KALASALINGAM UNIVERSITY
CURRICULUM

M. Tech. ENVIRONMENTAL ENGINEERING

PROGRAMME OUTCOME

1. Analyze and interpret environmental pollution data
2. Design environmental engineering systems
3. Forecast and predict fate of pollutants in the environment.
4. Identify best waste management practices
5. Predict the environmental impacts of developmental projects and engineered solutions in global, and socio-economic context.
6. Pursue life-long learning as a means of enhancing the knowledge and skills in environmental modeling.
7. Model environmental systems using modern tools and techniques
8. Engage in critical thinking and contribute to research in solving contemporary environmental problems with professional and ethical responsibility
9. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
10. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
11. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
12. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

SEMESTER – I

Code No.	Course Title	L	T	P	C
MAT5008	Statistics and Computational Methods	3	1	0	4
CIV5001	Environmental Chemistry	3	0	0	3
CIV5002	Environmental Microbiology	3	0	0	3
CIV5003	Air Pollution and Control	3	0	0	3
CIV5004	Transport of water and waste water	3	0	0	3
CIV****	Elective I	3	0	0	3
CIV5081	Environmental Engineering Lab	0	0	3	2
Total Credits					21

SEMESTER – II

Code No.	Course Title	L	T	P	C
CIV5011	Solid and Hazardous Waste Management	3	0	0	3
CIV5012	Physico - chemical Treatment of Water and Wastewater	3	0	0	3
CIV5013	Biological Treatment of Wastewater	3	0	0	3
CIV5014	Industrial Waste Water Management	3	0	0	3
CIV5015	Environmental Impact Assessment	3	0	0	3
CIV****	Elective II	3	0	0	3
CIV5082	Unit Process & Operations Lab	0	0	2	2
Total Credits					20

SEMESTER – III

Code No.	Course Title	L	T	P	C
CIV****	Elective III	3	0	0	3
CIV****	Elective IV	3	0	0	3
CIV****	Elective V	3	0	0	3
CIV6098	Project Work (Phase-I)	0	0	12	6
					15

SEMESTER – IV

Code No.	Course Title	L	T	P	C
CIV6099	Project Work (Phase-II)	0	0	24	12

Total Credits – 68

ELECTIVES

Code No.	Course Title	L	T	P	C
CIV 5016	Models For Air And Water Quality	3	0	0	3
CIV 5017	Instrumental Monitoring Of Environment	3	0	0	3
CIV 5018	Remote Sensing and GIS for Environmental Applications	3	0	0	3
CIV 5019	Ecological Engineering	3	0	0	3
CIV 5020	Ground Water Contamination and Transport Modeling	3	0	0	3
CIV 5021	Environmental Biotechnology	3	0	0	3
CIV 6001	Indoor Air Quality	3	0	0	3
CIV 6002	Environmental Policies and Legislation	3	0	0	3
CIV 6003	Environmental Engineering Structures	3	0	0	3
CIV 6004	Mass Transfer in Air-Water-Soil Interaction	3	0	0	3
CIV 6005	Marine Pollution Monitoring	3	0	0	3
CIV 6006	GIS Application In Natural Resources And Management	3	0	0	3
CIV 6007	Water Quality Modeling	3	0	0	3
CIV 6008	Water Resources Systems Engineering	3	0	0	3
CIV 6009	Network Analysis and Optimization	3	0	0	3

SEMESTER – I

		L	T	P	C
MAT 5008	**STATISTICS AND COMPUTATIONAL METHODS**	**3**	**1**	**0**	**4**

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply numerical schemes for solution of differential equations in Water Resources and Environmental Engineering
CO2	Apply finite difference schemes for solution of hydraulic and hydrologic models
CO3	Formulate finite element model for solution of flow through porous media
CO4	Perform statistical analysis of water resources and environmental engineering systems

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	-	L	L	H	L	L			
COM	M	M	H	-	M	L	H	L		L	M	
COH	M	-	H	M	L	L	M	L				L
CO4	M	M	M	-	L	-	H	L				

Probability Distributions

Probability basic concepts – Binomial, poisson, geometric, normal, uniform, exponential, Gamma and weibull– distributions – mean, variance, Moment generating functions.

Estimation Theory

Estimation of parameters- Principles of least squares – maximum likelihood estimation – method of moments – interval estimation.

Testing of Hypothesis

Sampling distribution, large sample tests – Mean and Proportion, Small sample tests – t-test, F-test and Chi-square test- Goodness of fit – Independence of attributes.

Design of Experiments

Design of Experiments: Basic Designs, Factorial Design, Taguchi Techniques, ANOVA.

Optimization Methods

Classical optimization methods, unconstrained minimization – Univariate, Conjugate direction, gradient and variable metric methods, constrained minimization, feasible direction and projections.

REFERENCES

1. Freund John, E and Miller, Irvin, “Probability and Statistics for Engineering”, 5[TH] Edition, Prentice Hall, 1994.
2. Jay, L.Devore, “Probability and Statistics for Engineering and Sciences”, Brooks cole Publishing Company, Monterey, California, 1982.
3. Gupta, S.C. and Kapoor, V.K, “Fundamentals of Mathematical Statistics”, 11[th] Edition (Reprint), Sultan Chand and Sons, New Delhi, 2007.
4. Trivedi, K.S., “Probability and Statistics with Reliability, Queing and Computer Science Applications”, PHI.
5. Kapur,J.N.and Saxena, H.C, “mathematical Statistics”, 18[th] Revised Edition, S.Chand & Co. Ltd., 1997.
6. Douglasc.Montgomery, “Design and analysis of experiements”, John Wiley and Sons, 7[th] edition, 2010.
7. Philip J. Ross, “Taguchi techniques for quality engineering”, Mcgraw Hill Book Company, 2[nd] edition, 1995.

		L	T	P	C
CIV 5001	**ENVIRONMENTAL CHEMISTRY**	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the fundamentals principles of environmental chemistry.
CO2	Understand water chemistry required in the treatment processes of water and wastewater
CO3	Analyze the growth kinetics of microorganisms.
CO4	Understand the processes in biological treatment systems.

Mapping of course outcomes with program outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	L	-	L	L	M	-	-	L	L			
CO2	L	H	L	L	L	-	-	L		M	L	L
CO3	M	M	M	L	L	-	L	-				
CO4	L	H	L	L	L	-	-	L				

Introduction

Colloids – Redox potentials – partition co-efficient – Been – Lambert’s Law – Limitations – UV visible spectroscopy – basic principles – application – Atomic absorption spectroscopy – Principles – applications - Gas chromatograph – Principles and applications – Principles of green chemistry – Error Analysis of Environmental Data.

Degradation

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

Aquatic chemistry

Metals, complex formation, oxidation and reduction and sorption – E^h – p^H diagrams - chemical speciation – QSAR – Risk evaluation of chemicals.

Atmospheric chemistry

Regions of atmosphere - Chemical and photochemical reactions – photochemical smog, ozone layer depletion – green house gases and global warming – Acid rain.

Soil chemistry

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

TEXT BOOK

1. C.N. Sawyer, P.L. MacCarty and G.F. Parkin, Chemistry for Environmental Engineering and Science, Tata McGraw-Hill, New Delhi, 5th edition, 2003

REFERENCES

1. G.W. Vanloon and S.J. Duffy Environmental chemistry – a global perspective, Oxford University press, New York., 1st edition, 2000.
2. D.W.Connell, Basic concepts of Environmental Chemistry, Lewis publishers, New York, 2nd edition, 1997.
3. Colin Baird, “Environmental Chemistry”, Freeman and Company, New York, 3rd edition, 1997.
4. S.E. Manahan, Environmental Chemistry, Sixth Edition, Lewis Publishers, New York, 1994.

CIV 5002	**ENVIRONMENTAL MICROBIOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the fundamentals principles of environmental microbiology.
CO2	Understand water chemistry required in the treatment processes of water and wastewater
CO3	Analyze the growth kinetics of microorganisms.
CO4	Understand the processes in biological treatment systems.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	-	L	L	M	-	-	L	L			
COM	L	H	L	L	L	-	-	L		M	L	L
CO3	M	M	M	L	L	-	L	-				
CO4	L	H	L	L	L	-	-	L				

Introduction

Classification of microorganisms—prokaryotic, eukaryotic, structure, characteristics, nucleic acids-DNA, RNA, replication. Culturing of microorganisms, Recombinant DNA technology.

Microbiology of environment

Distribution of microorganisms—Water, Air and Soil, Indicator organisms, coliforms—fecal coliforms, E. coli, Streptococcus, Clostridium, Significance in water - Algae in water supplies—problems and control. Concentration and detection of virus, Transmissible diseases.

Metabolism of microorganisms

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism-aerobic and anaerobic-respiration, fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics.

Role of microorganisms in wastewater treatment

Microbiology of biological treatment processes—aerobic and anaerobic, Biodegradation of toxic pollutants—mechanism-- α-oxidation, β-oxidation, nitrification and denitrification, eutrophication.

Toxicology

Ecotoxicology—toxicants and toxicity, factors influencing toxicity, effects—acute, chronic, concentration response relationships, test organisms, toxicity testing, bioconcentration, bioaccumulation, biomagnification, bioassay, biomonitoring.

TEXT BOOK

1. Maier, R.M., I.L. Pepper and C.P. Gerba, Environmental Microbiology, Academic Press, New York, 2^{nd} edition, 1999.

REFERENCES

1. Tortora. G.J, B.R. Furke, and C.L. Case, Microbiology-An Introduction Benjamin/Cummings Publ. Co., Inc., California, 4th edition, 1992.
2. Frank C. Lu and Sam Kacew, LU's Basic Toxicology, Taylor & Francis, London, 4th Edition, 2002
3. Baker. K.H. and D.S.Herson, Bioremediation, McGraw-Hill Inc., New York, 2nd edition 1994.

CIV 5003	AIR POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify sampling techniques and analyze air quality.
CO2	Understand plume behaviour for different atmospheric stability conditions.
CO3	Assess concentration of pollutant at different receptor locations using plume dispersion modelling
CO4	Design air pollution control systems and evaluate their efficiency

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	L	L	-	L	L				L
CO2	H	M	M	-	L	-	L	-	L		L	
CO3	H	M	H	-	M	M	L	L		M		
CO4	M	M	L	-	L	M	L	L				

Introduction

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

Control of particulate contaminants

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

Control of gaseous contaminants

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

Emerging trends

Process Modification – Automobile Air Pollution and its control – Fuel Modification - Mechanical Particulate Collectors – Entrainment Separation – Internal Combustion Engines – Membrane Process – Ultraviolet Photolysis – High Efficiency Particulate Air Filters – Technical & Economic Feasibility of selected emerging technologies for Air pollution control – Control of Indoor Air Quality – Radio active pollution and its control.

Noise control

Noise Standards - Measurement – Modeling - Control and preventive measures.

TEXT BOOK

1. Noel de Nevers, Air Pollution Control Engg., McGraw-Hill, New York, 2nd edition, 1995.

REFERENCES

1. Lawrence K.Wang, Norman C Perelra, Yung-Tse Hung, Air Pollution Control Engineering, Tokyo, 2nd edition, 2004.
2. David H.F Liu, Bela G.Liptak Air Pollution, Lewis Publishers, 2nd edition, 2000.
3. Anjaneyulu.Y, Air Pollution & Control Technologies, Allied Publishers (P) Ltd, India, 2nd edition, 2002.

		L	T	P	C
CIV 5004	**TRANSPORT OF WATER AND WASTE WATER**	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify the problems pertaining to water supply and sanitation.
CO2	Design water supply and sanitation system for the community.
CO3	Design low cost waste management systems
CO4	Plan and design an effluent disposal mechanism.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M		M	L	-	-	-		L		
CO2	H	H	L	M	L	L	L	L	L		L	
CO3	H	H	L	M	L	L	M	L				L
CO4	H	H	L	M	L	L	L	L				

Principles of hydraulics

Fluid properties - fluid flow – continuity principle, energy principle and momentum principle - frictional head loss in free and pressure flow, major and minor head loss, formula for estimation of head loss – pumping of fluids – selection of pumps – Flow measurement.

Water transmission and distribution

Planning factors – Water transmission main design – pipe material – economics – water hammer analysis - water distribution pipe networks – methods for analysis and optimisation – Laying and maintenance, insitu lining – appurtenances – corrosion prevention – minimization of water losses – leak detection.

Wastewater collection and conveyance

Planning factors – Design of sanitary sewer - partial flow in sewers, economics of sewer design; sewer appurtenances - material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing condition - conveyance of corrosive wastewaters.

Storm water drainage

Planning – run-off estimation, rainfall data analysis, storm water drain design – rain water harvesting

Case studies and computer applications

Computer applications for water transmission, water distribution and sewer design.

TEXT BOOK

1. G.S.Bajwa, Practical Handbook on Public Health Engineering, Deep Publishers, Shimla, 2003

REFERENCES

1. Manual on water supply and Treatment, CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2nd edition, 1999.

2. Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2nd edition, 1993.
3. B.A. Hauser, Practical Hydraulics Handbook, Lewis Publishers, New York, 2nd edition, 1991.

CIV 5081	ENVIRONMENTAL ENGINEERING LABORATORY	L	T	P	C
		0	0	3	2

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify and analyze physical parameters of water and wastewater.
CO2	Determine the concentration of Chlorides, Fluorides, Hardness, DO and other quality parameters.
CO3	Estimate BOD and COD of given wastewater samples.
CO4	Determine pollutant concentrations using AAS, Spectrophotometer, HPLC, Ion Analyser and flame photometer.
CO5	Determine bacterial count in a given sample

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	L	M	-	-	L	L			L
CO2	H	H	L	-	L	-	-	L	L	L	M	
CO3	H	H	L	-	-	-	L	L				L
CO4	H	H	L	-	-	M	-	-				
CO5	H	H	-	-	L	-	L	-				

Physical and chemical analysis of water

pH, Conductivity, Turbidity, Solids, Chlorides, Sulphates, Alkalinity, Fluorides, Nitrate and heavy metals.

Physical and chemical analysis of wastewater

Phosphate, COD, BOD, Organic and ammonical nitrogen, Oil & grease.

Air quality analysis

SPM, SO_2, CO, NO_x

Soil analysis

pH, Conductivity, Cation exchange capacity, Sodium Absorption ratio

Microbiological analysis

Preparation of media, serial dilution and plating, Growth curve, Sampling of Microorganisms from air, water and soil, staining – simple and gram staining, Effect of pH, temperatures and nutrients on growth of bacteria, Bacteriological analysis of water - coliforms and streptococcus fecalis by MPN and membrane filter techniques, Study of aquatic organisms – Algae, protozoa and fungi

SEMESTER - II

CIV 50LL	SOLID AND HAZARDOUS WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Examine physical and chemical composition of hazardous wastes
CO2	Analyze activities associated with the management of solid waste.
CO3	Understand method to recover materials, conserve products, and to generate energy from solid and hazardous wastes.
CO4	Design and locate waste containment systems as per regulatory standards.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	H	M	L	-	-	-	L	L		
CO2	M	M	L	M	L	-	-	L		L	M	
CO3	H	M	L	M	L	L	-	L			L	L
CO4	H	H	M	H	L	M	-	L				L

Introduction

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

Waste characterisation and source reduction

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

Storage, collection and transport of wastes

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

Waste processing technologies

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes

Waste disposal

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

TEXT BOOK

1 George Tchobanoglous, Hilary Theisen and Samuel A, Vigil Integrated Solid Waste Management, McGraw- Hill International edition, New York, 2nd edition, 1993

REFERENCES

1 CPHEEO Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2nd edition, 2000.
2 Micheael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and Environmental Resources Management, Hazardous waste Management, McGraw-Hill International edition, New York, 3rd edition, 2001
3 Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2nd edition, 2002

CIV 5012	PHYSIO - CHEMICAL TREATMENT OF WATER AND WASTEWATER	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify and assess the characteristics of wastewater and their impacts
CO2	Plan and design the components of wastewater treatment systems
CO3	Understand underlying principles of processes involved in secondary wastewater treatment systems.
CO4	Design sludge treatment and disposal methods.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	H	H	L	-	M	-	L	-	L	L	L	L
CO2	H	H	L	-	L	-	L	L		M		
CO3	M	M	-	-	L	L	-	-				
CO4	H	H	L	-	L	M	-	L				L

Introduction

Pollutants in water and wastewater - characteristics, Standards for performance – Significance and need for physico-chemical treatment.

Physical treatment principles

Principles of Screening – Mixing, Equalisation – Sedimendation - Filtration – modelling - back washing – Evaporation - Incineration – gas transfer - mass transfer coefficients. Adsorption – Isotherms – Principles, equilibria and kinetics, reactors, regeneration, membrane separation, Reverse Osmosis, nano filtration ultra filtration and hyper filtration – electrodialysis, distillation – stripping and crystallization – Recent Advances.

Chemical treatment principles

Principles of Chemical treatment – Coagulation flocculation - Precipitation – flotation, solidification and stabilization – Disinfection. Ion exchange, Electrolytic methods, Solvent extraction – advance oxidation /reduction – Recent Advances.

Design of treatment plants

Selection of unit operations and processes - Design of conventional water treatment plant units – Aerators – chemical feeding – Flocculation – clarifier – filters – Rapid sand filter, slow sand filter, pressure filter – chlorinators. Displacement and gaseous type. Layouts – flow charts – Hydraulic Profile - O & M aspects – case studies, Residue management – Upgradation of existing plants - Recent Advances.

Design of industrial water treatment units

Selection of process - Design of softeners – Demineralisers – Wastewater reclamation - Reverse osmosis plants – Residue management – O and M aspects – Recent Advances - case studies.

TEXT BOOK

1 Metcalf and Eddy, Wastewater engineering, Treatment and Reuse, Tata McGraw-Hill, New Delhi, 3rd edition 2003

REFERENCES

1. Manual on water supply and Treatment CPHEEO, Ministry of Urban Development, GOI, New Delhi, 2nd edition,1999.
2. Lee, CC and Shun dar Lin, Handbook of Environmental Engineering Calculations, McGraw-Hill, New York, 2nd edition, 1999.

3. Qasim, S.R., Motley, E.M., Zhu, G. Water works Engineering – Planning, Design and operation, Prentice Hall, New Delhi, 2nd edition 2002.
4. Casey, T.J. Unit treatment processes in water and wastewater Engineering, John Wiley and Sons, London,4th edition, 1993

CIV 5013	BIOLOGICAL TREATMENT OF WASTEWATER	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify and assess the characteristics of wastewater and their impacts
CO2	Plan and design the components of wastewater treatment systems
CO3	Understand underlying principles of processes involved in secondary wastewater treatment systems.
CO4	Design sludge treatment and disposal methods.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	L	-	M	-	L	-	L	L	L	L
CO2	H	H	L	-	L	-	L	L		M		
CO3	M	M	-	-	L	L	-	-				
CO4	H	H	L	-	L	M	-	L				L

Introduction

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

Aerobic treatment of wastewater

Design of sewage treatment plant units – screen chamber, Grit chamber with proportional flow weir, sedimentation tank - Trickling filters, Rotating Biological contactor, activated sludge process & variations, aerated lagoons, waste stabilization ponds – nutrient removal systems – natural treatment systems – Disinfected disposal options – reclamation and reuse - Flow charts, layout, hydraulic profile - Recent advances.

Anaerobic treatment of wastewater

Attached and suspended growth, Design of units – UASB, up flow filters, Fluidised beds – septic tank and disposal – Nutrient removal systems – Layout and Hydraulic profile – Recent advances.

Sludge treatment and disposal

Design of Sludge management facilities, sludge thickening, sludge digestion, Biogas generation, sludge dewatering (mechanical and gravity) – upgrading existing plants – ultimate residue disposal – Recent Advances.

Operations, maintenance, management and case studies

Operational problems – Trouble shooting, Planning, Organising and Controlling of plant operations – capacity building, Case studies on sewage treatment plants – sludge management facilities

TEXT BOOK

1. Arceivala, S.J., Wastewater treatment for pollution control, TMH, New Delhi, 2nd edition, 1998.

REFERENCES

1. Manual on Sewerage and Sewage Treatment CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2nd edition, 1999.
2. METCALF & EDDY, INC. 'Wastewater Engineering, Treatment and Reuse. Third Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2nd edition, 2003.
3. Qasim, S.R, Wastewater Treatment Plant, Planning, Design & Operation Technomic Publications, New York, 1994.

CIV 5014	INDUSTRIAL WASTE WATER MANAGEMENT	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Sample and analyze the characteristics of industrial wastewaters.
CO2	Analyze the effects of disposal of industrial wastes
CO3	Identify and design treatment options for handling industrial wastewater.
CO4	Under different types of industrial waste water treatment.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	M	L	M	M	-	-	-	L	M		L

CO2	M	-	M	M	M	-	L	L		L	L	
CO3	M	3	M	M	L	L	M	L			L	M
CO4	M	M	L	M	M	M	L	M				

Introduction

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater generation rates, characterization and variables – Population equivalent – Toxicity of industrial effluents and Bioassay tests

Industrial pollution prevention

Prevention Vs Control of Industrial Pollution – Benefits and Barriers – Source reduction techniques – Waste Audit – Evaluation of Pollution prevention options – Environmental statement as a tool for pollution prevention – Waste minimization Circles

Industrial wastewater treatment

Equalisation - Neutralisation – Oil separation – Flotation – Precipitation – Heavy metal Removal – Refractory organics separation by adsorption – Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.

Wastewater reuse and residual management

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

Case studies

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Petroleum Refining – Pharmaceuticals – Sugar and Distilleries – Food Processing – fertilizers – Thermal Power Plants and Industrial Estates.

TEXT BOOK

1. Eckenfelder, W.W., Industrial Water Pollution Control, McGraw-Hill, 3rd edition, 1999.

REFERENCES

1. Arceivala, S.J., "Wastewater Treatment for Pollution Control", Tata McGraw-Hill, 2nd edition, 1998.
2. Frank Woodard Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001.
3. World Bank Group Pollution Prevention and Abatement Handbook – Towards Cleaner Production, World Bank and UNEP, Washington D.C.1998.
4. Paul L. Bishop Pollution Prevention: - Fundamentals and Practice, McGraw-Hill International, 2000.

CIV 5015	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify environmental attributes for the EIA study.
CO2	Identify methodology and prepare EIA reports.
CO3	Specify methods for prediction of the impacts.
CO4	Formulate environmental management plans.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	H	-	M	L	L			
CO2	M	L	L	L	H	-	M	L	M	L		L
CO3	M	M	3	L	H	-	M	L		M	M	M
CO4	M	M	M	M	M	M	M	L		L	L	L

Introduction

Environmental Impact Assessment (EIA) – Environmental Impact Statement – EIA in Project Cycle – Legal and Regulatory aspects in India according to Ministry of Environment and Forests – Types and limitations of EIA – Cross sectoral issues and terms of reference in EIA – Participation of Public and Non-Governmental Organizations in environmental decision making.

Components and methods

Components of EIA - Processes – screening – scoping - setting – analysis – mitigation. Matrices – Networks – Checklists – Connections and combinations of processes - Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA.

Prediction, assessment of impacts and reporting

Prediction tools for EIA – Mathematical modeling for impact prediction – Assessment of impacts – air – water – soil – noise – biological – socio-cultural environments – Cumulative Impact Assessment – Documentation of EIA findings – planning – organization of information and visual display materials – Report preparation.

Environmental management plan

Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans – Policy and guidelines for planning and monitoring programmes – Post project audit – Ethical and Quality aspects of Environmental Impact Assessment.

Case studies

Case studies related to the following sectors - Infrastructure - Mining – Industrial - Thermal Power - River valley and Hydroelectric - Nuclear Power.

TEXT BOOK

1. Canter, L.W., Environmental Impact Assessment, McGraw-Hill, New York, 2nd edition, 1996

REFERENCES

1. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey – 2nd edition, 2003
2. Petts, J., “Handbook of Environmental Impact Assessment”, Vol., I and II, Blackwell Science London, 2nd edition, 1999.
3. Biswas, A.K. and Agarwala, S.B.C. Environmental Impact Assessment for Developing Countries, Butterworth Heinemann, London, 2nd edition 1994
4. The World Bank Group, Environmental Assessment Source Book, Vol. I, II and III. The World Bank, Washington. 1991

CIV 5082	UNIT OPERATIONS AND UNIT PROCESSES LABORATORY	L	T	P	C
		0	0	3	2

Course Outcomes: At the end of the course the student will be able to:

CO1	Operation of flocculation and coagulation unit
CO2	Determine silt density index
CO3	Determine kinetic parameters related to chemical and biological processes
CO4	Design of waste water treatment unit.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	H	-	M	L	L			
CO2	M	L	L	L	H	-	M	L	M	L		L

CO3	M	M	H	L	H	-	M	L		M	M	M
CO4	M	M	M	M	M	M	M	L		L	L	L

(Prerequisite: Physical and Chemical treatment of water and wastewater, and biological treatment of wastewater)

LIST OF EXPERIMENTS

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

TEXT BOOK

1. Casey T.J. Unit treatment processes in water and wastewater engineering, John Wileys Sons, London, 3rd edition, 1993.

REFERENCES

1. Metcalf & Eddy, Inc. Wastewater Engineering, Treatment, Disposal and Reuse, Tata McGraw-Hill Publishing Company Limited, New Delhi 3rd edition, 2003.
2. Lee, CC & Shun dar Lin, Hand book of Environmental Engineering Calculations, Mc Graw Hill, New York, 2nd edition, 1999.

ELECTIVES

CIV 5016	MODELS FOR AIR AND WATER QUALITY	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Know the importance of model building
CO2	Identify methodology and prepare water quality modelling
CO3	Identify methodology and prepare air quality modelling
CO4	Determine model performance, accuracy and utilization

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	-	L	L	M	-	-	L	L	L	L	L
CO2	L	H	L	L	L	-	-	L				
CO3	M	M	M	L	L	-	L	-		L	M	M
CO4	L	H	L	L	L	-	-	L			L	L

Introduction

Basics of mathematical Modeling- Modeling as a tool - Procedures of model development - Importance of model building - Characteristics of deterministic models - Classical approach to constrained and unconstrained optimization - State of the art in environmental engineering systems models – climate and system modeling – Erosion and sediment transport

Water quality modelling

Rivers and streams water quality modeling-river hydrology and flow-low flow analysis-dispersion and mixing-flow, depth - water quality modeling process-model sensitivity-assessing model performance - Models for dissolved oxygen, pathogens - Groundwater modeling.

Air quality modelling

Air Pollution modeling and prediction - modeling technique - modeling for non reactive pollutants - single source short term impact - multiple sources and area sources - model performance - accuracy and utilization.

Case studies

Software package applications: -Air quality modeling and water quality modeling

TEXT BOOK

1. John Wainwright and Mark Mulligan, Environmental Modelling Finding Simplicity in Complexity, John Wiley and sons Ltd, USA, 2nd edition, 2004

REFERENCES

1. Deaton and Wine brake, Dynamic Modeling of Environmental Systems, Wiley &sons, USA, 3rd edition, 2002
2. Steven C. Chapra, Surface water quality modeling, McGraw-Hill Inc., New York, 2nd edition, 1997
3. Boubel R.W., Fox, D.L., Turner D. B. & Stern, A C. Fundamentals of Air Pollution, Academic Press, New York, 3rd edition,1994.

CIV 5017	INSTRUMENTAL MONITORING OF ENVIRONMENT	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Know the importance of model building
CO2	Application of spectroscopic method for instrumental monitoring
CO3	Identify methodology and continuous monitoring of instruments
CO4	Analyse electro and radio analytical methods

Mapping of course outcomes with program outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	L	-	L	L	M	-	-	L	L	L	L	L
CO2	L	H	L	L	L	-	-	L				
CO3	M	M	M	L	L	-	L	-		L	M	M
CO4	L	H	L	L	L	-	-	L			L	L

Introduction

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

Spectroscopic methods

Electromagnetic radiation - matter radiation interactions - Colorimetry and spectrophotometry, fluorimetry, nephelometry and turbidimetry, flame photometry Atomic Absorption Spectrometry (AAS), Atomic Emission Spectrometry (AES) – Inductively coupled plasma (ICP) and Direct Current Plasma (DCP) spectrometry - ICP – MS (Mass spectrometry).

Chromatographic methods

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

Electro and radio analytical methods

Conductometry, potentiometry, coulometry, amperometry polarography, Neutron Activation Analysis (NAA), X-ray Fluorescence (XRF) and X-ray Diffraction (XRD) methods.

Continuous monitoring instruments

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

TEXT BOOK

1. Willard. H., Merritt, L., Dean, D.A. and Settle. F.A. Instrumental methods of analysis, Words Worth, New York, 7th edition, 2004.

REFERENCE

1. Ewing Instrumental Methods of Chemical Analysis, McGraw-Hill, New York, 5th edition, 1995.

		L	T	P	C
CIV 5018	**REMOTE SENSING AND GIS FOR ENVIRONMENTAL APPLICATIONS**	3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply basic principles of remote sensing for resource mapping and evaluation
CO2	Develop geospatial database of water resources and environmental engineering systems
CO3	Apply GIS models for hydrological simulation
CO4	Apply GIS models for planning environmental engineering systems

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	L	L	M	-	M	-	L	L	M	L
COM	M	L	M	M	M	L	H	L				L
CO3	M	-	M	L	L	M	M	M		L		
CO4	M	M	M	M	M	M	H	L	L		L	L

Principles of electro magnetic radiation

Concepts of Remote Sensing – Energy sources and radiation principles, Energy interactions in the atmosphere - Spectral reflectance of earth surface features

Remote sensing platforms

Aerial Photographs, Photographic Systems – Visible, Infra Red and Microwave sensing - Active and passive sensors - Satellites and their sensors, Indian Space Programme - Satellite data products

Data processing

Photogrammetry – Satellite data analysis – Visual Interpretation, Interpretation equipments - Digital Image Processing – Image rectification, enhancement, classification, data merging and biophysical modeling – Image Processing software

Geographic information system

Introduction to GIS concepts - Data base structure – Data analysis - GIS software

Remote sensing and gis applications

Management and monitoring of environment, conservation of resources, coastal zone management – Limitations

TEXT BOOK

1. Lillesand, T.M. and Kiefer, R.W., Remote Sensing and Image Interpretation, John Wiley and Sons, New York, 5th edition, 2004.

REFERENCES

2. Burrough, P.A. and McDonnell, R.A., Principles of Geographic Information Systems, Oxford University Press, New York, 2nd edition, 2001.
3. Lintz, J. and Simonet, Remote Sensing of Environment, Addison Wesley Publishing Company, New Jersey, 1998.

CIV 5019	ECOLOGICAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fundamental concepts of ecology
CO2	Identify components of ecosystems and their interrelationships.
CO3	Understand importance of stream water chemistry and its possible changes.
CO4	Assess self purification capacity of receiving waters.
CO5	Model pollutant transport processes.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	-	M	L	M	L	M	-	L	L	L	L
COM	L	-	M	L	M	L	M	-				M
CO3	L	L	M	L	L	L	M	-				
CO4	M	H	M	M	M	M	L	L	M		L	
CO5	-	M	H	H	M	M	L	L		L		

Introduction to ecology and ecological engineering
Aim, scope and applications of ecology – Development and evolution of ecosystems – Principles and concepts pertaining to communities in ecosystem – Energy flow and material cycling in ecosystems – productivity in ecosystems – Rationale of ecological engineering and ecotechnology – Classification of ecotechnology – Principles of ecological engineering.

Systems approach in ecological engineering

Principles, components and characteristics of Systems – Classification of systems – Structural and functional interactions of environmental systems – Environmental systems as energy systems – Mechanisms of steady-state maintenance in open and closed systems – Modelling and ecotechnology – Elements of modelling – Modelling procedure – Classification of ecological models – Applications of models in ecotechnology – Ecological economics.

Ecological engineering processes

Self-organizing design and processes – Multi seeded microcosms – Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems.

Ecotechnology for waste treatment

Ecosanitation – Principles and operation of soil infiltration systems – Wetlands and ponds – Source separation systems – Aquacultural systems – Agro ecosystems – Detritus based treatment for solid wastes – Applications of ecological engineering for marine systems.

Case studies

Case studies of Integrated Ecological Engineering Systems and their commercial prospects.

TEXT BOOK

1. Mitsch, J.W. and Jorgensen, S.E., Ecological Engineering – An Introduction to Ecotechnology, John Wiley & Sons, New York, 2nd edition, 1989.

REFERENCES

1. Kangas, P.C. and Kangas, P., Ecological Engineering: Principles and Practice Lewis Publishers, New York, 4th edition, 2003.
2. Etnier, C. and Guterstam, B., Ecological Engineering for Wastewater Treatment, Lewis Publishers, New York, 2nd edition, 1997.
3. White, I.D., Mottershed, D.N. and Harrison, S.J., Environmental Systems – An Introductory Text, Chapman Hall, London, 3rd edition 1994.

CIV 5020	GROUND WATER CONTAMINATION AND TRANSPORT MODELING	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Model regional groundwater flow and design water wells
CO2	Formulate and solve conjunctive use of surface water and groundwater resource utilization problems
CO3	Identify sites for artificial recharge of groundwater and determine the consequences of artificial recharge
CO4	Conduct Geophysical exploration studies for groundwater source identification

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	H	L	L	-	M	M	L	L	L	
CO2	-	M	M	H	M	-	M	M				M
CO3	-	M	L	M	H	L	L	M	L	L	L	
CO4	M	H	M	-	-	-	M	L		M		L

Introduction

Ground water and the hydrologic cycles – Ground water as a resource - Ground water contamination – Water quality standards – Sources of contamination – Land disposal of solid wastes – Sewage disposal on Land. Ground water and geologic processes. Physical properties and principles – Darcy's Law – Hydraulic Head and Fluid Potential – Piezometers and Nests. Hydraulic conductivity and permeability – Homogeneity and Anisotropy – Porosity and voids Ratio– Unsaturated flow and the water table – Steady state flow and Transient flow – Compressibility and effective stress – Transmissivity and storativity –

Equations of Ground water Flow – Limitations of Darcian Approach – Hydro dynamic dispersion.

Hydrologic cycle and flow nets

Flow nets – Graphical construction – Flow nets by numerical simulation. Steady state Regional Ground Water flow – steady state hydrologic budgets – Fluctuations in ground water levels.

Resource evaluation

Development of Ground Water resources – Exploration for Aquifers – the response of Ideal aquifers to pumping – Measurement of parameters – Laboratory tests – Piezometer test – Pumping tests – Estimation of saturated hydraulic conductivity – Numerical simulation for aquifer yield prediction – Artificial recharge and induced infiltration – Land subsidence – Sea water intrusion.

Chemical properties and principles

Constituents – Chemical equilibrium – Association and Dissociation of dissolved species – effects of concentration gradients – Mineral dissolution and solubility – Oxidation and reduction Process – Ion exchange and Adsorption – Environmental isotopes – Field Measurement of Index parameters. Chemical Evolution: Hydro Chemical sequences and facies – graphical methods – Hydro chemical Facies – Ground water in carbonate terrain – Ground Water in crystalline rocks – Ground Water in complex sedimentary systems – Geochemical interpretation of ^{14}C Dates – Process rates and molecular diffusion.

Solute transport

Transport process – non-reactive constituents in homogeneous media and Heterogeneous media – Transport in Fracture media – Hydro chemical behavior of contaminants – Trace metals– Trace nonmetals – Nitrogen, organic substances – Measurement of parameters – Velocity – Dispersivity – chemical partitioning.

USGS – MOC model

Modelling Principles – MOC Modelling. Case studies

TEXT BOOK

1. Randall J. Charbeneau, Ground water Hydraulics and Pollutant transport Prentice Hall, Upper Saddle River, 5th edition 1999.

REFERENCES

1. Todd David Keith, Ground water Hydrology, Second edition, John Wiley and Sons, New York, 2nd edition, 1980
3. Allen Freeze, R. and John A. Cherry, Ground Water, Prentice Hall, Inc., 1979.

CIV 5021	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fundamental principles of environmental biotechnology
CO2	Identify bioremediation processes different pollutants.
CO3	Design process for enhancing biodegradation.
CO4	Identify ethical, and regulatory issues of microbial technology.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M	M	M	L	L	-	L	L	L	
CO2	H	M	L	M	M	-	L	L				M
CO3	H	H	M	H	M	L	L	L	L	L	L	
CO4	L	-	L	-	M	M	L	H		M		L

Introduction

Principles and concepts of environmental biotechnology - usefullness to mankind, current status.

Detoxification of environmental 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.

Microbial technology for waste treatment

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

Recombinant dna technology and genetic application

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

Ethical and regulatory issues

Environmental effects and ethics of microbial technology – safety of genetically engineered organisms – microbial containment – Risk assessment, IPR – patents.

TEXT BOOK

1. Wainwright, M, An Introduction to Environmental Biotechnology, 6th edition, 1999.

REFERENCES

1. Chaudhury, G.R. Biological degradation and Bioremediation of toxic chemicals, Dioscorides Press, Oregon, 2nd edition, 1994.
2. Martin.A.M, Biological degradation of wastes, Elsevier Applied Science, London, 2nd edition, 1991.
3. Blaine Metting.F (Jr.,) Soil Microbiology Ecology, Marcel Dekker Inc., 3rd edition, 1993.
4. Old, R.W., and Primrose, S.B., Principles of Gene Manipulation, Blackwell Sci. Publ., Cambridge, 3rd edition, 1985.

CIV 6001	INDOOR AIR QUALITY	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify sampling techniques and analyze air quality.
CO2	Understand plume behaviour for different atmospheric stability conditions.
CO3	Assess concentration of pollutant at different receptor locations using plume dispersion modelling
CO4	Design air pollution control systems and evaluate their efficiency

Mapping of course outcomes with program outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	M	H	H	L	L	-	M	M	L	L	L	L
CO2	-	M	M	H	M	-	M	M		M		
CO3	-	M	L	M	H	L	L	M			L	M
CO4	M	H	M	-	-	-	M	L	L			

Introduction

Indoor activities of inhabitants -residence time. Levels of many pollutants in indoor and outdoor air - Design and operation of buildings for improvements of public health - IAQ policy issues - sustainability - indoor air quality as a basic human right.

Indoor air pollutants

Air pollutants in indoor environments, private residences, offices, schools, sand public buildings, factors that govern pollutant indoors concentrations, including ventilation - Characteristics, Consequences.

Control of pollutants

Control of several pollutant classes, such as radon, toxic organic gases, combustion byproducts, and microorganisms such as molds and infectious bacteria - Case study by an exploration of public policy related to indoor air.

Concepts and tools

Concepts and tools - exposure, material-balance models, statistical models Ventilation

Indoor air pollution from outdoor sources

Indoor air pollution from outdoor sources - particulate matter and ozone; Combustion byproducts - Radon and its decay products - Volatile organic compounds - odors and sick-building syndrome, Humidity Bio-aerosols - infectious disease transmission - Special indoor environments - A/C units in indoor - museums-labs - Measurement methods, Control technologies, Control strategies.

TEXT BOOK

1. Thaddes Godish, Indoor air and Environmental Quality, CRC press, California, 3rd edition, 2000.

REFERENCES

1. Nazaroff W.W and L Alvarez-Cohen, Environmental Engineering Science Wiley sons, New York, 4th edition, 2001.
2. Moroni Marco, Seifet Bernd and Lindrall Thomas, Indoor Air Quality: A ComprehensiveReference Book, Elsvier Science, Vol. 3, 9th edition, 1995

		L	T	P	C
CIV 6002	**ENVIRONMENTAL POLICIES AND LEGISLATION**	3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand background and importance of environmental auditing.
CO2	Identify safety and health aspects of environmental systems.
CO3	Apply key auditing tools and techniques for quantitative assessment
CO4	Prepare environmental audit reports

Mapping of course outcomes with program outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	L	L	M	M	-	M	L	L	L	L	L
CO2	L	L	L	M	M	-	M	M		M		
CO3	M	M	L	M	M	L	M	-			L	M
CO4	M	L	-	M	M	-	L	M	L			

Introduction

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

Indian constitution and environment

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

Administrative regime & legal regime

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

Pollution control laws

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

Environmental (protection) Act 1986

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

TEXT BOOK

1. Divan, A. and M. Noble. Environmental Law and Policy in India (cases, Materials and Statutes) Tripathi Bombay, 1991,.

REFERENCES

1. Constitutional Law of India – J 1997 (31st Edn.) Central Law Agency Allahabad.
2. Pandey, N. and U.P.D. Kesari Administrative Law Universal Book Trade, Delhi, 1998
3. Tiwari, H.N., Environmental Law, Allahabad Law Agency, Allahabad, 1997.

CIV 6003	ENVIRONMENTAL ENGINEERING STRUCTURES	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fundamental concept of design of structures
CO2	Design of Roofing systems and water retaining structures
CO3	Analysis and design of water tanks
CO4	Understand the procedure of repair and rehabilitation of structures

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	-	-	-	M	M	L	L	L	L
CO2	H	H	M	-	H	M	M	M		M		
CO3	H	H	-	-	-	-	M	M			L	M
CO4	-	-	H	-	H	H	M	M	L			

Design of pipes

Structural design – Concrete, Prestressed Concrete, Steel and, Cast-iron piping mains, sewerage tanks design - anchorage for pipes - massive outfalls - structural design and laying - hydrodynamic considerations - Advances in the manufacture of pipes.

Design of Roofing systems and water retaining structures

Design of concrete roofing systems – Cylindrical, Spherical, Conical shapes using membrane theory and design of various types of folded plates for roofing with concrete - IS Codes for the design of water retaining structures.

Analysis and design of water tanks

Design of circular, rectangular, spherical and Intze type of tanks using concrete - Design of prestressed concrete cylindrical tanks - Economic analysis - introduction to computer aided design and packages.

Design of special purpose structures

Underground reservoirs and swimming pools, Intake towers, Structural design including foundation of water retaining structures such as settling tanks, clarifloculators, aeration tanks - effect of earth pressure and uplift considerations - selection of materials of construction.

Repair and rehabilitation of structures

Diagonising the cause and damage, identification of different types of structural and non-structural cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures.

TEXT BOOKS

1. Reinforced Concrete by P.Dayaratnam.
2. Krishna Raju, Prestressed Concrete, Tata McGraw-ill Publishing Co, New Delhi, 2nd Edition 1988.
3. Sinha, N.C. & S.K.Roy Reinforced Concrete, S.Chand and Co. , New Delhi, 1985.

REFERENCES

1. Hulse R., and Mosley, W.H., Reinforced Concrete Design by Computer, Macmillan Education Ltd., 1986.
2. Ramaswamy, G.S., Design and Construction of Concrete shell roofs, CBS Publishers, India, 2nd edition,1986.
3. Green, J.K. and Perkins, P.H., Concrete liquid retaining structures, Applied Science Publishers, 1981.

CIV 6004	MASS TRANSFER IN AIR-WATER-SOIL INTERACTION	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fundamental concept of environmental interface
CO2	Evaluate the exchange rate between water and air
CO3	understanding of transport mechanism
CO4	Evaluate the exchange rate between soil and air

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	-	-	-	M	M	L	L	L	L
CO2	H	H	M	-	H	M	M	M		M		
CO3	H	H	-	-	-	-	M	M			L	M
CO4	-	-	H	-	H	H	M	M	L			

Equilibrium at environmental interface

Ideal solutions – air – water equilibrium occurrences – pure gases in contact with water-pure liquid in contact with air – partition coefficient for the air – water system - Earthern solid – waste equilibrium occurrences – pure solid and liquid chemicals in contact with water and earthern solids. Earthern solid – air equilibrium occurrences – water – liquid chemical equilibrium occurrences – thermal equilibrium at environmental interfaces.

Transport mechanisms

Diffusion and mass transfer – molecular diffusion – eddy diffusion – mass transfer theories – mass transfer coefficients – binary mass transfer coefficients in two phases and two resistance theory of interphase mass transfer turbulence in the environment – fundamentals of heat transfer – analogy theories of momentum, heat and mass transfer.

Exchange rates between air and water

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

Exchange rates between water and the earthern

Dissolution of chemicals on the bottom of flowing streams – geometric forms – stream bottom mass transfer coefficients – natural convection dissolution – the upsurge of chemicals from the sediment – water interface of lakes – a Fikian analysis – annual upsurge rate at sediment – water interface – mass transfer coefficients at the sediment – water interface. Flux of chemicals between sediment and the overlying seawater – movement of chemicals through the benthic boundary layer.

Exchange rates between air and soil

Turbulence above the air – soil interface – the Richardson number – chemical flux rates through the lower layer of the atmosphere – Thronthwaite – Holzman equation – evaporation of liquid chemicals spilled on land – chemical flux rates through the upper layer of earthern material.

TEXT BOOK

1. Thibodeaux, L.J, Environmental Chemo dynamics: Movement of Chemicals In Air, Water and Soil, Wiley - Interscience, New York, 2nd edition, 1996.

REFERENCES

1. Cusssler, E.L, Diffusion: Mass Transfer In Fluid Systems, Cambridge University press, 1994.

CIV 6005	MARINE POLLUTION MONITORING	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fundamental concept of Marine surveying
CO2	Evaluate performance of pollution monitoring
CO3	Plan measures for reclamation of polluted areas
CO4	Develop strategies to control marine pollution

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	-	-	-	M	M	L	L	L	L
CO2	H	H	M	-	H	M	M	M		M		
CO3	H	H	-	-	-	-	M	M			L	M
CO4	-	-	H	-	H	H	M	M	L			

Oceanography

General features of ocean – Conservation laws – Wave characteristics and theories - Sediment transport –– Tides - Ocean Currents – Thermocline circulation – General circulation of ocean waters, Tsunamis, Storm surge – Principles of Marine geology

Coastal environment

Living resources – coral reefs, mangroves, seagrass, seaweeds, fishery potential – nonliving resources – manganese nodules, heavy minerals – Beaches, Estuaries, Lagoons – Shoreline changes

Marine surveying

Sea surveying planning and preparation – Oceanographic instrumentation - Hydrographic Surveying – Underwater surveying - Measurement of physical properties of ocean water - sea bed sampling

Marine pollution and monitoring

Physiochemical properties of sea water - Sources of marine pollution and impacts on coastal ecosystems, Oil pollution – oil spill detection, dispersion, impacts on adjacent area – Oil spill modeling, mitigation measures – Oil exploration and their effects – Marine outfalls - Impacts of Ports and Harbour on marine water quality – dredging – Human intervention in estuarine ecosystem –- sea water classification - Physical modeling in Coastal Engineering – Ocean monitoring satellites -Applications of Remote sensing and GIS in marine studies,

Marine pollution control

National and International treaties, protocols in marine pollution - Exclusive Economic Zone - Sustainable development

TEXT BOOK

1. Kennish, M.J., Pollution impacts on Marine Biotic Communities, CRC press, New York, 3rd edition1998

REFERENCES

1. Newman, M.C., Roberts Jr. M.H., Male R.C. (Editors), Coastal and Estuarine Risk Assessment, Lewis Publishers, Washington, D.C., 2002
2. U.S. Army Corps of Engineers, Shore Protection Manual, Washington D.C., Washington, 4th edition, 2002

CIV 6006	GIS APPLICATION IN NATURAL RESOURCES AND MANAGEMENT	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Plan irrigation systems and command area development programs
CO2	Evaluate performance of an irrigation system
CO3	Plan measures for reclamation of water logged lands
CO4	Develop strategies for conflict management in irrigation projects

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	-	-	-	-	M	M	L	L	L	L
CO2	H	H	M	-	H	M	M	M		M		
CO3	H	H	-	-	-	-	M	M			L	M
CO4	-	-	H	-	H	H	M	M	L			

Introduction to GIS
Definition – Spatial Data – Raster and Vector Structures – database management system – Liking spatial and attribute data – Data Input and Editing – Data analysis – Vector and Raster Overlay – map outputs.

Land evaluation
Objectives – Principles – Procedures – Approaches – land use requirements and land quality parameters – layer creation – matching – classification – case studies.

Wastelands
Types – Identification – Management – eroded lands – types – layer creation – case studies.

Water resources
Surface water: Precipitation – space time analysis – overland flow – storage – groundwater: potential – quality – layer creating – overlay analysis – integrated watershed development – case studies.

Natural vegetation
Forests – Classification (NRSA) – grasslands – layer creation – overlay – management – case studies.

TEXT BOOK

1. Burrough P.A. 1986, Principles of Geographic Information Systems for Land Resources Assessment, Watten street Oxford OX26DP, Oxford University Press.

REFERENCES

1. Fischer, M., H.J. Scholten, and D. Unwin, 1996. Spatial Analytical Perspectives on GIS, Taylor & Francis, London, UK.
2. Fotheringham. S., and P. Rogerson, Ed. 1995. Spatial Analytical GIS, Taylor & Francis, London, UK.
3. Heit, Michael, H. Dennison Parker and Art Shortreid (eds.) 1996, GIS application in Natural Resources2, GIS World, Inc., Fort Collins, Colorads, 540p.

		L	T	P	C
CIV 6007	**WATER QUALITY MODELING**	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify forecasting and prediction problems in hydrology
CO2	Formulate and solve flood routing models for linear and nonlinear hydrologic systems
CO3	Develop and solve rainfall-runoff models using transformation and simulation techniques
CO4	Develop synthetic unit hydrograph for un-gauged watersheds

Mapping of course outcomes with program outcomes

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	M	-	-	-	M	-	-	L	L	L	
CO2	H	M	-	-	-	M	-	M				M
CO3	-	H	-	M	-	M	M	M	L		L	
CO4	-	H	-	-	-	-	L	L		M		M

Water quality
Physical and chemical properties of water – Suspended and dissolved solids – EC and pH – Trace constituents – Principles of water quality. - Water quality investigation – Sampling design - samplers – automatic samplers - data collection platforms – Field kits and investigations – Water quality data storage, analysis and inference, Water Quality in Distribution System – factors affecting water quality, predictive tools and intermediate disinfection – Software packages

Irrigation water quality
Water quality standards – Water quality for irrigation – Salinity and permeability - Irrigation practices for poor quality water – Waste water irrigation: problems and prospects – Saline water irrigation – Future strategies - Water quality indices

Surface water quality modeling

Historical development of water quality models ; rivers and streams water quality modelling - river hydrology and flow - low flow analysis - dispersion and mixing - flow, depth, and velocity - estuaries - estuarine transport, net estuarian flow, estuary dispersion coefficient; Lakes and impoundments - water quality response to inputs; water quality modeling process - model sensitivity - assessing model performance ; Models for dissolved oxygen, pathogens; Streeter - Phelps models.

Groundwater quality modeling
Mass transport of solutes, degradation of organic compounds, application of concepts to predict groundwater contaminant movement.

Water quality management
Water Quality Objectives and Standards, Water Quality control Models, Flow Augmentation, wastewater Transport Systems, River Water Quality Models and Lake Quality Models.
Water Quality: Monitoring and Mapping Through Remote Sensing.

TEXT BOOKS

1. Fried, J.J., Groundwater Pollutions: Theory, Methodology, Modelling and Practical rules, Elsevier Scientific Pub. Co., 1975.
2. James, A., Mathematical Models in Water Pollution Control, John Wiely, 1978.
3. Jorgensen, S.E., Application of Ecological Modelling in Environmental Management, Part A & B, Elsevier Scientific Pub. Co., 1983.
4. Thomann, R.V. & Mweller, Principles of Surface Water Quality Modelling & Control, Harper & Row, 1987.

REFERENCE BOOKS

1.Thomann R.V, Principles of Surface Water Quality Modelling and Control.
2.Gower. A.M., Water Quality in Catchment Ecosystem.
3.Scalf M.R. Manual of SW Quality Sampling procedure
4.Trivedi R Singh, Water Resources and Quality Management
5. Steven C.Chapra, " Surface Water quality modeling ", The McGraw-Hill-Companies, Inc., New York, 1997.
6.Ralph A. Wurbs, " Water Management Models - A Guide to Software ", Prentice Hall PTR, New Jersey, 1995.

CIV 6008	WATER RESOURCES SYSTEMS ENGINEERING	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply concepts of systems analysis for planning of water resources systems
CO2	Perform basic economic analysis to evaluate the economic feasibility of water resources and environmental engineering projects
CO3	Formulate and solve deterministic optimization models for design and operation of water resources systems
CO4	Formulate and solve stochastic and fuzzy optimization problems for decision making under uncertainty

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	L	H	H	M	M	M	M	L	L	L	L
CO2	-	-	M	H	H	H	M	L	L			
CO3	-	L	H	H	H	H	H	H		L	L	M
CO4	-	L	H	H	H	H	H	H	L			L

Introduction to Water Resources Systems

Element of a water system – concept of a system – types of system - system approach – system analysis – basic problem - applications

Linear and Dynamic Programming

System Techniques in Water Resources - Single variable function – optimization of single variable function – function of multi variables – optimization of function of multi variables – Linear Programming – Simplex method – Dual Problem – Introduction to Dynamic Programming - Characteristics of a DP problem – solution of a DP problem – applications.

Simulation

Components of a simulation model – steps in simulation – simulation runs – combination of simulation and optimization

Economic considerations

Basics of engineering economics – discount factors – economic analysis – market demand and supply – aggregation of demand – conditions of project optimality – benefit cost analysis

Multi objective Planning

Concept – Non-inferior solutions – weighting method – constraint method – plan selection.

TEXT BOOKS

1. Vedula, S. and Mujumdar P P. Water Resources Systems – Modelling Techniques and Analysis, Tata McGraw Hill Publications, New Delhi

2. Ossenbruggen, P, J. Systems Analysis for Civil Engineering. John Wiley and Sons, New York.

REFERENCE BOOK

1. Loucks D.P, Stedinger, J R and Haith D. Water Resources Systems Planning and Analysis, Prentice-Hall, NJ.

CIV 6009	NETWORK ANALYSIS AND OPTIMIZATION	L	T	P	C
		3	0	0	3

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the characteristics of Soft Computing Techniques
CO2	Develop neural network models with applications in Civil Engineering
CO3	Apply fuzzy logic and fuzzy reasoning for decision making
CO4	Apply genetic algorithm for simple optimization problems

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	-	-	-	-	M	M	L	L	L	L
CO2	M	M	-	-	M	M	M	M				L
CO3	-	-	M	M	H	-	M	M		L	L	
CO4	-	-	-	M	M	M	M	M	L			

Introduction to Graphs, Flows & Shortest path problems

Graphs flows, network flow models, network flow algorithms, generic shortest path algorithm, dijkstras method, binary heap, dial's algorithm, bellman-ford method, single/destination method, multiple origin/destination, auction algorithm.

Max – Flow Problem

Max – flow min cut theorem, ford-Fulkerson labeling algorithm, Floyd – warshall algorithm. Min – cost flow problem, combinatorializing the capacities and cost, simplex method for min-cost flow problems – main ideas, the basic simplex algorithm.

Optimization
Introduction – linear programming – transportation problem – the assignment problem and binary constraints – solving linear programs – the simplex method – sensitivity analysis – the gradient method.

Non-linear Network Optimization
Convex and separable problems, problems with side constraints, multicommodity flow problems, integer constraints, network with gains, optimality conditions, duality.

Simulation Modeling

Introduction – basic examples – birthday problem – random number generators – modeling random number variables – approximating density functions – a theoretical queuing model – a coffee shop queuing model – a scheduling model – an inventory model.

TEXT BOOK

1. Dimitri P. Bertsekas Massachusetts Institute of Technology, Network Optimization: Continuous and Discrete Models, Athena Scientific, Belmont, Massachusetts.

REFERENCE BOOKS

1. Christos H. Papadimitriou, university of california-berkeley & Kenneth steiglitz Princeton University, Combinatorial optimization: Algorithms and Complexity, Dover publications, inc. Mineola. New York
2. Brain Albright, Mathematical modeling with excel, Jones and Bartlett India Pvt. Ltd, New Delhi.