics
- To understand the concept and application of hydrology modeling.

Total No. of Lectures- 42

Lecture wise Break Up No. of Lectures		
1	Uniform and Non-uniform flow in channels and sewers	12
2	Hydrologic cycle and its interaction with human activity	9
3	Atmospheric and subsurface water, Surface water	10
4	Hydrologic analysis, Hydrologic statistics.	11

Course Outcomes:

The students shall be able to apply the concept of hydrology in real life environmental engineering problems.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Environmental Hydraulics of Open Channel Flows, Chanson H., Butterworth-Heinemann.	2004
2	Applied Hydrology, Chow, V.T., Maidment, D.R. and Mays, L.W., McGraw Hill Inc.	2010
3	Open Channel Hydraulics, Chow, V.T., McGraw Hill Inc.	1979

Course Name	Principles and Design of Water Supply And Treatment System
Course Code	CEN – 583
Credits	3
L T P	3 0 0
Course Objectives:	
• To understand the process and designing of water supply and treatment system.	

Total No. of Lectures- 42

Sr. No.	Lecture wise Break Up	No. of lectures
1	**INTRODUCTION** Definition and Concepts: Water sources, philosophy of water treatment, review of water quality characteristics and potable and industrial waste standard unit operations, unit processes	5
2	**WATER SUPPLY** Theory and design of water supply systems; Estimation of water quantity, Review of flow in pipes and open channel flow, Review of pump characteristics.	10
3	**DISTRIBUTION NETWORK** Design of water distribution networks	8
4	**WATER TREATMENT TECHNIQUES** Theory and design of conventional unit operations used in water treatment; Sedimentation, Floatation, Coagulation, Flocculation, Filtration And Disinfection Process; Theory and design of advanced unit operation used in water treatment; Membrane Process , Ion Exchange , Aeration/Stripping, Precipitation, Adsorption, Oxidation-Reduction And Advanced Oxidation Processes.	12
5	**TREATMENT PLANT DESIGNING** Water Treatment Plant Design; selection of raw water source, Planning and Sitting of Water Treatment Plant; Hydraulics of Water Treatment Plant, Chemical Requirement and Residuals Management.	7

Course Outcomes:
Students should be able to implement their knowledge into designing of the treatment plant.

Suggested Books:		
Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Water Works Engineering, Qasim S.R., PHI, New Delhi	2000
2	Environmental Engineering, Peavy H.S., Rowe D.R. and Tchobanoglous G., Tata Mcgraw Hill	1985

Course Name	**:**	**Remote sensing and GIS in Engineering**
Course Code	**:**	**CEN - 591**
Credits	**:**	**3**
L T P	**:**	**3 0 0**
Course Objectives:		
• To learn the basics of remote sensing and GIS. To know the application of remote sensing & GIS in various fields.		

Total No. of Lectures- 42

Lecture wise Break Up No. of Lectures		
1	Basic concepts of remote sensing	3
2	Data acquisition	5
3	Digital image processing, Restoration, Enhancement, Segmentation: Segmentation feature extraction, Clustering edge detection	7
4	Introduction to microwave remote sensing and GPS	7
5	Software's in GIS	12
6	Application to water resources and Land use.	8

Course Outcomes:
To apply the remote sensing & GIS methods in real life problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Understanding GPS; Principles and Application., E.D. Kaplan, 2nd ed.	2005
2	Remote Sensing and image Interpretation, Lillesand, T.M. and Kiefer, R.W., John Wiley and Sons.	2008
3	Remote Sensing and Photogrammetry – Principles and Applications, M. L. &Chouhan, T.S., VigyanPrakashan.	1998

Program Elective –II

Course Name	**:**	**Environmental Systems Analysis**
Course Code	**:**	**CEN – 569**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To learn about analytical & design methods for environmental systems.
- To study various optimization models for environmental systems.
- To study various stochastic models for environmental systems.

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	**System Engineering** Analysis - Design- Synthesis – applications to environmental engineering Systems.	8
2	**Role of optimization models** Deterministic models/ linear programming, Dynamics programming, Separable and Nonlinear program models. Formulation of objective functions and constraints for environmental engineering planning and design.	16
3	**Probabilistic models** Fuzzy models – Simulation models.	10
4	**Modern tools** Experts - Neural Networks – Genetic Algorithm- Case studies.	8

Course Outcomes:

- Knowledge of analytical & design methods for environmental systems.
- Knowledge of optimization models for environmental systems.
- Knowledge of stochastic models for environmental systems.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Environmental System Engineering, Rich L.G., McGraw Hill.	1973
2	System Analysis & Water Quality Management, Thomann R.V., McGraw Hill.	1978

Course Name	**:**	**Environmental Impact Assessment**
Course Code	**:**	**CEN - 570**
Credits	**:**	**3**
L T P	**:**	**3 0 0**
Course Objectives:		
To learn the concept and methodology of EIA and its documentation.		

Total No. of Lectures- 42

Sr. No.	**Lecture wise Break Up**	**No. of Lectures**
1	**Evolution of EIA** Concepts – Methodologies – Screening- Scoping- Base line studies- Mitigation – Matrices - Check List.	5
2	**Rapid and comprehensive EIA** Legislative and Environmental Clearance procedures in India- Predication tools for EIA.	7
3	**Assessment of impacts** Air – Water – Soil- Noise- Biological.	6
4	**Socio Cultural Environment** Public participation- resettlement and rehabilitation.	6
5	**Documentation of EIA** Environmental management Plan- Post Project monitoring- Environmental Audit- Life cycle Assessment – EMS – case studies in EIA.	18

Course Outcomes:
Knowledge about EIA tools & methodologies, auditing and documentation of EIA.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Environmental Impact Assessment, Canter R.L., McGraw Hill International Edition.	1997
2	Environmental Impact Analysis Handbook, Rau J.G. and Wooten D.C. (Ed), McGraw Hill Book Company.	1980

Course Name	**:**	**Surface and Groundwater Modeling**
Course Code	**:**	**CEN – 576**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To learn about surface water hydrology.
- To learn about groundwater- occurrence and movement.
- To study well designing.

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	**Land Processes** Subsurface and Channel Processes- Precipitation – Rain gauge network, Abstractions, Infiltration, Evaporation, Transpiration, Process and models	8
2	Unit Hydrograph & S curve hydrograph, Dimensionless unit hydrograph, GUIH, Watershed Model and Conceptual Models.	8
3	Occurrence and Movement of Ground water, Properties of aquifer, Groundwater flow equations, Dupuit For chheimer assumptions, Well hydraulics, Partial penetration of wells, Interference of wells, Collector wells and Infiltration galleries.	8
4	Pumping tests, Analysis for unconfined and non leaky and leaky confined aquifer and water table aquifer, Locating hydro geologic boundaries, Well design criteria.	10
5	Natural and Artificial Recharge of Ground water- Salt water intrusion, Application of Finite Difference in ground water.	8

Course Outcomes:

- Knowledge about surface water hydrology.
- Knowledge of well development.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Applied Hydrology, VenTe Chow, McGraw Hill Science Publishers	1988
2	Elementary Hydrology, Singh V., Prentice Hall	1994
3	Ground Water, Raghunath. ,McGraw Hill	2007
4	Hydraulics of Ground Water, Bear J., McGraw Hill	2007

Course Name	**Life Cycle Analysis**
Course Code	**CEN - 578**
Credits	3
L T P	3 0 0
Course Objectives:	
• To understand the analysis techniques used in LCA.	

Total No. of Lectures- 42

Sr. No.	**Lecture wise Break Up**	**No. of lectures**
1	Introduction to LCA	6
2	Inventory analysis	8
3	Impact assessment, Ecological risk and human risk, Eco-system impacts and un-certainty analysis	10
4	Applications of LCA, Case-studies of product LCA, Case studies of process LCA, Limitations of LCA	10
5	LCA project study	8

Course Outcomes:
Students will be able to use the knowledge in real life.

Suggested Books:		
Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Environmental Life Cycle Analysis, Ciambrone D.F., CRC Press	1997
2	Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards, Kluwer Academic Publishers	2004

Course Name	**:**	**Fate and Transport of Contaminants in Natural System**
Course Code	**:**	**CEN – 582**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To learn about physico-chemical and bio transformations of pollutants in natural systems.
- To study various models of predicting contaminant/ pollutant transport.

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	Introduction	2
2	Modeling of volatilization, sorption / desorption.	6
3	Chemical transformations, photochemical transformation.	6
4	Biological transformation and bioturbation.	8
5	Concepts of scale in natural system, brief review of mass, momentum and energy balance, advection, molecular diffusion, dispersion.	8
6	Modeling of rivers, lakes, large lakes, sediments, estuaries, wetlands, subsurface, flow and transport.	8
7	Finite difference and linear algebraic methods to solve the system equations. Some special models.	4

Course Outcomes:

- Understanding of the natural physico-chemical and bio transformations of pollutants.
- Knowledge of various models of predicting contaminant/ pollutant transport.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Groundwater, Freeze, R.A. and Cherry. J. A., Prentice hall.	1979
2	Physico-chemical Processes For Water Quality Control, Weber.W.J. Jr. Wiley- Interscience, NY.	1972
3	Biostatistical Analysis, Zar, J.H., Prentice Hall(4^{th} edition).	1999

Course Name	**:**	**Environmental Impact of Disaster & Management**
Course Code	**:**	**CEN – 585**
Credits	**:**	**3**
L T P	**:**	**3 0 0**
Course Objectives:		
• To understand the impact of disasters on environment.		

Total No. of Lectures- 42

Sr. No.	Lecture wise Break Up	No. of lectures
1	**INTRODUCTION TO DISASTER** Overview of disaster, major natural disasters – flood, tropical cyclone, droughts, landslides, heat waves, earthquakes, fire hazards, tsunami, etc	3
2	**BASIC ECOSYSTEM CONDITION & FACTOR CAUSING DISASTER** Basic understanding of fragile ecosystems, hydrological factors, inclement climatic conditions like thunder storm, cyclone, tsunami and flooding. Factors for disaster – climatic change and global sea rise, coastal erosion, environmental degradation, large dams and earthquakes, road building and landslides, Chemical and Biological weapons – case studies.	5
3	**DISASTER MANAGEMENT** Disaster management, mitigation, and preparedness; Management issues related to disaster; Mitigation through capacity building, legislative responsibilities of disaster management; disaster mapping, assessment, pre-disaster risk and vulnerability reduction, post disaster recovery and rehabilitation; disaster related infrastructure development. Disaster management plan, national crisis management committee, state crisis management group.	8
4	**TECHNIQUES & DESIGN FOR DISASTER** Techniques of monitoring and design against the disasters.	10
5	**DESIGN GUIDELINES** Disaster proofing construction at appropriate situation. Engineering, architectural, landscaping and planning solution for different types of calamities. Vulnerability atlas, norms, standards and practice procedures for shelter and settlement. Organizational and management aspects. Emergency water supply and sanitation.	7
6	**WATER SUPPLY PREPAREDNESS AND PROTECTION** Water supply preparedness and its protection; Emergency water supply strategy, rural and urban emergencies. Assessment of damage. Emergency water supply schemes – sources, quality, treatment, storage and distribution, operation and maintenance. Sanitation – human waste and health, strategy for excreta disposal in emergencies, techniques for excreta disposal, disposal of wastewater, management of refuse.	9

Course Outcomes:
Student will be able to know different techniques and methods for management of disasters.

Suggested Books:		
Sr. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Principles of Emergency Planning and Management, Alexander D., Oxford University Press	2002
2	Disaster Management and Preparedness, Schneid T. D. and Collins L., Boca Raton	2001
3	Introduction to Emergency Management, Hallow G. and Bullock J., Elsevier	2002
4	Disaster Management, Gosh G.K., Saujanya Books, Delhi	2007

Course Name	**:**	**Energy Systems and Environment**
Course Code	**:**	**CEN - 588**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To familiarize the students with the basics of energy systems in relation to environment
- To explore the energy conversion choices to determine viable means of reducing the environmental impact of energy conversion that are economically and politically acceptable, and technologically feasible.

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	Fundamental concepts of energy and environment	2
2	Energy sources – conventional and non - conventional	2
3	Energy generation – basics and environmental issues/impact	6
4	Non-conventional sources – options, technology and issues	10
5	Energy management – conservation, audit, modelling	6
6	Case studies	8
7	New sources and future energy problems, policies	8

Course Outcomes:

- Students shall be able to understand the interrelationship between energy and environment.
- They shall be capable of decision making with respect energy options on an environmental perspective.

Suggested Books:

Sr No	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Non-Conventional Energy Sources, Rai G D, Khanna Pub.	2011
2	Energy Management Principles, Smith, Pergamon Press	1981
3	Relevant BIS codes and Govt. of India Notifications	
4	Basic Ecology , Odum E .P., H.S Publication	1983
5	Energy and Ecological Modeling, Mitch W.J, Bosserman R.W. and Klopatik, JN Elsevier Publication	1981
6	Energy Technology and Environment Encyclopedia, Vol 1-4, Allilio Bicio, Sharon boots, John Willey and Sons Inc.	1996
7	Introduction to Chemical Engineering Thermodynamics, Smith J.M, Van Ness H.C, McGraw Hill.	2000

Program Elective –III

Course Name	**:**	**Industrial Wastewater Management**
Course Code	**:**	**CEN – 568**
Credits	**:**	**3**
L T P	**:**	**3 0 0**
Course Objectives:		
• To learn about effluent treatment methods. • To learn about essence of effluent and sludge management vis-a-vis EMS (ISO 14000)		

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	Sources and types of industrial wastewater- Environmental impacts- Regulatory requirements- generation rates- characterization – Toxicity and Bioassay tests.	6
2	Prevention vs Control of Industrial Pollution – Source reduction techniques- Waste Audit- Evaluation of pollution prevention options.	6
3	Waste minimization- Equalization- Neutralization- Oil Separation- Flotation- Precipitation—Heavy metal Removal- adsorption- Aerobic and Anaerobic biological treatment- Sequencing batch reactors- chemical oxidation - ozonation- photo catalysis- Wet Air Oxidation – Evaporation – Ion Exchange- Membrane Technologies- Nutrient removal.	14
4	Individual and Common Effluent Treatment Plants- Zero effluent discharge systems- wastewater reuse- Disposal of effluent on land- Quantification, Characteristics and disposal of sludge.	6
5	Industrial manufacturing process description, wastewater characterization, source reduction options and waste treatment flow sheet for textiles- tanneries- pulp and paper- metal finishing- Petrochemical- Pharmaceuticals- Sugar and Distilleries- food processing- fertilizers- Thermal Power Plants and Industrial Estates, ISO 14000:2003- Waste Audit.	10

Course Outcomes:
• Knowledge about treatment methods & design. • Knowledge about effluent and sludge management vis-a-vis EMS (ISO14000).

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Industrial Water Pollution Control, Eckenfelder W.W., McGraw-Hill, 1999.	1999
2	Wastewater Treatment for Pollution Control and Reuse, Arceivala S.J., Asolekar McGraw Hill.	2006
3	Industrial Waste treatment Handbook, Frank W., Butterworth Heinemann	2001

Course Name	**Indoor Air Quality**
Course Code	**CEN - 574**
Credits	3
L T P	3 0 0
Course Objectives:	
• To better know indoor air quality and its methods to maintain it.	

Total No. of Lectures- 42

Sr. No.	Lecture wise Break Up	No. of lectures
1	**Indoor activities of inhabitants** Level of pollutants in indoor and outdoor air- Design and operation of building for improvements of public health – IAQ policy issues- sustainability. Air pollutants in indoor environment- private residences - offices- schools- public building - ventilation.	7
2	**Concepts of several pollutant classes** Radon- toxic organic gases- combustion byproducts- microorganisms such as molds and infectious bacteria.	8
3	**Concepts and tools** Exposure - material balance models; statistical models.	10
4	**Indoor air pollution from outdoor sources** Particulate matter and ozone- combustion	7
5	**Byproducts** Radon and its decay products- volatile organic compounds-odors- and sick building syndrome- Humidity- bio aerosols- infectious disease transmission- special indoor environment - A/C units in indoor- Measurement methods- Control technologies – Control strategies.	10

Course Outcomes:
Students will have better understanding of air quality and will be able apply its methods in real life problems

Suggested Books:		
Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Indoor Air and Environmental Quality, Godish T., CRC press	2000
2	Environmental Engineering Science, Nazaroff W.W. and Alvarez–Cohen L., John Wiley & Sons, New York	2000

Course Name	**:**	**Rural Water Supply and Environmental Sanitation**
Course Code	**:**	**CEN – 579**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To learn about water supply in rural areas.
- To learn about environmental sanitation methods in rural areas.

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	Rural water supply schemes - treatment and remedies.	7
2	Epidemiology	7
3	Sanitation of public	8
4	Pasteurization, Industrial hygiene	
5	Occupational hazards, Radiological health	8
6	Effluent disposal, Low cost treatment systems, Biogas plants, Composting.	12

Course Outcomes:

- Knowledge about water supply scheme in rural areas.
- Knowledge about environmental sanitation methods and design in rural areas.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Municipal and Rural Sanitation, Eulers, V.M. and Steel E.W., McGraw Hill Book Company, 7th Edition.	1986
2	Text Book of Preventive and Social Medicine, Park K., Banarsidas Bhanot.	2011
3	Rural Water Supply and Sanitation, Wright F.B., E. Robert Krieger Publishing Company, Huntington, New York.	1977
4	Environmental History of Water: Global Views on Community Water Supply and Sanitation, Juuti, P., Tapio S. K., and Vuorinen H., Iwa Publishing (Intl. Water Assoc).	2007

Course Name	**:**	**Climate Change and Sustainable Development**
Course Code	**:**	**CEN – 580**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:

- To understand the climate system and anthropogenic effects.
- To study various models of predicting climate change.
- To emphasize upon climate protection for sustainable development.

Total No. of Lectures- 42

Lecture wise Break Up		**No. of Lectures**
1	Climate system	4
2	Human impacts on the climate	8
3	Modeling-interpretation and prediction of climate, Long term climate monitoring, Concepts of climate change, Potential causes of climate change, Integrated approach and sectoral approach, Climate change regimes	22
4	Sustainable development, Climate protection pathways of development	8

Course Outcomes:

- Understanding of the climate system and anthropogenic effects.
- Understanding of monitoring and modeling of predicting climate change.
- Understanding of climate protection strategies for sustainable development.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Climate Change and Sustainable Development: Prospects for Developing Countries, Anil Markandya, Routledge.	2002
2	Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty, Heal, G. M., Kluwer Academic Publ.	1998
3	Climate Change Policy - Facts, Issues and Analysis, Jepma, C.J., and Munasinghe, M., Cambridge University Press.	1998

Course Name	**Environmental Systems Modeling**
Course Code	**CEN – 584**
Credits	3
L T P	3 0 0
Course Objectives:	
• To understand the concept of environmental systems and their modeling; and to learn different techniques used in modeling.	

Total No. of Lectures- 42

	Lecture wise Break Up	**No. of lectures**
1	Mathematical modeling and simulation, Defining systems and its components, Types of models and their applications.	6
2	Models for Fate and Transport of Contaminants	5
3	Modeling of volatilization, chemical transformations, sorption/desorption, photochemical transformations, biological transformations. Brief review of mass, momentum and energy balance, advection, molecular diffusion, dispersion, their application in modeling of rivers, lakes, sediments, wetlands, subsurface flow and transport, air pollution modeling.	9
4	Introduction to Soft Computing Techniques-Fuzzy set theory and logic, Fuzzy MCDM and FRBS, simple applications in environmental engineering. Neural networks and Genetic Algorithms.	12
5	Introduction to GIS, concepts and data base structure, introduction to GIS software GIS Applications in Environmental Engineering. Introduction to Remote Sensing & its Applications in Environmental Engineering.	10

Course Outcomes:	
1	Students will be able to make use of the software packages and its application in civil engineering projects

Suggested Books:		
Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Integrated Environmental Modeling - Pollutant Transport, Fate and Risk in the Environment, Ramaswami A., Milford J.B., Small M. J., John Wiley & Sons	2005
2	Principles of Geographical Information Systems, Burrough P.A. and McDonnell, R.A., Oxford University Press	1998
3	Dynamics of Environmental Bioprocesses Modeling and Simulation Snape J.B., Dunn I.J., Ingham J and Prenosil J.E., VCH, Weinheim	1995
4	Activated Sludge Models ASM1, ASM2, ASM2d and ASM3, Henze M., IWA Publ.	2000
5	Surface Water Quality Modeling, Chapra S.C., McGraw-Hill Inc.	1997

OPEN ELECTIVE

Course Name	**:**	**Environmental Impact Assessment**
Course Code	**:**	**CEN - 570**
Credits	**:**	**3**
L T P	**:**	**3 0 0**
Course Objectives:		
To learn the concept and methodology of EIA and its documentation.		

Total No. of Lectures- 42

Sr. No.	**Lecture wise Break Up**	**No. of Lectures**
1	**Evolution of EIA** Concepts – Methodologies – Screening- Scoping- Base line studies- Mitigation – Matrices - Check List.	5
2	**Rapid and comprehensive EIA** Legislative and Environmental Clearance procedures in India- Predication tools for EIA.	7
3	**Assessment of impacts** Air – Water – Soil- Noise- Biological.	6
4	**Socio Cultural Environment** Public participation- resettlement and rehabilitation.	6
5	**Documentation of EIA** Environmental management Plan- Post Project monitoring- Environmental Audit- Life cycle Assessment – EMS – case studies in EIA.	18

Course Outcomes:
Knowledge about EIA tools & methodologies, auditing and documentation of EIA.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Environmental Impact Assessment, Canter R.L., McGraw Hill International Edition.	1997
2	Environmental Impact Analysis Handbook, John G. Rau and David C. Wooten (Ed), McGraw Hill Book Company.	1980

Course Name	Clean Technology
Course Code	CEN – 581
Credits	3
L T P	3 0 0
Course Objectives:	
• To understand the processes and technologies to keep environment clean.	

Total No. of Lectures- 42

Sr. No.	Lecture wise Break Up	No. of lectures
1	**Introduction to society and its problem** Industrial Society, Resource Limitations, Environmental Problems.	3
2	**Development and its processes** Sustainable Development, Thermodynamics	5
3	**Energy system** Global Energy Situation, Energy System, Net Energy Analysis, Energy Saving, Energy Storage	8
4	**Engineering chemistry** Engineering Separation, Process Development, Photochemistry, Thermo-Chemistry	10
5	**Wastes** Waste, Industrial Waste, Hazardous Waste	7
6	**Eco- friendly technologies** System Analysis, Flexible Processes, Materials & products eco-design, Material Recycling, Biodegradable Materials.	9

Course Outcomes:
Student will be should be able to grasp the knowledge of different technologies used to maintain clean environment.

Suggested Books:		
Sr. No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	Clean Technology, Johansson A., CRC Press	1992
2	Green Energy Technology, Economics and Policy, Aswathanarayana U., Harikrishnan T., and Kadher-Mohien S. T., CRC Press	2012
3	Pollution Prevention Handbook, Bernard Ganne and YvelineLecler, CRC Press	2002