PG-Curriculum

(Structure and Course Contents)

Environmental Engineering

With effect from July 2022(22231 onwards)

EXPLORE INNOVATE EXCEL

Civil Engineering Department

Punjab Engineering College

(Deemed to be University)

Chandigarh

Proposed Semester Wise PG Scheme to be implemented w.e.f. 2022-23 session

Semester I		
S.No.	**Courses**	**Credits**
1	**Engineering Mathematics**	**3**
2	**PCC-I**	**3**
3	**PCC-II**	**3**
4	**PCC-III**	**3**
5	**PEC-I**	**3**
6	**Soft-Computing/Soft Skills and Management**	**3**
	Total	**18**

Semester II		
S.No.	**Courses**	**Credits**
1	**PCC-IV**	**3**
2	**PCC-V**	**3**
3	**PCC-VI**	**3**
4	**PEC-II**	**3**
5	**Open Elective-I**	**3**
6	**Industrial Tour**	**0**
7	**Design of Experiments and Research Methodology**	**3**
	Total	**18**

Semester III		
S.No.	**Courses**	**Credits**
1	**Seminar and Report Writing**	**2**
2	**Research and Publication Ethics**	**2**
3	**Dissertation-I**	**14**
	Total	**18**

Semester IV		
S. No.	**Courses**	**Credits**
1	**Dissertation-II**	**18**
	Total	**18**

Total Credits = 18 + 18 + 18 + 18 = 72

PG Curriculum Structure

Sr. No.	Course Stream	Course Name (Course Code)	Credits
Semester I			
1	Engineering Mathematics	Engineering Mathematics	3
2	Program Core Course (PCC-I)	Physico-Chemical Processes in Water & Wastewater Engineering (ENR-1101)	3
3	Program Core Course (PCC-II)	Environmental Chemistry & Microbiology (ENR-1102)	3
4	Program Core Course (PCC-III)	Solid & Hazardous waste management (ENR-1103)	3
5	Program Elective Course (PEC-I)	●Environmental Impact Assessment (ENR-1201) ●Environmental Geo-technology (ENR-1202) ●Environmental Hydraulics & Hydrology (ENR-1203) ●Principles & Design of water supply treatment systems (ENR-1204) ●Environmental Systems Analysis (ENR-1205) ●Environmental Biotechnology (ENR-1205) ●Fate & transport of contaminants in natural systems (ENR-1206)	3
6	Soft-Computing/Soft Skills and Management	Soft-Computing (SCR-1001)/Soft Skills and Management (SMR-1001)	3
Total Credits			**18**

Sr. No.	Course Stream	Course Name	Credits
Semester II			
1	Program Core Course (PCC-IV)	Biological Processes - Design for Wastewater Treatment (ENR-1104)	3
2	Program Core Course (PCC-V)	Air & Noise Pollution & Control (ENR-1105)	3
3	Program Core Course (PCC-VI)	Industrial Wastewater Management (ENR-1106)	3
4	Program Elective Course (PEC-II)	● Surface & Ground water Modeling (ENR-1251) ● Environmental System Modeling (ENR-1252) ● Energy Systems & Environment (ENR-1253) ● Ecological & Ecosystem Engineering(ENR-1254) ● Indoor Air Quality (ENR-1255) ● Life Cycle Analysis (ENR-1256) ● Rural Water Supply & Environmental Sanitation (ENR-1257) ● Remote Sensing & GIS for Environmental Engineers (ENR-1258)	3
5	Open Elective -I	● Climate Change & Sustainable Development (ENR-3001) ● Clean Technology (ENR-3002) ● Hazardous, Solid, Plastic and E-waste Management (ENR-3003)	3
6	Industrial Tour	Industrial Tour (ENR-4001)	0
7	Research Methodology	Design of Experiments and Research Methodology (ENR-1001)	3
Total Credits			**18**

Sr. No.	Course Stream	Course Name	Credits
Semester III			
1	Seminar and Report writing	Seminar and Report writing (ENR-5001)	2
2	Research and Publication Ethics	Research and Publication Ethics (RPR-6001)	2
3	Dissertation - I	Dissertation – I (ENR-7001)	14
Total Credits			**18**

Sr. No.	Course Stream	Course Name	Credits
Semester IV			
1	Dissertation - II	Dissertation – II (ENR-8001)	18
Total Credits			**18**

Note:

1. **Industrial Tour will be held in winter vacation after 1st semester and will be recorded in 2nd Semester.**
2. **In the First and Second Semester, atleast one of Department Core Courses should have laboratory component.**

SEMESTER -I

Program Core Course

PCC-I

Course Name	**:**	**Physico-Chemical Process in Water & Wastewater Engineering**
Course Code	**:**	**ENR-1101**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Total No. of Lab Hours: 28

Course Objectives:

Total No. of Lectures: 28

The main objectives of this course are:	
1.	To introduce the concept of water quality.
2.	To understand the various physico-chemical unit processes and operations as applied to water and wastewater systems.
3.	To provide a hands on experience in environmental quality monitoring of Water and wastewater systems.

Course Contents:

Sr. No.	**Course contents**	**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	**6**
2.	**Water Purification Systems in Natural Systems** Physical processes-chemical processes and biological processes - Primary, Secondary and tertiary treatment-Unit operations – unit processes.advance oxidation, Membrane, ion exchange etc.	**5**
3.	**Clarification, Sedimentation** Types; Tube & Plate Settlers, Aeration& gas transfer; Coagulation & flocculation, coagulation processes, stability of colloids, destabilization of colloids, transport of colloidal particles, Clariflocculation.	**5**
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.	**5**

5.	**Adsorption** Adsorption equilibria - adsorption isotherms, Disinfection - chlorine dioxide; chloramines; ozonation; UV radiation Ion Exchange-processes, Application Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodyalisis.	**5**
6.	**Introduction to water supply system of smart cities and use of software EPANET**	**2**

Lab Work:

Sr. No.	**Lab contents**	**No. of Hours**
1.	Testing of various physico- chemical properties (like BOD, COD, Chlorides, alkalinity, sulphates, nitrates etc) of water and wastewater, Project based testing of water & wastewater quality parameters	8
2	Project based testing of water quality parameters	10
3	Project based testing of wastewater quality parameters	10

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Design various physico-chemical unit processes and operations to achieve the desired water quality in water and wastewater systems.
2.	To impart knowledge of various processes used in the purification of water
3.	To Aquent the student with the most recent advanced knowledge in this field.

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher**	**Year of Publication/ Reprint**
1.	Water works engineering, S. R. Qasin. PHI, New Delhi	2015
2.	Environmental Engineering, Howard S. Peavy, Donald R. Rowe, George Tchobanoglous Mc Graw Hill Publishing	2015
3.	Standard Methods for examination of water and wastewater: 23rd Edition APHA	2017

MOOCs on this course are available at:

1) https://www.Courses.edx.org/Courses/CourseV-I: T Singhua x
2) https://onlinecourses.nptel.ac.in (Course on Water Supply Engineering by IIT Madras by Prof. Ligy Philips at NPTEL.ac.in

PCC-II

Course Name	**:**	**Environmental Chemistry and Microbiology**
Course Code	**:**	**ENR-1102**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives: **Total No. of Lectures: 28**

Total No. of Lab Hours: 28

	The main objective of this course are:
1.	To familiarize the students with the chemical and biological principles as applied to Environmental Engineering.
2.	To apply these concepts to Water and Wastewater Treatment and Pollution Control.

Course Contents:

Sr. No.	Course Contents	No. of Lectures
1.	**Introduction** Importance of Chemistry and Microbiology in Environmental Engineering; The related uses and applications. Catalysis, colloidal and surface chemistry, chemistry of organic pollutants, heavy metals and nanomaterials ,green chemical processes	**4**
2.	**Chemical Equations** Types, solutions, activity and activity coefficients, chemical equilibria, chemical thermodynamics.	**2**
3.	**Acid Base Equilibria** Equilibrium diagrams, carbonic acid system, buffering, Solubility Equilibria, effect of other solutes on salt solubility, removal of heavy metals.	**2**
4.	**Oxidation Reduction Equilibria** Ectrochemistry and electrochemical cells, stability diagrams measuring redox potentials.	**3**
5.	**Water Stabilization** Water softening and water conditioning, chemical precipitation, ion exchange.	**2**
6.	**Basic of Quantitative Chemistry** Analytical methods, instrumentation: Organic pollution: BOD, COD, And TOC.	**2**
7.	**Microbiology** Classification, identification, Taxonomy, Reproduction and growth, cultures & characteristics, Enzymes, Microbial metabolism - energy production, biosynthesis, Mixed and pure culture, Growth rate; Application.	**7**

8.	**Fungi, Bacteria, Molds and Yeasts** Algae, protozoa, viruses. Control of microorganisms.	**3**
9.	**Microbiology of Domestic Water & Waste Water** Industrial microbiology. Epidemiology of infectious diseases, microbial agents of diseases.	**3**

Lab Works:

Sr. No.	**Lab Contents**	**No. of Hours**
1.	Water & Wastewater Quality, Bacteriological Quality (like MPN, Plate Count etc.)	8
2.	experiments involving use of GC-MS and Ion Chromatography	10
3	Air & Noise Testing, Project based testing of water & wastewater	10

Course Outcomes:

At the completion of this course, students will be able to:	
1.	The student is able apply the principles of Chemistry and Microbiology in Environmental Engineering practice.
2.	Analyze and interpret the environmental engineering systems from the chemistry and microbiological point of view.
3.	To Aquent the student with the most recent advanced techniques and practices in this field.

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher**	**Year of Publication/ Reprint**
1.	Chemistry for Environmental Engineering: Sawyer, McGraw Hill Book Company, New York.	2015
2.	Microbiology – Concepts and applications: Pelczar, McGraw Hill Book Company, New York.	2015
3.	Process Chemistry for water and wastewater treatment: Benefield, Printice-Hall Inc, New Jersey.	2015
4.	Microbiology for Environmental Scientists and Engineers: Gaudy and Gaudy McGraw Hill Book Company, New York.	2014
5.	Standard Methods for examination of water and wastewater: 23rd Edition APHA	2017

MOOCs on this course are available at:

1) https://onlinecourses.nptel.ac.in (Course on Environmental Engineering-Chemical Processes by Prof. Bhanu Prakash Vellanki, Department of Civil Engineering, IIT Roorkee

PCC-III

Course Name	**:**	**Solid and Hazardous Waste Management**
Course Code	**:**	**: ENR-1103**
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Total Number of Lectures: 42

Course Objectives:

	The main objectives of the course are:
1.	To have knowledge of solid waste treatment and management.
2.	To Aquent the student with the most recent practices and design methods in this field.

Course contents

Sr. No.	Course contents	No. of Lectures
1.	**Introduction to Solid and Hazardous Wastes:** 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	**07**
2.	**Waste Characterization and Analysis:** Waste generation rates – Composition - Hazardous Characteristics – TCLP tests – waste sampling- Source reduction of wastes – Recycling and reuse.	**07**
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.	**07**
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.- Biomass waste valorisation	**07**
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.	**07**
6.	**MSW Management of Smart Cities, e-waste, bio-medical waste, hazardous waste management, IOT technologies involving solid & hazardous waste management.**	**07**

Course outcomes:

At the completion of this course, students will be able to:	
1.	Students will be able to know processing and handling of solid waste in better way.
2.	Analyze and interpret the segregation, collection and disposal point of view.
3.	To Aquent the student with the most recent advanced techniques in material and energy recovery from MSW.

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher**	**Year of Publication/Reprint**
1.	Integrated Solid Waste Management, George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, , McGraw- Hill, New York.	2013
2.	Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization (CPHEEO), Government of India (GOI), New Delhi.	2000

MOOCs on this course are available at:

1. https://onlinecourses.nptel.ac.in(Course on Integrated waste management for a Smart City by Prof. B K Dubey of IIT, Kharagpur)

ENR1001

Program Elective Course
PEC-I

Course Name	**:**	**Environmental Impact Assessment**
Course Code	**:**	**ENR-1201**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To learn the advanced concepts and application methodology of EIA and its documentation.
2.	To learn the planning and mitigation methods

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Evolution of EIA:** Concepts – Methodologies – Screening- Scoping- Base line studies- Mitigation – Matrices - Check List.	**8**
2.	**Rapid and comprehensive EIA:** Legislative and Environmental Clearance procedures in India- Predication tools for EIA.	**8**
3.	**Assessment of impacts:** Air – Water – Soil- Noise- Biological.	**8**
4.	**Socio Cultural Environment:** Public participation- resettlement and rehabilitation.	**9**
5.	**Documentation of EIA:** Environmental management Plan- Post Project monitoring- Environmental Audit- Life cycle Assessment – EMS – case studies in EIA.	**9**

Course Outcomes:

At the end of the course, students will have:	
1.	Knowledge about EIA tools & methodologies.
2.	Knowledge about environment management systems and planning for pollution control
3.	Auditing and documentation of EIA

Bibliography:

Sr. No	Name of Book/ Authors/ Publisher	Year of Publication/Reprint
1.	‑Methods of Environmental Impact Assessment‖, *Peter Morris*, UBC Press/ Vancouver	2000
2.	‑Introduction to Environmental Impact Assessment: Guide to Principles and Practice‖, *Bram F. N.,* Oxford University Press	2006

Course Name	**:**	**Environmental Geo-Technology**
Course Code	**:**	**ENR-1202**
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Total Number of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To know the advanced geo-techniques used in environment globally.
2.	To design various geo-technology models and systems.

Course Contents:

Sr. No.	Course contents	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.	**6**
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.	**6**
4.	**Soil Mechanics:** Introduction to unsaturated soil mechanics; water retention property and soil-water characteristic curve; flow of water in unsaturated soil.	**7**
5.	**Waste & its Transport in Soil:** Concepts of waste containment facilities; desirable properties of soil; contaminant transport and retention; contaminated site remediation.	**7**
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.	**8**
7.	**AnAqSimEDU (analytic aquifer simulator-educational)**	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	To learn the soil science and methods to preserve it.
2.	To Aquent the student with the most recent advanced techniques in this field

3.	To Aquent the student with the most advanced materials to be used in geo-environmental engineering.

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher:**	**Year of Publication/Reprint**
1.	Funtamentals of Soil Behavior, Mitchell, J.K and Soga, K, John Wiley and Sons Inc.	2005
2.	Introduction to Environmental Geotechnology, Fang, H-Y, , CRS press	2016
3.	Geotechnical Practice for Waste Disposal, Daniel, D.E, , Chapman and Hall	2012
4.	Geotechnical and Geoenvironmental Engineering Handbook, Rowe , R. K, , Kluwer Academic Publishers	2001
5.	Geo-environmental Engineering Principles and Applications, Reddi, L.N. And Inyang, H.F, Marcel Dekker Inc.	2000

Course Name	**:**	**Environmental Hydraulics & Hydrology**
Course Code	**:**	**ENR-1203**
Credits	**:**	**3**
LTP	**:**	**3-0--0**

Total Number of Lectures: 42

Course Objectives:

	The main objectives of thiscourse are:
1.	To familiarize the students with the basics of hydrology and introduce them to the concept of hydraulics.
2.	To understand the concept and application of hydrology modeling.

Course Contents:

Sr. No.	**Course contents**	**No. of Lectures**
1.	Uniform and Non-uniform flow in channels and sewers	8
2.	Hydrologic cycle and its interaction with human activity, Hydrologic processes, Transport processes, Porous medium flow.	8
3.	Atmospheric and subsurface water, Surface water	8
4.	Hydrologic analysis, Hydrologic statistics	9
5.	**Introduction to softwares** **FLO-2D Software, EPANET**	9

Course Outcomes:

At the completion of this course, students will be able to:	
1.	The students shall able to apply the concept of hydrology engineering in real life environmental engineering problems.
2.	Complete Knowledge about modelling of hydrological systems
3.	Complete Knowledge about designing and forecasting of hydrological systems

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher:**	**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.	2009

Course Name	**:**	**Principles and Design of Water Supply And Treatment System**
Course Code	**:**	**ENR-1204**
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Total Number of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To give knowledge about the advanced concepts and methods
2.	To inculcate the design capabilities in this field.

Course Contents:

Sr. No.	Course contents	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	**07**
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.	**07**
3.	**Distribution Network:** Design of water distribution networks& Smart water distribution systems	**07**
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.	**07**
5.	**Treatment Plant Designing:** Water Treatment Plant Design; selection of raw water source, Planning and Siting of Water Treatment Plant; Hydraulics of Water Treatment Plant, Chemical Requirement and Residuals Management.	**07**
6.	**Introduction to softwares** WATERCAD& PFCALC	**07**

Course Outcomes:

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

1.	Students able to do the implementation of knowledge into treatment systems.
2.	Students able to do the implementation of knowledge into designing of WS scheme plant.
3.	To Aquent the student with the most advanced materials and methods to be used in water treatment.

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher:**	**Year of Publication/Reprint**
1.	Water works engineering, S.R Qasim, PHI	2015
2.	Environmental Engineering,Peavy Rowe Tchobanoglous, McGraw Hill Inc	2015

MOOCs on this course are available at:

https//www.Courses.edx.org (Course on Water Management by Delf University)

Course Name	**:**	**Environmental System Analysis**
Course Code	**:**	**ENR-1205**
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Total Number of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To learn about analytical & design methods for environmental systems.
2.	To study various optimization models for environmental systems.
3.	To study various stochastic models for environmental systems

Course Contents:

Sr. No.	**Course contents**	**No. of Lectures**
1.	**System Engineering:** Analysis – Design- Synthesis – applications to environmental engineering Systems.	**10**
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.	**10**
3.	**Probabilistic Models**: Fuzzy models – Simulation models.	**11**
4.	**Modern Tools**: Experts - Neural Networks – Genetic Algorithm- Case studies. Remote Sensing & GIS technologies	**11**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Knowledge of analytical & design methods for environmental systems.
2.	Knowledge of optimization models for environmental systems.
3.	Knowledge of stochastic models for environmental systems.

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher:**	**Year of Publication/Reprint**
1.	Environmental System Engineering, Rich L.G., McGraw Hill.	1973
2.	System Analysis & Water Quality control, Thoman R.V., McGraw Hill.	1978
3.	Environmental System Analysis with MATLAB, Stefano Marsili- Libelli, , CRC Press	2016
4.	Environmental Systems – Philosophy, Analysis and Control, Robert Bennett, Richard Chorley, Princeton Legacy Library.	2018

Course Name	**:**	**Environmental Biotechnology**
Course Code	**:**	**ENR-1206**
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Total Number of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To have the recent knowledge of bio-techniques on environment
2.	To have the knowledge of design and application capabilities

Course Contents:

Sr. No.	**Course Contents:**	**No. of Lectures**
1.	**Introduction to Environmental Biotechnology:** Principles and concepts - usefulness to mankind.	10
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.	11
4.	**Impact on Environment:** Environmental effects and ethics of microbial technology–genetically engineered organisms- Microbial containment-Risk assessment.	11

Course outcomes:

At the completion of this course, students will be able to:	
1.	To know the importance of biological techniques and application of them.
2.	Students able to do the implementation of knowledge into designing of biological techniques
3.	To Aquent the student with the most advanced materials and methods to be used in biological techniques

Bibliography:

Sr. No.	Name of the Book/ Author/ Publisher:	Year of Publication/Reprint
1.	Biological degradation and Bioremediation of toxic chemicals, Chaudhury, G.R., Dioscorides Press, Oregon.	2010
2.	Biological degradation of wastes, Martin A.M, Elsevier Applied Science, London	2014
3.	Environmental Biotechnology: Principles and Applications, Bruce E. Rittmann, Perry L. McCarty Tata McGraw-Hill Education.	2012

MOOCs on this course are available at:

https//www.onlinecourses.nptel.ac.in (Course on Environmental Biotechnology)

Course Name	**:**	**FATE and Transport of Contaminants in Natural System**
Course Code	**:**	**ENR-1207**
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Total Number of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To learn about physico- chemical and bio transformations of pollutants in natural systems.
2.	To study various models of predicting contaminant/ pollutant transport.

Course contents:

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

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand the natural physic chemical and bio transformations of pollutants.
2.	Have the complete knowledge of various models of predicting contaminant/ pollutant transport.
3.	Design various processes involved in the contaminant transport

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher:**	**Year of Publication/Reprint**
1.	Biostatistical Analysis, Zar, J.H., Pearson Education,.	2008
2.	Water Quality Engineering in Natural Systems, David A. Chin, Wiley	2013
3.	Groundwater Hydrology, Todd D.K., Wiley	2014

MOOCs on this course are available at:

1. www.ocw.mit(Course no. 1.061

SEMESTER- II

Program Core Courses (PCC)

PCC-IV, PCC-V, PCC-VI

PCC-IV

Course Name	:	**Biological Process Design for Wastewater Treatment**
Course Code	:	**ENR-1104**
Credits	:	**3**
L T P	:	**2 0 2**

Course Objectives: **Total No. of Lectures: 28**

Total No. of Lab Hours: 28

	The main objectives of this course are:
1.	To introduce the various biological process in wastewater treatment: Design and application.
2.	To provide a hands on experience in environmental quality monitoring of Air, Soil and water systems.

Course Contents:

Sr. No.	Course contents	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.	**1**
2.	**Design of wastewater treatment systems**-primary, secondary and tertiary Treatments	**5**
3.	Evaluation of bio-kinetic parameters- activated sludge and its process – modifications, biological nitrification and de nitrification.	**3**
4.	**Aeration**- fundamentals of gas transfer - attached growth biological treatment systems trickling filters-rotating biological contactors - activated biofilters.	**6**
5.	Waste stabilization ponds and lagoons: aerobic pond, facultative pond, anaerobic ponds- polishing ponds, aerated lagoons.	**5**
6.	**Anaerobic processes**-process fundamentals-standard, high rate and hybrid reactors, anaerobic filters-expanded/fluidized bed reactors – up flow anaerobic sludge blanket reactors, expanded granular bed reactors- two stage / phase anaerobic reactors, sludge digestion ,sludge disposal.	**6**
7.	**Introduction to MATLAB Software**	**2**

Lab Work:

Sr. No.	Lab Contents	No. of Lectures
1.	Air Quality Monitoring & Measurements	**7**
2.	Soil Pollution Parameters &Measurements	**7**
3.	Industrial Waste Water Characteristics	**7**
4.	GCMS and IC instrumentation	**7**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Analyze and design the biological processes in wastewater treatment. He shall be able to trouble shoot the biological wastewater treatment systems.
2.	Making measurements and interpretation of Air quality and Soil pollution
3.	Making measurements and interpretation of WQ parameters through instrumentation methods.

Bibliography:

Sr. No.	Name/ Author/Publisher	Year of Publication/ Reprint
1.	‐Chemistry for Environmental Engineering‖, *Sawyer, C.N., McCarty, P.L. and Parkin, G.F., Tata*, McGrawHill, New Delhi.	2003
2.	‐Microbiology‖, Pelczar, M.J., Chan E.C.S. and Krieg, N.R. Tata McGraw Hill, New Delhi.	2002
3.	Standard methods for examination of water & wastewater by AWWA.	2017

MOOC'S are available at:

1. https://www.edx.org/course/urban-sewage-treatment-delftx-ctb3365stx-1
2. https://nptel.ac.in/courses/105105048/ Wastewater Management

PCC-V

Course Name	**:**	**Air and Noise Pollution & Control**
Course Code	**:**	**ENR-1105**
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To familiarize the students with the basics of air pollution including atmospheric physics and chemistry
2.	To apply these concepts to Air and noise Pollution Control and Environmental Management

Course Contents:

Sr. No.	**Course contents**	**TOTAL No. of Lectures 42**
1.	**Introduction to air pollution** – environmental engineering significance – global issues – units	**3**
2.	**Effects of air pollution** – visibility – basic calculations Atmospheric composition – temperature profile	**2**
3.	**Meteorology -** lapse rate – stability conditions	**5**
4.	Maximum mixing depth – plume behaviour	**2**
5.	**Dispersion** – modelling – engineering decisions – maxi ground level concentration - effective stack height	**10**
6.	Air pollution sampling – Stack monitoring	**2**
7.	Engineered systems of AP control – particulates – gaseous pollutants, Vehicular AP – models – control measures	**7**
8.	**Air pollution control regulations – laws – Standards**	**2**
9.	**Noise pollutionand control**	**7**
10.	**Introduction to Air Pollution Modelling Software's: CALINE4, HIWAY2**	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Have knowledge of the importance of air and noise pollution.
2.	Model the air and noise pollution and design control devices.
3.	Design various methods to curb air and noise pollution.

Bibliography:

Sr. No.	Name of the Book/ Author/ Publisher	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	2007
3.	–Air Pollution: Its origin and control‖, *Wark, K and Warner, C F.*, Harper and Row Pub. New York	1998
4.	–Environmental Engineering, A Design Approach‖, *Sincero, A P and Sincero, G A*, Printice Hall Pub. New Delhi	1996

MOOC'S are available at:

1. *https://nptel.ac.in/courses/105104099/ Environmental Air Pollution*
2. https://nptel.ac.in/courses/105101087/03-Ltexhtml/p6/p.html *Noise Pollution*

PCC-VI

Course Name	**:**	**Industrial Wastewater Management**
Course Code	**:**	**ENR-1106**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To learn about effluent treatment methods.
2.	To learn about essence of effluent and sludge management vis-à-vis EMS (ISO14000)

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	Sources and types of industrial wastewater- Environmental impacts- Regulatory requirements- generation rates- characterization – Toxicity and Bioassay tests.	**8**
2.	Prevention vs Control of Industrial Pollution – Source reduction techniques- Waste Audit- Evaluation of pollution prevention options.	**8**
3.	Waste minimization- Equalization- Neutralization- Oil Separation- Flotation- Precipitation—Heavy metal Removal- adsorption- Aerobic and Anaerobic biological treatment- Sequencing batch reactors- chemical oxidation - ozonation- photocatalysis- Wet Air Oxidation – Evaporation – Ion Exchange- Membrane Technologies- Nutrient removal.	**8**
4.	Individual and Common Effluent Treatment Plants- Zero effluent discharge systems- wastewater reuse- Disposal of effluent on land- Quantification, Characteristics and disposal of sludge.	**9**
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.	**9**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Have knowledge about treatment methods & design.
2.	Have knowledge about effluent and sludge management vis-à-vis EMS (ISO14000).
3.	Design various methods to curb and control industrial pollution.

Bibliography:

Sr. No.	Name of the Book/ Author/ Publisher:	Year of Publication/Reprint
1.	–Industrial Water Pollution Control‖, *Eckenfelder, W.W.,* McGraw-Hill.	2002
2.	*"*Wastewater Treatment for Pollution Control*", Arceivala, S.J.,* McGraw- Hill.	2000
3.	*"*Industrial Waste treatment Handbook,‖ *Frank Woodard*, Butterworth Heinemann, New Delhi.	2001

Program Elective Course
PEC-II

Course Name	**:**	**Surface and Groundwater Modelling**
Course Code	**:**	**ENR-1251**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of the course are:
1.	To learn about surface water hydrology.
2.	To learn about groundwater- occurrence and movement.
3.	To study well designing.

Course Contents:

Sr. No.	Course contents	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, DupuitForchheimer 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.	**9**
5.	Natural and Artificial Recharge of Ground water- Salt water intrusion, Application of Finite Difference in ground water.	**9**

Course Outcomes:

At the completion of this course, students will have:	
1.	Knowledge about the surface water hydrology
2.	Knowledge of Ground Water Aquifer development methods
3.	Knowledge about the ground water recharge methods and designing the same.

Bibliography:

Sr. No.	Name of the Book/ Author/ Publisher	Year of Publication/Reprint
1.	-Applied Hydrology‖, *VenTe Chow,* Mc Graw Hill Science Publishers	2013
2.	-Elementary Hydrology‖, *Vijay Singh*, Prentice Hall	1994
3.	-GroundWater‖, *Raghunath*, Mc Graw Hill.	2007
4.	-Hydraulics of Groundwater‖, *Bear, J*., Mc Graw Hill.	2007

MOOCs are available at:

1. https://nptel.ac.in/courses/105105042/40
   Groundwater Hydrology Prof. AnirbanDhar, Department of Civil Engineering, Indian Institute of Technology – Kharaghpur

Course Name	**:**	**Environmental Systems Modelling**
Course Code	**:**	**ENR-1252**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of the course are:
1.	To understand the concept of system and its modeling.
2.	To learn different techniques used in modelling.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	Mathematical modelling and simulation, Defining systems and its components, Types of models and their applications.	**8**
2.	Models for Fate and Transport of Contaminants	**8**
3.	Modelling 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 modelling of rivers, lakes, sediments, wetlands, subsurface flow and transport, air pollution modelling.	**8**
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.	**9**
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.	**9**

Course outcomes:

At the completion of this course, students will be able to:	
1.	make use of the software packages and its application in civil engineering projects
2.	Understand the various phenomena involved in pollution diffusion & dispersion
3.	Development and design capabilities in this field of Environmental Systems Modelling

Bibliography:

Sr. No.	Name of the Book/ Author/ Publisher	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

MOOCs are available at:

1. https://www.coursera.org/learn/modeling-simulation-natural-processes

Course Name	**:**	**Energy Systems and Environment**
Course Code	**:**	**ENR-1253**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of the course are:
1.	To familiarize the students with the basics of energy systems in relation to environment
2.	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.

Course contents:

Sr. No.	Course contents	No. of Lectures
1.	Fundamental concepts of energy and environment-units of measurement, indoor and outdoor environmental systems, built and natural environment	**6**
2.	Energy sources – conventional and non – conventional, renewable and non-renewable energy sources	**6**
3.	Energy generation – basics and environmental issues/impact	**6**
4.	Non-conventional sources – options, technology and issues	**6**
5.	Energy management – conservation, audit, modelling	**6**
6.	Case studies	**6**
7.	New sources and future energy problems, policies	**6**

Course outcomes:

At the completion of this course, students will be able to:	
1.	Understand the interrelationship between energy and environment.
2.	Making decision with respect energy options on an environmental perspective
3.	Understand and design the systems for Energy and environment.

Bibliography:

Sr. No.	Name of the Book/ Author/ Publisher	Year of Publication/ Reprint
1.	–Non-conventional energy sources‖, *G D Rai*, Khanna Pub.	2005
2.	–Energy Management Principles‖, *Smith*, Pergamon Press	2000
3.	–Introduction to Chemical Engineering Thermodynamics‖ *J.M Smith, H.C Van Ness*, McGraw Hill.	2001

MOOCs are available at:

1. https://www.edx.org/course/energy-within-environmental-constraints-0

Course Name	**:**	**Ecological and Ecosystems Engineering**
Course Code	**:**	**ENR-1254**
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Total Number of Lectures: 42

Course Objectives:

	The main objectives of the course are:
1.	To understand the concept and application of ecological modeling.
2.	To familiarize the students with the basics of ecological systems and introduce them to the concept of ecological engineering.

Course Contents:

Sr. No.	**Course contents**	**No. of Lectures**
1.	Development and Evolution of ecosystems- Principles and concepts	**07**
2.	Energy flow and material cycling- productivity- classification of eco-technology- ecological engineering.	**07**
3.	Classification of systems- Structural and functional interactions of environmental systems- Mechanisms of steady- state maintenance in open and closed systems.	**07**
4.	Modeling and eco-technology- Classification of ecological models- Applications- Ecological economics- Self – organizing design and processes- Multi seeded microcosms.	**07**
5.	Interface coupling in the ecological systems- concepts or energy- determination of sustainable loading of ecosystems.	**07**
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.	**07**

Course outcomes:

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

1.	The students shall able to apply the concept of ecological engineering in real life environmental engineering problems.
2.	Making decision with respect to eco system modelling options on an environmental perspective
3.	Understand and design the systems for conservation of ecosystems.

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher:**	**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	2007
3.	Basic Ecology, E .P. Odum, H.S Publication	2000
4.	Energy and Ecological Modelling, W.J Mitch, R. W. Bosserman and J N Klopatik, Elsevier Publication	2001

Course Name	**:**	**Indoor Air Quality**
Course Code	**:**	**ENR-1255**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To better know indoor air quality and its methods to maintain it.
2.	Design of mitigation methods of indoor pollution

Course Contents:

Sr. No.	Course Contents	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.	**8**
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.	**8**
4.	Indoor air pollution from outdoor sources- particulate matter and ozone- combustion	**9**
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.	**9**

Course outcomes:

At the completion of this course, students will be able to:	
1.	Understand the air quality parameters
2.	Apply the techniques of control of indoor air pollution
3.	Designing of green indoor systems.

Bibliography:

Sr. No.	Name of the Book/ Author/ Publisher	Year of Publication/Reprint
1.	–Indoor air and Environmental Quality‖, *ThaddesGodish*, CRC press.	2000

MOOCs are available at:https://www.coursera.org/learn/intro-indoor-air-quality

Course Name	**:**	**Life Cycle Analysis**
Course Code	**:**	**ENR-1256**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To understand the analysis techniques used in LCA.
2.	To understand the application methods for product LCA

Course Contents:

Sr. No.	**Course Contents:**	**No. of Lectures**
1.	Introduction to LCA, Scope and goal definition of the process of Life Cycle Assessment Studies.	**8**
2.	Inventory analysis, I/O and matrix LCI, data collection, data interpretation and data presentation	**8**
3.	Impact assessment, Ecological risk and human risk, Eco-system impacts and un-certainty analysis	**8**
4.	Applications of LCA, Case-studies of product LCA, Case studies of process LCA, Limitations of LCA	**9**
5.	LCA software based project study.	**9**

Course outcomes:

At the completion of this course, students will be able to:	
1.	Use the knowledge of LCA product design
2.	Understand and apply LCA for prevention & control of pollution
3.	Work on LCA Software and development of the same.

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher:**	**Year of Publication/Reprint**
1.	"Environmental Life Cycle Analysis", *Ciambrone, D.F.*, CRC Press.	2007
2.	‖Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards‖,*Guinee, J.B.*, Kluwer Academic Publishers.	2004

MOOCs are available at:https://onlinecourses.nptel.ac.in/noc17_ce10/preview

Course Name	**:**	**Rural Water Supply and Environmental Sanitation**
Course Code	**:**	**ENR-1257**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To learn about analytical the water supply in rural areas.
2.	To learn about environmental sanitation methods in rural areas.

Course Contents:

Sr. No.	Course Contents	No. of Lectures
1.	Rural water supply schemes - treatment and remedies.	**8**
2.	Epidemiology- Pathogens, viruses, and bacteria's	**8**
3.	Sanitation of public places and water bodies, natural and made methods for preservation of rural ecosystems.	**8**
4.	Pasteurization, Industrial hygiene associated with rural industries	**8**
5.	Occupational hazards, Radiological health associated with rural industries	**5**
6.	Effluent disposal, Low cost treatment systems, Biogas plants, Composting.	**5**

Course outcomes:

At the completion of this course, students will be able to:	
1.	Have knowledge about water supply scheme in rural areas.
2.	Have knowledge about environmental sanitation methods.
3.	Have knowledge about design of natural and mechanical sanitation techniques.

Bibliography:

Sr. No.	Name of the Book/ Author/ Publisher:	Year of Publication/Reprint
1.	"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	**Remote Sensing & GIS for Environmental Engineers**
Course Code	**ENR-1258**
L - T - P	**3 - 0 - 0**
Credits	**3**
Pre-Requisites	**Nil**

Course Objective (COs):	
At the end of the course, the students will be able to:	
1.	Apply the concepts and analytical methods related to surveying
2.	Prepare a map and concepts of 3-D view
3.	Identify the potential use of Remote Sensing and GIS in Civil Engineering

No. of Lectures: 42

S. No.	Lecture Wise Breakup of the Syllabus:	No. of Lectures
1	**MODERN TRENDS IN SURVEYING AND MAPPING:** Digital Mapping, Uses and applications, data collection techniques (Conventional and Non-conventional), Present Status in India and abroad	4
2	**AERIAL PHOTOGRAMMETRY** Introduction, types, Stereoscopy, Scale of a photograph, flight planning, Mosaics	3
3	**GEOGRAPHICAL INFORMATION SYSTEM (GIS**) Introduction, advantages, objectives of GIS, Definitions of GIS, Components of GIS, Overlay analysis, Digital Terrain Modelling, Digital Elevation Model Applications of GIS in various engineering fields, Four M's, Elements of Image visualization	5
4	**INTRODUCTION TO REMOTE SENSING (RS)** Introduction, EM spectrum, Ideal RS System, Real RS System, Visual Image interpretation, active and passive remote sensing, Reflectance; spectral reflectance of land covers; Spectral characteristics of solar radiation; energy interaction in atmosphere; energy interactions with Earth's surface, Spectral reflectance curves, Resolution	6
5	**DIGITAL IMAGE PROCESSING (DIP)** Introduction, Histogram and image statistics, Remote Sensing Image distortion and rectification: Radiometric errors and Geometric errors. Image Enhancement Techniques, Image classification – Supervised and Unsupervised classification, Formats	6
6	**GLOBAL POSITIONING SYSTEM** Introduction, GPS, DGPS, Applications	5
7	**SMART CITY & GEOSPATIAL TECHNOLOGY** Introduction, Applications of GIS/RS in a smart city.	3
8	Software demonstrations and working of GIS/RS software	10

Couse Outcomes:

At the completion of this course, students will be able to:	
1.	Have knowledge about RS and GIS
2.	Have knowledge about working of RS and GIS in environmental field.

3.	Have knowledge about software modelling and coding.

Bibliography:

Sr. No.	Name/ Author/ Publisher	Year of Publication/ Reprint
1.	"Surveying Vol. II", S.K.Duggal: Tata McGraw Hill, New Delhi.	2009
2.	"SurSuveying and Levelling," Subramanian, Oxford university press.	2012
3.	Surveying and Levelling," N N Basak, McGraw Hill.	2014
4.	Surveying Vol. I & II, B.C. Punmia, A.K. Jain & Jain. Luxmi Publications (P) Ltd., New Delhi. (2006)	2006

e-Learning Resources:
https://nptel.ac.in/courses/105/104/105104101/ NPTEL video course on Surveying
https://nptel.ac.in/courses/105/107/105107122/ NPTEL web course on Surveying

OPEN ELECTIVE-I

Course Name	**:**	**Climate Change and Sustainable Development**
Course Code	**:**	**ENR-3001**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To understand the climate system and anthropogenic effects.
2.	To study various models of predicting climate change
3.	To emphasize upon climate protection for sustainable development.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	Climate system- local, regional, national and global studies, heat balance of earth and its surrounding atmosphere, radiation spectrum, radioactive forcing	**11**
2.	Human impacts on the climate- temperature anomaly, impact on coastal areas of sea water level changes, emissions of greenhouse gases	**11**
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	**9**
4.	Sustainable development, Climate protection pathways of development	**11**

Course outcomes:

At the completion of this course, students will be able to:	
1.	Knowledge of the climate system and anthropogenic effects.
2.	Knowledge of the monitoring and modeling of predicting climate change.
3.	Knowledge of the climate protection strategies for sustainable development.

Bibliography:

Sr. No.	Name/ Author/ Publisher	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 Pub.	2000

MOOCs are available at:

1. https://www.edx.org/course/climate-change-science-ubcx-climate1x-3

Course Name	**:**	**Clean Technology**
Course Code	**:**	**ENR-3002**
Credits	**:**	**03**
L T P	**:**	**3-0-0**

Total No. of Lectures: 42

Course Objectives:

	The main objectives of this course are:
1.	To understand the processes and technologies to keep environment clean.
2.	To understand use of preventive methods of pollution control

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**INTRODUCTION TO SOCIETY AND ITS PROBLEM** Industrial Society, Resource Limitations, Environmental Problems.	**8**
2.	**DEVELOPMENT AND ITS PROCESSES** Sustainable Development, Thermodynamics	**8**
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	**8**
5.	**WASTES** Waste, Industrial Waste, Hazardous Waste	**5**
6.	**ECO- FRIENDLY TECHNOLOGIES** System Analysis, Flexible Processes, Materials & products eco-design, Material Recycling, Biodegradable Materials.	**5**

Course outcomes:

At the completion of this course, students will be able to:	
1.	Grasp the knowledge of different technologies used to maintain clean environment.
2.	Understand eco-friendly technologies and there applications
3.	Aquent the knowledge of different recent materials and methods.

Bibliography:

S. No.	Name/ Author/ Publisher	Year of Publication/ Reprint
1.	–Clean Technology‖, *Allan Johansson*, CRC Press.	2001
2.	*"*Green Energy Technology*", Aswathanarayana U., Harikrishnan T., and Kadher-Mohien S. T.*,Economics and Policy, CRC Press.	2012

MOOCs are available at:

1. https://www.coursera.org/learn/sustainable-development
2. https://www.edx.org/course/sustainable-energy-design-a-renewable-future

Course Name	**:**	**Hazardous, Solid, Plastic and E-waste Management**
Course Code	**:**	**ENR-3003**
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Total Number of Lectures: 42

Course Objectives:

	The main objectives of the course are:
1.	To have knowledge of solid, plastic, hazardous and E-waste treatment and management.
2.	To make the student apply the most recent practices and design methods in this field.

Course contents

Sr. No.	**Course contents**	**No. of Lectures**
1.	**Introduction to various kinds of Wastes:** Types and Sources of various kinds of wastes - Need for waste management - Legislations on management and handling of municipal solid wastes, hazardous wastes, and biomedical wastes, E and Plastic waste, Elements of integrated waste management	**07**
2.	**Waste Characterization and Analysis of wastes:** Waste generation rates – Composition - Hazardous Characteristics – TCLP tests – waste sampling- Source reduction of wastes – Recycling and reuse.	**07**
3.	**Management of Waste Materials:** 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.	**07**
4.	**Processing of Waste Materials:** 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.- Biomass waste valorization	**07**
5.	**Disposal of Wastes:** 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.	**07**
6.	**Management of e-waste, bio-medical waste, plastic waste, technologies involving E-waste & plastic waste management, Health hazards, sources, reuse and recycling issues**	**07**

Course outcomes:

At the completion of this course, students will be able to:	
1.	Students will be able to know processing and handling of various waste in better way.
2.	Analyze and interpret the segregation, collection and disposal point of view.
3.	To Aquent the student with the most recent advanced techniques in material and energy recovery from waste management .

Bibliography:

Sr. No.	**Name of the Book/ Author/ Publisher**	**Year of Publication/Reprint**
1.	Integrated Solid Waste Management, George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, , McGraw- Hill, New York.	2013
2.	Hazardous Waste Management, ERS, McGRAW Hill International Edition	2019
3.	Solid Waste Management, K. Sasikumar and Sanoop Gopi Krishna, PHI	2020
4.	Handbook of Electronic Waste Management, Elsevier	2019

MOOCs on this course are available at:

https://onlinecourses.nptel.ac.in(Course on Integrated waste management for a Smart City by Prof. B K Dubey of IIT, Kharagpur)

Course Name	:	**Design of Experiments and Research Methodology**
Course Code	:	**ENR1001**
Credits	:	**3**
L T P	:	**3 0 0**

Course Objectives

The main Objectives of this course are:	
1	To introduce the fundamentals of Statistical techniques, Sampling techniques, and Data Collection and the interpretation to the students.
2	To make the students understand the concept of research, need for research, types of research and steps in conducting research.

Total Nos. of Lectures: 42

Course Contents:

S. No.	Course Contents	No. of Lectures
1	**Introduction:** Principles of design of experiment, Methodology for design of experiment, Screening design, Factorial design, Randomized design.	**3**
2	**Sample & Estimation:** Population, Sample, Probability in sampling, sampling with replacement, parameters of samples.	**3**
3	**Probability and random variables:** Bayesian probability, conditional probability, Bayes theorem, statistical independence of events, random variables- discrete and continuous, probability distribution functions, cumulative distribution functions, Expectation and variance of a random variable, joint distribution of two random variables and their correlation.	**6**
4	**Statistics for Engineers:** Discrete & Continuous distributions, different distributions functions application in engineering, distribution estimation & its assessment.	**6**
5	**Simulation:** Monte Carlo method, Queuing theory, Markovian process.	**3**
6	**Random Variables Data Analysis:** Single and multi- variables data analysis, estimation of parameters, spline smoothing, residual analysis, ANOVA.	**6**
7	**Modelling:** Introduction to modelling, types of models, development of mathematical models	**3**
8	**Geostatistics:** Introduction to Geostatistics, Geostatistical data analysis methods.	**4**
9	**Stochastic Processes:** Time series analysis, model identification, forecast and uncertainty analysis.	**4**
10	**Research Report Writing:** Purpose and nature of research, Research ethics Research proposal and literature review, Defining the problem, Finding and managing information, Developing and stating hypotheses. Research report, writing a thesis, writing for publication.	**4**

Course Outcomes:

At the completion of this course, students will be able to:	
1	Make use of various Research methodologies and its applications in the relevant field of engineering.
2	Organize and conduct research in a more appropriate manner.

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Probability and Statistics for Engineers and scientists, Walpole, Myers, MyersandYe, Pearson Education.	7th edition, 2002
2	Statistics in Research, Bernand Ostleand Richard N. Mensing, Oxford & IBH Pub Co.	3rd edition,1975
3	Probability and Statistics in Engineering, Hines, Montgomery, Gold sman and Borror, John Wiley & Sons.	4th edition, 2003
4	Experimental design, Theory & application, Federer, Oxford & IBH pub Co.	1955
5	Introduction to probability & statistics for Engineers and scientists, Sheldon M. Ross Elsevier Academic press, California, USA	2014

MOOCs on this course are available at:

1. http://professional.mit.edu/programs/short-programs/design-and-analysis-experiments
   By Prof. Paul Berger, MIT Professional Education

2. https://nptel.ac.in/courses/107108011/
   By Prof. Amaresh Chakraborty, Indian Institute of Science, Bangalore