NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

SCHEME OF INSTRUCTION AND SYLLABI

FOR

M.TECH PROGRAM IN ENVIRONMENTAL ENGINEERING

Effective from 2019-20

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.

- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.

- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

DEPARTMENT OF CIVIL ENGINEERING

VISION

To be a knowledge nerve centre in civil engineering education, research, entrepreneurship and industry outreach services for creating sustainable infrastructure and enhancing quality of life.

MISSION

- Generating a specialized cadre of civil engineers by imparting quality education and training.

- Attain international standards in teaching, research and consultancy with global linkages.

DEPARTMENT OF CIVIL ENGINEERING
M.TECH. ENVIRONMENTAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

PEO1	Apply basic principles of environment and their significance in the socio-economic development
PEO2	Identify, formulate and design engineered solutions to environmental problems related to air, water and land.
PEO3	Apply best management practices for sustainable development.
PEO4	Communicate and manage interdisciplinary teams in solving complex environmental engineering problems.
PEO5	Demonstrate leadership qualities and exhibit professional ethics.

Mapping of Mission statements with program educational objectives

Mission Statement	PEO1	PEO2	PEO3	PE04	PEO5
MS1	3	3	3	2	2
MS2	2	3	2	3	3

PROGRAM OUTCOMES: At the end of the program the student will be able to:

PO1	Engage in critical thinking and pursue investigations/research and development to solve practical problems.
PO2	Communicate effectively, write and present technical reports on complex engineering activities by interacting with the engineering fraternity and with society at large.
PO3	Demonstrate higher level of professional skills to tackle multidisciplinary and complex problems related to Environmental Engineering
PO4	Analyze and predict environmental parameters /variables using formulated methodologies and techniques.
PO5	Design technically feasible solutions to environmental problems which are legally, ethically, socially and economically acceptable
PO6	To develop strategies for mitigating environmental problems at local, regional and global scales

Mapping of program outcomes with program educational objectives

Programme outcomes	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	2	3	2	3	-
PO2	2	2	2	3	3
PO3	2	3	2	3	3
PO4	2	3	1	2	1
PO5	2	3	1	3	1
PO6	1	3	2	3	1

CURRICULAR COMPONENTS

The total course package M.Tech. Degree program will typically consist of the following components.

a) Core Courses ≥ 24 Credits
b) Elective Courses ≥ 15 Credits
c) Dissertation = 27 Credits

Degree Requirements for M. Tech in Environmental Engineering

Category of Courses	Credits Offered	Min. credits to be earned
Program Core Courses (PCC)	30	30
Departmental Elective Courses (DEC)	18	18
Dissertation	27	27
Total	75	75

SCHEME OF INSTRUCTION

M.Tech. (Environmental Engineering) Course Structure

M. Tech. I - Year I - Semester

S No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	CE5301	Environmental Chemistry and Microbiology	3	0	0	3	PCC
2	CE5302	Water and Wastewater Treatment	3	0	0	3	PCC
3	CE5303	Design of Water Supply and Sewerage Systems	3	0	0	3	PCC
4		Elective – I	3	0	0	3	DEC
5		Elective - II	3	0	0	3	DEC
6		Elective – III	3	0	0	3	DEC
7	CE5304	Advance Environmental Engineering Lab	0	1	2	2	PCC
8	CE5305	Environmental Systems Design Lab	0	1	2	2	PCC
9	CE5341	Seminar – I	0	0	2	1	PCC
		TOTAL	**18**	**2**	**6**	**23**	

M. Tech. I - Year II - Semester

S No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	CE5351	Air Pollution and Control	3	0	0	3	PCC
2	CE5352	Solid and Hazardous Waste Management	3	0	0	3	PCC
3	CE5353	Environmental Impact Assessment and Management	3	0	0	3	PCC
4		Elective – IV	3	0	0	3	DEC
5		Elective – V	3	0	0	3	DEC
6		Elective – VI	3	0	0	3	DEC
7	CE5354	Environmental Monitoring Laboratory	0	1	2	2	PCC
	CE5355	GIS Laboratory	0	1	2	2	PCC
8	CE5391	Seminar – II	0	0	2	1	PCC
		TOTAL	**20**	**2**	**6**	**23**	

M. Tech. II - Year I - Semester

S No	Course Code	Course Title	Credits	Cat. Code
		Industrial Training (8-10 Weeks) – Optional		
1	CE6342	Comprehensive Viva Voce	2	PCC
2	CE6349	Dissertation Part A	9	PCC
		Total	11	

M. Tech. II - Year II - Semester

S No	Course Code	Course Title	Credits	Cat. Code
1	CE6399	Dissertation Part B	18	PCC
		Total	18	

List of Electives

I Year I Semester

S.No	Course Code	Course Title
1.	CE5701	Applied Hydrology
2.	CE5703	Computational Methods
3.	CE5311	Ecology and Stream Pollution
4.	CE5312	Life Cycle Analysis
5.	CE5313	Sustainable Development
6.	CE5314	Environmental regulations and Management System
7.	CE5315	Environmental Systems Engineering

I Year II Semester

S.No.	Course Code	Course Title
1.	CE5361	Industrial Wastewater Management
2.	CE5362	Water Quality Modeling and Management
3.	CE5363	Advanced Wastewater Treatment
4.	CE5364	Applications of RS and GIS in Water Resources and Environmental Engineering
5.	CE5365	Environmental Fluid Mechanics
6.	CE5752	Geo-Hydrology and Groundwater Modelling
7.	CE5762	Urban Water Management
8.	CE5765	Applications of Soft Computing Techniques

Note: In addition to the above listed electives, a student can also register one elective per semester from other departments and two electives per semester from other specializations of the same department, based on suitability of timetable.

DETAILED SYLLABUS

CE5301	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY	PCC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Develop an understanding of the fundamental aspects of chemistry valuable for solving environmental problems
CO2	Apply the principles of chemistry in the treatment processes of water and wastewater
CO3	Classify and analyze the microorganisms
CO4	Understand the processes in biological treatment systems

Detailed Syllabus:

General Chemistry:-Basic principles – chemical equations – types of chemical reactions - calculations from chemical equations; gas laws; Equilibrium and Le Chatelier's Principle – factors affecting chemical equilibrium - activity and activity coefficient - ionic strength.

Physical Chemistry:- Thermodynamics – heat and work – enthalpy – entropy – free energy – temperature dependence of equilibrium constant; membrane processes; principles of solvent extraction; electrochemistry; chemical kinetics; adsorption.

Equilibrium Chemistry:- Variations of Equilibrium relationships; ways of shifting chemical equilibrium; solutions to equilibrium problems -acid base equilibrium – solubility equilibrium – oxidation reduction equilibrium.

Organic Chemistry and Biochemistry:- Organic compounds of interest to environmental engineers, general properties of the functional groups of organic compounds; Enzymes, classification enzymes catalyzed reaction, energy considerations coupling of reaction; Breakdown and synthesis of carbohydrates, fats, proteins under aerobic and anaerobic reactions; CNP cycles under aerobic and anaerobic reactions; Concepts of BOD, COD, TOC.

Environmental Chemistry:- Fundamentals of surface and colloidal chemistry; chemistry involved in water treatment; Atmospheric chemistry; soil chemistry; emerging pollutants and sources of pollution for water, air and soil

Environmental Microbiology:- Introduction of microbiology, classification and characterization of microorganisms, viruses; Morphology and structure of bacteria, nutrient requirement, growth of bacteria; Basic microbiology of water and sewage; Basic principals involved in the analysis of fecal indicator bacteria – coli forms and streptococci, plankton analysis, analysis of pseudomonas & streptococci; Pathways of aerobic and anaerobic metabolism, Energy transfer in metabolism; Kinetics of microbial growth. Microbiology of water, wastewater, soil and air.

Readings:

1. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, 5th Ed., McGraw-Hill Inc., 2002
2. Benefield D. L., Judkins F. J., Weand L. B., Process Chemistry for Water and Wastewater Treatment, 1st Ed., Prentice Hall, 1982
3. Bitton, G., Wastewater Microbiology, 3rd Ed., Wiley, 2005
4. Mitchell, R., and Gu, J.D., Environmental Microbiology, 2nd Ed., Wiley-Blackwell, 2010
5. Eugene Weiner R., Applications of EnvironmentalChemistry - A Practical Guide for Environmental Professionals, 1st Ed., Lewis Publishers, 2000

CE5302	WATER AND WASTEWATER TREATMENT	PCC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Design the components of water treatment plant
CO2	Design the components of wastewater treatment plant
CO3	Design the low cost sanitation systems
CO4	Design sludge treatment and disposal methods.

Detailed Syllabus:

Water transmission main design- Gravity and pumping main; Design of pump house; – Storage reservoirs- Water treatment Plant Design: Screening – Aeration- Sedimentation – Coagulation, Flocculation- Slow sand Filtration–Rapid Sand Filtration- Back washing –Membrane Processes- --Disinfection-

Design of Preliminary and Primary Treatment Operations for wastewater: Screening, Comminuting, Grit removal, Skimming Tank, Primary sedimentation.

Design of Suspended Growth Processes, Modifications, Process Design Criteria, Oxygen and Nutrient Requirements- Design of Attached Growth Processes: Trickling Filters (Standard Rate, High Rate), Biofilters, Rotating Biological Contactors.

Design of Waste stabilisation Ponds, Lagoons, Root Zone Treatment Systems, Membrane bioreactors, fluidized bed reactors, Hybrid Systems, Anaerobic systems for wastewater treatment, Design of Septic tank, Sludge Treatment and Disposal, Design of Digester Tank, Sludge Dewatering and Ultimate Disposal.

Readings:

1. Mackenzie L. Davis, Water and Wastewater Engineering: Design Principles and Practice, McGraw Hill, 2010.
2. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw Hill., 1984
3. Nazih K. Shammas, Lawrence K. Wang, Water Supply and Wastewater Removal, 3rd Edition, John Wiley & Sons, Inc, 2011
4. David Hendricks , Fundamentals of Water Treatment Unit Processes - Physical, Chemical, and Biological, CRC Press, 2011
5. Metcalf and Eddy, *Wastewater Engineering – Collection, Treatment, Disposal and Reuse*, 4th Ed., McGraw Hill Pub. Co., 2003
6. CPHEEO, Manual on Water Supply and Treatment, 3rd Ed., Ministry of Urban Development, New Delhi, May 1999.
7. CPHEEO, Manual on Sewerage and Sewage Treatment, 3rd Ed., Ministry of Urban Development, New Delhi, November 2013.

CE5303	DESIGN OF WATER SUPPLY AND SEWERAGE SYSTEMS	PCC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Understanding the need of Water supply and sewage systems
CO2	Design and optimization of water distribution networks
CO3	Understand underlying principles of processes involved in secondary wastewater treatment systems.
CO4	Understanding the Principles of sludge treatment and disposal methods.

Detailed Syllabus:

Need for Transport of water- Sources of water and quality- Planning of water supply systems, Selection of water treatment trains, Selection of Pumps- Characteristics-Economics; Selection of pipe materials, Jointing, Laying and Maintenance, Water distribution pipe networks- Design, analysis and optimization Water hammer analysis; Appurtenances –Corrosion prevention – Minimization of water losses – Leak detection- SCADA systems- Specific contaminant removal systems.

Wastewater Sources and flow rates, Characteristics, Standards of Disposal, Treatment Objective and Strategies, Sewage collection systems; Sanitary sewer design, Biological Treatment Processes: Types, Kinetics of Plug Flow and Completely Mixed Systems- low cost sanitation systems; Treated wastewater reuse/recycle.

Water treatment residuals and Wastewater sludge management and disposal. Use of computer software in water transmission, water distribution, wastewater collection.

Readings:

1. McGhee, T. J., Water Supply and Sewerage, 7th Ed., McGraw Hill International, 2007
2. Quasim, S. R., Motley E. M. and Zhu, G., Water Works Engineering- Planning, Design and Operation, Prentice Hall, 2000
3. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw Hill., 1984
4. Nazih K. Shammas, Lawrence K. Wang, Water Supply and Wastewater Removal, 3rd Edition, John Wiley & Sons, Inc, 2011
5. CPHEEO, Manual on Water Supply and Treatment, 3rd Ed., Ministry of Urban Development, New Delhi, May 1999.
6. CPHEEO, Manual on Operation and Maintenance of Water Supply Systems, Ministry of Urban Development, New Delhi, January 2005.
7. CPHEEO, Manual on Sewerage and Sewage Treatment, 3rd Ed., Ministry of Urban Development, New Delhi, November 2013.

CE5304	ADVANCED ENVIRONMENTAL ENGINEERING LAB	PCC	0 – 1 – 2	2 Credits

Pre-requisites: NONE

Course Outcomes: At the end of the course the student will:

CO1	Learn sampling, and storage of water, wastewater and soil samples
CO2	Experience on lab scale physicochemical treatment processes
CO3	Expose to sophisticated environmental monitoring and analytical instruments
CO5	Determine pollutant concentrations in air samples.

Detailed Syllabus:

Experiment No.1: Estimation of Solids (TDS/TDIS, TSS, VS), Acidity, Alkalinity, Hardness, Chlorides and Fluorides
Experiment No.2: Determination of pH and Conductivity
Experiment No.3: Estimation of Biochemical Oxygen Demand
Experiment No.4: Estimation of Chemical Oxygen Demand
Experiment No.5: Estimation of Nitrogen (Different Forms like Ammonia, Nitrite, Nitrate)
Experiment No.6: Estimation of Phosphates and Sulphates
Experiment No.7: Estimation of Residual Chlorine
Experiment No.8: Determination of Available Chlorine in bleaching powder
Experiment No.9: Conducting Break Point Chlorination Test
Experiment No.10: Determination of Dissolved Oxygen
Experiment No.11: Conducting Jar test for determining optimum dosage of coagulant
Experiment No.12: Estimation of Organic Compounds Using HPLC
Experiment No.13: Analysis of air samples using Gas Chromatograph
Experiment No.14: Determination of Heavy metals using spectrophotometer
Experiment No.15: Estimation of suspended particulate matter, SO_x, NO_x and VOC in air

Readings:

1. Standard methods for the examination of water and wastewater, 21st Edition, Washington: APHA., 2012
2. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, 5th edition McGraw-Hill Inc., 2002
3. B. Kotaiah and Dr. N. Kumara Swamy, Environmental Engineering Laboratory Manual, Charotar Publishing House Pvt. Ltd., 1st Ed., 2007
4. A Guide to the Sampling and Analysis of Waters, Wastewaters, Soils and Wastes, Environment Protection Authority State Government of Victoria March 2000
5. Handbook for sampling and sample preservation of water and wastewater
6. Industrial Waste Resource Guidelines Sampling and Analysis of Waters, Wastewaters, Soils and Wastes, EPA Victoria, 2009

CE5305	ENVIRONMENTAL SYSTEM DESIGN LAB	PCC	0 – 1 – 2	2 Credits

Pre-requisites: NONE

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

CO1	Design stormwater sewers using precipitation data.
CO2	Design water supply mains and distribution system
CO3	Estimate the effect of water hammer in water supply pipelines and design the appurtanances
CO4	Determine kinetic parameters related to chemical and biological processes
CO5	Design air pollution control systems

Detailed Syllabus:

Design problem 1: Analysis of Precipitation Data
Design problem 2: Analysis of Distribution Networks
Design problem 3: Design of water Treatment plant
Design problem 4: Design of Wastewater Treatment plant
Design problem 5: Design of Air Pollution Control Devices
Design problem 6: Determination of Rate Constants and Ultimate BOD
Design problem 7: Kinetics of Biological Processes
Design problem 8 :Kinetics of Chemical Processes
Design problem 9 :Design integrated solid waste management system

Readings:

Metcalf & Eddy, Inc., Waste water Engineering Treatment and Reuse, McGraw Hill Inc., New Delhi., 2003
Peavy, H.S, Rowe, D.R., and G. Tchobanoglous ,Environmental Engineering, McGraw Hill Inc., New York., 1995

CE5351	AIR POLLUTION AND CONTROL	PCC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

Detailed Syllabus:

Air Pollution: Definition of Air Pollution - Sources & Classification of Air Pollutants - Effects of air pollution - Global effects - Air Quality and Emission standards - Sampling of Pollutants in ambient air - Stack sampling.

Meteorology And Air Pollution: Factors influencing air pollution, Wind rose, Mixing Depths, Lapse rates and dispersion - Atmospheric stability, Plume rise and dispersion, Prediction of air quality, Box model - Gaussian model - Dispersion coefficient - Application of tall chimney for Pollutant dispersion.

Control of Particulate Pollutants: Properties of particulate pollution - Particle size distribution - Control mechanism - Dust removal equipment - Design and operation of settling chambers, cyclones, wet dust scrubbers, fabric filters & ESP.

Control of Gaseous Pollutants: Process and equipment for the removal by chemical methods - Design and operation of absorption and adsorption equipment - Combustion and condensation equipment, fugitive gas emissions and control.

Automobile Pollution And Control: Sources, Theoretical Considerations, Operating conditions Vs Emissions, Pollution control Measures, Emission Standards.

Control of Air Pollution: Zoning and site selection – Other Management controls, AP Legislation.

Readings:

1. Colls, J., Air Pollution: Measurement, Modeling and Mitigation, CRC Press, 2009
2. Noel, D. N., Air Pollution Control Engineering, Tata McGraw Hill Publishers, 1999
3. Stern, A.C., Fundamentals of Air Pollution, Academic Press, 1984

CE5352	SOLID AND HAZARDOUS WASTE MANAGEMENT	PCC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Examine physical, chemical and biological composition of wastes
CO2	Provide knowledge on recovering materials, conserve products, and to generate energy from solid and hazardous wastes.
CO3	Design aspects of the solid waste management as per regulatory standards

Detailed Syllabus:

Solid Waste: Definitions, Characteristics, and Perspectives
Types of solid wastes, sources of solid wastes, properties of solid wastes, solid waste management: an overview

Engineering Systems for Solid Waste Management
Solid waste generation; on-site handling, storage and processing; collection of solid wastes; transfer and transport; processing techniques; ultimate disposal; Integrated SW Management concepts

Engineering Systems for Resource and Energy Recovery
Processing techniques; RRR approach, materials-recovery systems; recovery of biological conversion products; recovery of thermal conversion products; recovery of energy from conversion products; materials and energy recovery systems.

Engineering Disposal of SW
Dumping of solid waste; sanitary land fills – site selection, design and operation of sanitary landfills – Leachate collection & treatment. Identify methods of solid waste disposal during a site visit and follow safety precautions.

Hazardous Waste Management
Introduction; Concern about Hazardous Waste Management; Characteristics of Hazardous Waste; Transportation and Disposal of Hazardous Waste; Industrial/biomedical waste, E- waste management

Readings:

1. Tchobanoglous G, Theisen H and Vigil SA , Integrated Solid Waste Management, Engineering Principles and Management Issues' McGraw-Hill, 1993
2. Vesilind PA, Worrell W and Reinhart D, Solid Waste Engineering' Brooks/Cole Thomson Learning Inc., 2002
3. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, Environmental Engineering, McGraw Hill Inc., N.York, 1985
4. G. Tchobanoglous., Frank Kreith ,Hand Book of Solid Waste Management, McGrawHill, Inc., N.York., 2002
5. Qian X, Koerner RM and Gray DH, Geotechnical Aspects of Landfill Design and Construction, Prentice Hall, 2002
6. CPHEEO, Manual on Municipal Solid Waste Managment, Ministry of Urban Development, New Delhi, 2016.

CE5353	ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT	PCC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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.

Detailed syllabus:

Introduction: Definitions - Environmental Inventory, Standards, Indices - Environmental attributes— Air, Water Noise, Land Economic; Cultural and detailed discussions of individual parameters of each attributes; methods for Prediction and assessment of impacts air - water - soil - noise - biological - cultural - social - economic environments - Standards and guidelines for evaluation, EIA notification.

EIA - EIA Terminology - Need for EIA - Evolution of EIA - Concepts of EIA - Merits and demerits of EIA - Procedures - Screening, Scoping baseline data, Impact prediction - Stake holders of EIA - Public Participation in Decision making - Projects requiring Environmental Clearance.

EIA methodologies - Criteria for Selection -Impact identification, measurement, interpretation and Evaluation - Impact Communication - Adhoc Methods, Checklists Methods, matrices , Networks and Overlays Methods - Cost-Benefit Analysis - Rapid EIA and Comprehensive EIA - General Framework for Environmental Impact Assessment, Characterization and site assessment.

EMP and Monitoring - Document Planning - Scope and Baseline conditions - Construction Stage Impacts - Environmental Management Plan - Identification of significant or Unacceptable Impacts - Environmental Mitigation Plans - Relief and rehabilitation - Environmental Legislation and Audit - Concept of Environmental Risk Analysis and Life Cycle Assessment - Legal and regulatory Aspects in India.

EIA Case Studies of Developmental Projects : Preparation of EIA for developmental projects - Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Mining, Nuclear fuel complex, Highway project, Sewage treatment plant, CETP, Treatment Storage Disposal Facility, Municipal Solid waste processing plant, Tannery industry. Software for rapid EIA.

Readings:

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill Pub. Co., 1997
2. David P. Lawrence, Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley & Sons, 2003
3. Hosetti, B. B., Kumar A, Eds, Environmental Impact Assessment & Management, Daya Publishing House, 1998
4. UNESCO, Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development, UNESCO/UNEP, Paris, 1987
5. Anjaneyulu.Y., and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007
6. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004

CE5354	ENVIRONMENTAL MONITORING LABORATORY	PCC	0 – 1 – 2	2 Credits

Pre-requisites: NONE

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

CO1	Microscopic examination of microbes from soil, water and air
CO2	Isolation of microorganisms, understanding bacterial staining and cultural techniques
CO3	Quantitative estimation of microbes, report writing on microbial analysis of the samples

Detailed Syllabus:

1. Preparing a Culture Medium and Culturing Bacteria
2. Bacterial Strain Isolation by Using Plate Streaking
3. Microscopy and Environmental Strain Isolation 2
4. Bacterial staining techniques
5. Culturing techniques
6. Plate count test and MPN test
7. Bacterial Genomic DNA Extraction
8. DNA Measurement & PCR of Bacterial 16S Rrna
9. Gel Electrophoresis, Purification of 16S rRNA Genes
10. Repeating DNA extraction, PCR or Gel Electrophoresis

Analysis of the above parameters (1 to 10) and preparation of Report on

1. Soil samples
2. Water samples
3. Wastewater samples
4. Anaerobic digestate
5. Composting
6. Industrial wastewater (tannery wastewater, textile wastewater)

CE 5355	GIS LABORATORY	PCC	0-1-2	2 Credits

Prerequisites: None

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

CO1	Prepare the different geospatial layers
CO2	Compute geometric measurements and perform spatial analysis
CO3	Create high-quality maps and associated graphics

Detailed Syllabus:

1. Digitization of Points and Lines
2. Editing Map Elements
3. Attribute Data Entry and Manipulation
4. Cleaning, Building and Transformation
5. Data Analysis – Overlay, Buffer
6. Map Generation with Patterns and Legends
7. Buffer Analysis
8. Network Analysis

Reading:

1. ArcGIS 10.1 user manuals, 2013
2. ERDAS Imagine 2013 user manual

CE5311	ECOLOGY AND STREAM POLLUTION	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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 in assessment of fate of pollutants.
CO4	Assess self purification capacity of receiving waters.
CO5	Model the pollutant transport processes in water bodies.

Detailed syllabus:

Introduction To Ecosystems: Development and evolution of ecosystems – Principles and concepts – Energy flow and material cycling – Nutrient cycles- productivity – Classification of ecotechnology – ecological engineering- Classification of systems – Structural and functional interactions of environmental systems – Mechanisms of steady-state maintenance in open and closed systems- Modeling and ecotechnology – Classification of ecological models – Applications- Ecological economics- Self-organizing design and processes.

Introduction To Fluvial Ecosystems: Fluvial Ecosystem Diversity- The Water Cycle – Stream flow- Flow Variation- The Stream Channel- Sediments and their Transport- Fluvial Processes along the River Continuum

Stream water Chemistry: Dissolved Gases -Major Dissolved Constituents of River Water-Variability in ionic concentrations -The dissolved load -Chemical classification of river water-The Bicarbonate Buffer System-Influence of Chemical Factors on the Biota-Variation in ionic concentration-Salinization -Effects of acidity on stream ecosystems

Water Quality: Water quality models – Historical development – Non point source pollution- Mass balance equation – Streeter - Phelps Equation – Modification to Streeter – Phelps Equation – Waste load allocations – Dissolved oxygen in Rivers and estuaries; Lake Water Quality Models; Models for Nitrogen, Bacteria, Phosphate and toxicants - Ground Water Quality Modeling - Contaminant solute transport equation, Numerical methods- legislations for water quality.

Readings:

1. Tebutt T.H.Y., Principles of Water Quality Control, 5th Ed., Pergamon Press, 1998
2. Thomann V. R., and Mueller A. J., Principles of Surface Water Quality Modelling and Control, Prentice Hall, 1997
3. Welch, E.D., Ecological Effects of Wastewater, Cambridge University Press, 1992
4. Frank R. Spellman and Joanne Drinan, Stream Ecology and Self Purification: An Introduction, 2nd Ed., CRC Press, 2001

CE5312	LIFE CYCLE ANALYSIS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Understanding the concept of Life cycle thinking and frame work of Life cycle assessment.
CO2	Understand the computational structure behind LCA software packages
CO3	Writing report/paper based on a LCA study

Detailed Syllabus:

Introduction, Life Cycle Assessment concepts.

A brief history of Life-cycle Inventory analysis, overview of methodology, Three components, Indentifying and setting boundaries for life-cycle stages, issues that apply to all stages, Applications of inventory analysis

Procedural framework of Life-cycle inventory: Introduction, define the purpose and scope of inventory

General issues in Inventory analysis: Introduction, Using Templates, Data issues, special case boundary issues

Issues Applicable to specific life cycle stages: Introduction, Raw Material acquisition stage, Manufacturing stage, Use/Reuse/Maintenance stage, Recycle/Waste Management stage.

Term Project Proposal, Process Based LCA, Software Demo: SimaPro Part-1, LCA Software Demo: SimaPro Part 2, LCA Software Demo: GREET, LCA Software Demo: BEES (Construction Materials)

Readings:

1. Ciambrone , D.F., Environmental Life Cycle Analysis, CRC Press, 1997
2. Handbook on Life Cycle Assessment : Operational guide to the ISO standards, Kluwer Academic Publishers, 2004

CE5313	SUSTAINABLE DEVELOPMENT	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Familiarize with the concepts of sustainable development and connection with engineering
CO2	Learn the interlink between sustainability components and global climate change
CO3	Develop the skills in selecting and analyzing the sustainability indicators
CO4	Acquire knowledge in the realistic problems and future scope in sustainable development

Detailed Syllabus:

Overview and Need of Sustainable Development
Introduction. Why Sustainability? Nine Ways to Achieve Sustainability, Challenges - Concept of Sustainability, Factors Governing Sustainable Development, Resource consumption and its drivers, Linkages Among Sustainable Development, Environment, and Poverty, Determinants of Sustainable Development, Case Studies on Sustainable Development, Population and Consumption. Technical Approaches to Quantifying Sustainability. The Difficulty of Environmental Valuation.

Exergy, Environment and Climate Change
Introduction. Exergy and environmental problems, Basic Science of Climate Change, Climate Science History. Carbon Sources and Emissions. Carbon Flow Pathways and Repositories. Global Energy Balance. Surface Temperature Model. Greenhouse Gases and Effects. Thermodynamics and climate change, Consequences of Human Induced Climate Change, Climate Change Projections and Impacts. Adaptation, The Water-Energy Nexus. Carbon Dioxide Mitigation, Capture, and Sequestration.

Indicators of Sustainable Development
Introduction. What Do We Mean by Sustainability? The Nature of Natural Resources. Need for Indicators, Aggregating Indicators, Other Weighting Systems, Use of Principal Component Analysis, Three Environmental Quality Indices, Footprint Indicators of Sustainability. Mass Balance and the Footprint Concept. Waste Management and Material Life Cycles. Ecological Design. Sustainable and Green Engineering. Circular Economy Models.

Challenges and Opportunities for Sustainability Development.
Introduction. Case studies, Cleaner Technologies, The Economics of Sustainability. The Role of Government. Social Justice and Sustainability in Wealthy Countries.

Reading:

1. Bradley Striebig, Adebayo A. Ogundipe, Engineering Applications in Sustainable Design and Development, SI Edition, © 2016, ISBN 9781133629788, Edition 1, Cengage Learning US
2. Peter P. Rogers, Kazi F. Jalal, John A. Boyd, An introduction to sustainable development 2008, Glen Educational Foundation, Inc .
3. Ibrahim Dincer, Marc A. Rosen, 2007, EXERGY: Energy, Environment and Sustainable Development, Elsevier
4. Jeffrey D. Sachs, 2015, The Age of Sustainable Development, Columbia University Press

CE5314	ENVIRONMENTAL REGULATIONS AND MANAGEMENT SYSTEM	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Identify the importance of Management System and the process
CO2	Develop the strategic Environmental Management System to achieve cleaner production and pollution control
CO3	Identify the requisites for Environmental auditing and Documentation
CO4	Formulate environmental management System for various industries

Environmental Management System

Environmental management system - What is an EMS? Costs and Benefits of an EMS, Principles, problems and strategies; Review of political, ecological and remedial actions. Future strategies; multidisciplinary environmental strategies, the human, planning, decision-making and management dimensions. EMS in India

Develop an EMS

Plan, Do, Check and Act. Plan - Planning, including identifying environmental aspects and establishing goals, Do - Implementing, including training and operational controls, Act Reviewing, including progress reviews and acting to make needed changes to the EMS, Check Checking, including monitoring and corrective action

Preventive Environmental Management

Pollution control vis a vis Pollution Prevention - Opportunities and Barriers – Cleaner production and Clean technology, closing the loops, zero discharge technologies - source reduction, raw material substitution, toxic use reduction and elimination, process modification – Cleaner Production Assessment- Material or resource balance – CP option generation and feasibility analysis

Standardization

Introduction to ISO and ISO 14001-2004, 2015, ISO 9001-2015, EMAS regulations, Wider application of system based approach. Local infrastructure development and environmental management: A system approach, Regional environmental management system, Conversion plan development and implementation strategies, Environmental management systems in local government**.** Twelve-step transition process from ISO 14001:2004 to 2015 revision

Environmental Audit and Applications

Environmental management system audits as per ISO 19011-2011 vs 2018 – Principles of auditing, Types of Audits, objective of Audit, Principle areas of environmental auditing, Benefits of Environmental Audit Environmental Audit Activities Roles and qualifications of auditors - Environmental performance indicators and their evaluation – Nonconformance – Corrective and preventive actions -compliance audits – waste audits and waste minimization planning – Environmental statement - Due diligence audit , Applications of EMS.

Case Studies

Waste Audits and Pollution Prevention opportunities in Textile, Sugar, Pulp & Paper, Electroplating, Mining, petroleum refining, Tanning industry, Dairy, Cement, Chemical industries, etc.

Reading:

1. Vijay Kulkarni and Ramachandra T.V., 2006. Environmental Management, Commonwealth of Learning, Canada and Indian Institute of Science, Bangalore.
2. Hillary, R., Environmental Management Systems and Cleaner Production,Wiley Publishers, 1997
3. Parvesh, A newsletter from ENVIS Centre, Environmental Management System- February 2001, CPCB, India

4. Christopher Sheldon and Mark Yoxon, Installing Environmental management Systems – a step by step guide, Earthscan Publications Ltd, London, 1999
5. ISO 14001/14004, ISO 9001, ISO 19011: Environmental management standards, International Organisation for Standardisation,
6. https://www.epa.gov/ems - Environmental Management Systems (EMS)
7. Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations, Second Edition, NSF International, Ann Arbor, Michigan, January 2001

CE5315	ENVIRONMENTAL SYSTEMS ENGINEERING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Analyze physical, chemical and biological processes in environmental systems
CO2	Formulate and solve governing equations for pollutant transport
CO3	Analyze engineered transport system
CO4	Plan and analyze treatment systems

Detailed syllabus:

Basic concepts of mole and mass concentration: notations and conventions, Review of mass balance concepts.

Diffusive transport: Diffusion and Fick's first law, Calculation of molecular diffusion coefficients in air and water

The constitutive transport equation: Derivation of general transport equation and special forms ie continuity and NS equations and similarity between equations of mass momentum and heat dispersion laws.

Theories of mass transport: two film theory, penetration and surface renewal theory, Boundary layer theory. Mass transport correlations

Transport in sheared reactors: Fluid shear and turbulence, transport in steady sheared fluids, turbulent sheared fluids, shear rates in mixed reactors

Particles and fractals: Introductions, particle size spectra, solid particles and fractal aggregate geometries, measuring and calculating fractal dimensions from particle size distributions.

Coagulation in natural and engineered systems: Introduction, general coagulation equations, factors affecting the stability of aquasols, coagulation kinetics, fractal coagulation models.

Finite difference and Finite volume procedures for solutions of partial differential equations of Mass, Momentum and Energy transport phenomenon

Readings:

1. Bruce E. Logan, Environmental Transport Processes, 2nd Ed., Wiley, 2012.
2. E.L. Cussler, Diffusion: Mass transfer in fluid systems, 3rd Ed., Cambridge University Press, 2007.
3. John S. Gulliver, Introduction to chemical transport in the environment, Cambridge University Press, 2007

CE5701	APPLIED HYDROLOGY	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyse components of hydrologic cycle
CO2	Predict hydrologic extreme events for hydraulic and hydrologic design
CO3	Develop forecasting models for operation of hydrologic systems
CO4	Assess surface water resources

Detailed syllabus

Introduction: Description of Hydrologic Cycle, Overview of application of hydrology in engineering, Historical aspects of development of hydrology

Precipitation: Characteristics of precipitation in India, Measurement of precipitation, rain gauge network, collection and presentation of rainfall data, Test for consistency and continuity of data, analysis of rainfall data, average precipitation over an area, intensity-duration-frequency analysis and depth-area-duration analysis, development of design storms for typical regions in data scarce environment

Abstractions from Precipitations: Evaporation and Evaporation Process, measurement, estimation and control of evaporation, Evapotranspiration, measurement and estimation of evapotranspiration, interception and depression storage, Infiltration process, measurement of infiltration, infiltration models and infiltration indices and effective rainfall, Core of Engineers Procedure for developing effective rainfall hyetograph

Stream flow Measurement: Stream flow measurement, stage-discharge relationship and rating curve, Runoff characteristics, catchment characteristics affecting the runoff, yield from a catchment, flow duration curve and flow mass curve

Hydrograph Theory: Components of hydrograph, base flow separation, direct runoff hydrograph, Unit hydrograph theory, derivation of unit hydrograph, S-hydrograph and instantaneous unit hydrograph, Derivation of unit hydrograph for ungauged catchments, conceptual models - Time Area Diagram, Nash model, Dooge models, synthetic unit hydrograph and its derivation

Flood Estimation: Peak discharge estimation procedures, deterministic and probabilistic approaches, enveloping curve, rational method, SCS and unit hydrograph methods, Design flood, return period, flood frequency analysis, probabilistic and statistical concepts, and time series analysis, Gumbel's and log Pearson Type III methods

Flood Routing: Concepts of flow routing, hydraulic and hydrologic routing, Reservoir routing, Channel routing, Muskingum and Muskingum-Cunge methods of channel routing and flood forecasting

Reading:

1. Chow, V.T, Maidment, D.R., and Mays, L.W.*, Applied Hydrology*, Tata McGraw Hill Edition, 2010
2. McCuen, R.H., *Hydrologic Analysis and Design*, Prentice Hall Inc. N York, 2005
3. Patra, K.C, *Hydrology and Water Resources Engineering,* Narosa Publications, 2008
4. Warren Viessman, Jr, and Lewis, G.L, *Introduction to Hydrology,* Prentice Hall India Pvt., Ltd., New Delhi, 2008

CE5703	COMPUTATIONAL METHODS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Apply numerical methods 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

Detailed syllabus

Overview of the course, the need for computational and statistical methods, overview of the applications in Civil Engineering in general and Water Resources and Environmental Engineering in particular.

Review of numerical techniques for finding roots of non-linear equations and numerical integration.

Ordinary differential equations, nature of problems, boundary and initial equations, Euler's method, modified Euler's method, Predictor-Corrector methods, Runge-Kutta methods, Boundary value problems, Applications for reservoir routing, gradually varied flow problems, pipe networks

Partial differential equations, classification, nature of problems, Concepts of finite difference method, finite difference schemes, Solution of parabolic equations, pollutant transport, Solution of elliptical equations, solution of Laplace equation and Poisson equation, flow through porous media, Solution of hyperbolic equation, method of characteristics, unsteady flow through open channels, propagation of waves, Concepts of finite volume method.

Basic concepts of Finite Element Method, FEM vs FDM, Element shapes, shape functions, development of shape functions for linear elements, Formulation of FEM for stress analysis problems, flow through porous media, Galerkin's method and Variational method for formulation of stiffness matrix.

Reading:

1. Hoffman, J.D., (2011), **"***Numerical Methods for Engineers and Scientists***",** CRC Press, Special Indian Edition
2. Kotteguda, N.T. and Renzo Resso, (1998), *"Statistics, Probability and Reliability for Civil and Environmental Engineers***"**, McGraw Hill Companies Inc., New York
3. Schilling, R.J., and S.L. Harris, (2007), *"Applied Numerical Methods for Engineering***",** CENGAGE Learning, India Edition
4. Abbot, M.A. and Vervey (1996), *"Computational Hydraulics",* Elsevier Publications

CE5361	INDUSTRIAL WASTEWATER MANAGEMENT	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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	Identify and design treatment options for handling industrial wastewater.

Detailed Syllabus:

Introduction:
General Characteristics of Industrial Effluents, Effects on Environment - ISI tolerance limits for discharging industrial effluents into surface water, into public sewers, onto land for irrigation and marine environment- Toxic chemicals from industry, Zero waste approach.

Pretreatment of Industrial Wastewater:
Necessity of pretreatment - Equalization - Seggregation - Process Changes - Salvaging - By product Recovery. Removal by Reverse Osmosis, Ion Exchange, Electrodialysis, Solvent Extraction, Floatation.- Removal of Refractory Organics - Removal of Nitrogen and Phosphorus.

Major Industrial Effluents:
Sources, Characteristics and Treatment.
Food Industries: Sugar, Dairy, Distilleries
Chemical and other Industries*:* Paper and Pulp, Tanneries, Textiles, Fertilizers, Pharmaceuticals, Cement, Steeland refineries.

Readings:

1. Industrial Wastewater Management, Treatment and Disposal, WEF Manual of practice No. FD-3, 3rd Ed., WEF Press and McGrawHill, 2008
2. Numerow, N.L., Liquid Waste from Industry – Theories, Practice and Treatment, Addison-Wesley, 1971
3. Patwardhan, A.D., Industrial Waste Water Treatment, PHI Learning, 2009 Rao, M.N., and Dutta, A.K., Wastewater Treatment, IBH Publ., 1995

CE5362	WATER QUALITY MODELING AND MANAGEMENT	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Assess water quality parameters and their importance
CO2	Identify water quality monitoring strategies and suitable approaches for monitoring water quality
CO3	Formulate mathematical models to assess water quality
CO4	Assess water quality indices and formulate water quality management/ plans for restoration

Detailed syllabus:

1. Introduction: Water Quality, Objectives and Standards, Water quality characteristics, sampling and analysis, Analytical methods, Automated analysis and remote monitoring.
2. Water quality monitoring: Water Pollution, Sources of Pollution, Nature of pollutants, Existing Approaches for Control/Abatement of Water Quality Degradation, Water Quality Monitoring in River Basins and lakes.
3. Water quality modeling: Modelling and Monitoring, Evolution of Water Quality Models, Types of Water Quality Models, Streeter Phelps Model, Non-Point Source Pollution, Modelling Approaches For Modeling Non-point Sources, River Water Quality Models and Lake Quality Models, Water quality indices
4. Water Quality Management: Overview of Water Quality Management, Water Quality degradation, Flow Augmentation, environmental flows in rivers, water quality restoration, , Regulatory Provisions Pertaining to Water Quality Management, Water quality indices and Legal Aspects of Water quality management, Public and Private Sector Involvement
5. Management Practices for pollution control - Technology based approach - Water quality based approach - Control of point sources - Control of nonpoint sources- BMPs to control NPS Pollution, Optimization in Water Quality Management, Management plan case studies, Rivers, Lakes, reservoirs and Ground water.

Readings:

1. Chin, David A., (2006),"Water Quality Engineering in Natural Systems", Wiley – Interscience.
2. Sincero, A.P. and Sincero, G.A. (1999) "Environmental Engineering - A Design Approach", Prentice Hall of India, N Delhi
3. Thomann, R.V., Mueller, J.A., (1987), "Principles of Surface Water Quality Modelling and Control", Harper and Row Publishers

CE5363	ADVANCED WASTEWATER TREATMENT	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Apply advanced technologies in Wastewater treatment.
CO2	Select the most appropriates types of membrane processes for tertiary treatment of wastewater
CO3	Apply advanced oxidation processes to treat concentrated non-biodegradable wastewater
CO4	Apply tertiary treatment processes like adsorption, ion exchange for optimum removal of pollutants

Detailed Syllabus:

Need of Advanced Wastewater Treatment, Nutrient removal technologies, Microorganisms involved in the process, Process configurations; Fundamentals of adsorption, Type of adsorbents Development of adsorption isotherms: Freundlich , Langmuir, BET Activated carbon adsorption, Granular carbon adsorption;

Membrane Processes for wastewater treatment; Membrane Configurations; Fouling of membranes; Membrane Bioreactors for Industrial Wastewater and Municipal Wastewater Treatment.

Types of Ion Exchange Resins, and Applications; Electrochemical Wastewater Treatment Processes;

Electro-oxidation: Electro oxidation process, Reactor configurations; advanced oxidation, Types of oxidizing agents, ozone based and non-ozone based processes Fenton and photo-Fenton Oxidation Solar Photo Catalytic Treatment Systems; advanced physico-chemical processes.

Readings:

1. Metcalf and Eddy, *Wastewater Engineering – Collection, Treatment, Disposal and Reuse*, 4th Ed., McGraw Hill Pub. Co., 2003
2. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw Hill., 1984
3. Water Environment Federation, Membrane Systems for Wastewater Treatment, McGraw Hill Pub. Co., 2006
4. Kaushik Nath, Membrane Separation Processes, PHI, New Delhi, 2008

CE5364	APPLICATIONS OF RS AND GIS IN WATER RESOURCES AND ENVIRONMENTAL ENGINEERING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

Detailed syllabus:

Physics of Remote Sensing: Sources of Energy, Active and Passive Radiation, Electromagnetic Spectrum - Reflectance, Transmission, Absorption, Thermal Emissions, Interaction with Atmosphere, Atmospheric windows, Spectral reflectance of Earth's surface features, Multi concept of Remote Sensing, Fundamentals of Microwave Remote Sensing.

Data Analysis: Data Products and Their Characteristics, Data Pre-processing – Atmospheric, Radiometric, Geometric Corrections – Basic Pattern Recognition Concepts, Basic Principles of Visual Interpretation

Fundamentals of GIS – Information Systems, Modelling Real World Features Data , Data Formats – Spatial and Non-spatial, Components, Data Collection and Input, Data Conversion, Database Management – Database Structures, Files; Standard Data Formats, Compression Techniques, Hardware – Computing, printing and scanning systems

Introduction to Standard Packages like Arcview, ArcGIS, Autocad Map, Map Info etc.

Spatial Analysis and Modelling – Proximity Analysis, Overlay Analysis, Buffer Analysis, Network Analysis, Spatial Auto Correlation, Gravity Modelling, DTM/DEM, Integration with Remote Sensing data

Surface-Water Hydrologic Data, Spatial techniques for Surface-Water Hydrology Modeling, Surface-Water Hydrology Models, ArcSWAT model and its applications;

Groundwater Data, Ground water Models and spatial techniques for Groundwater Modeling and Visualization, The ArcHydro Data Model.

Geospatial techniques for planning and design of Water-Supply and Irrigation Systems, Spatial Database Development for Wastewater and Storm water Systems, Geospatial technologies for Water Resources Monitoring and Forecasting; Spatial Decision-Support Systems in River Basin Management; Spatial systems for floodplain mapping and management, GIS for Water-Quality Management Decision Support

Taxonomy of Environmental Models in the Spatial Sciences. Geographic Data for Environmental Modeling and Assessment. Applications of Remote Sensing and Geographic Information Systems in Wildlife Mapping and Modeling. Land Use Planning and Environmental Impact Assessment Using Geographic Information Systems

Readings:

1. Agarwal, C. S., and Garg, P. K., *Textbook on Remote Sensing in Natural Resources Monitoring and Management,* Wheeler Publishing , Allahabad, 2000
2. Lillesand, T. M., and Keifer, R. W., *Remote Sensing and Image Interpretation,* John Wiley & Sons, N York, 1994
3. Meijerink M. J., de Brouwer, H.A.M., Mannaerts, C. M., and Velenzuela, C. R., *Introduction to the Use of Geographical Information Systems for Practical Hydrology,* ITC publication no. 23, UNESCO, Paris, 1994
4. Swain, P. H., and Davis, S. M., *Remote Sensing – The Quantitative Approach,* McGraw-Hill Pub. Co. N York, 1987Andrew Skidmore (Editor, Environmental Modelling with GIS and Remote Sensing, CRC Press), 2002

CE5365	ENVIRONMENTAL FLUID MECHANICS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Formulate momentum, energy and mass transport models.
CO2	Solve diffusion-dispersion equations.
CO3	Derive and solve basic equations of flow through porous medium.
CO4	Solve transport of momentum, heat, gases, and volatile organic chemicals across the air/water interface
CO5	Design multiport diffusers and submerged discharges

Detailed syllabus:

Basic concepts of fluid mechanics, conservation laws, continuity equation, momentum equation, Application of momentum and energy equations

Transport processes, diffusion phenomena, Fick's Ist and IInd Laws of diffusion, Advection diffusion equation, Turbulent diffusion and dispersion mixing in rivers

Porous medium flow, Approximation of Dupuit, Contaminant transport, Saltwater intrusion into aquifers, Non aqueous phase liquid (NAPL) in groundwater, aspects of numerical modelling

Exchange Processes at the Air/Water Interface, Exchange of Gases, Measurement of Gas Mass Transfer Coefficients.

Topics in Stratified Flow: Buoyancy and Stability Considerations, Internal Waves, Mixing, Double-Diffusive Convection, Mixed-Layer Modeling.

Dynamics of Effluents: Jets and Plumes, Submerged Discharges and Multiport Diffuser Design, Surface Buoyant Discharges

Readings:

1. Rubin, H and Atkinson, J, Environmental Fluid Mechanics, 2001, Marcel and Deckker
2. Gualtieri and Mihailovic, Fluid Mechanics of Environmental Interfaces, 2008, Taylor and Francis
3. Kundu and Cohen, Fluid Mechanics, Academic Press, 2012
4. Cussler, E. L, Diffusion: Mass transfer in fluid systems, 3rd Ed., Cambridge University Press, 2007.
5. Chow, V.T. , Open channel flows, McGraw Hill, 2010

CE5752	GEOHYDROLOGY AND GROUNDWATER MODELLING	PCC	3 – 0 – 0	3 Credits

Pre-requisites: CE5701

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

Detailed syllabus
Geo-hydrology, types of aquifers, aquitards, leaky – aquifers.

Geo-physical exploration studies, different types and procedures for analysis of geophysical studies.

Well hydraulics, partial differential equations governing groundwater flow in aquifers estimation of aquifer parameters by different methods, steady groundwater flow analysis for multiwall systems, method of images.

Groundwater modeling, formulation of anisotropic and non-homogenous flow of groundwater, finite difference methods for solving groundwater flow problems, regional groundwater flow modeling

Water well design and construction procedures

Conjunctive use of surface and sub surface flows

Artificial recharge techniques, water quality modeling

Reading:

1. Karamouz, M, Ahmadi, A, and Akhbari, M, Groundwater Hydrology: Engineering, Planning and Management, CRC Press, 2011.
2. Todd, D.K., and Mays, L. W., Groundwater Hydrology, John Wiley & Sons, Singapore, 2011.
3. Davis, S.N., and De Weist, R.J.M., Hydrogeology, John Wiley & Sons, New York, 1966.
4. Domenico, Concepts and Models in Groundwater Hydrology, McGraw Hill Inc. New York, 1972.

CE5762	URBAN WATER MANAGEMENT	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

CO1	Identify factors affecting urban hydrological cycle
CO2	Estimate urban water demand and urban stormwater quantity
CO3	Plan and design stormwater control and disposal systems
CO4	Develop integrated urban water management system

Detailed syllabus:

General introduction to urbanisation and its effect on water cycle – urban hydrological cycle – trends in urbanisation – Effect of urbanisation on hydrology.

Urban Hydrological cycle – time of concentration – importance of short duration of rainfall and runoff data – methods of estimation of time of concentration for design of urban drainage systems.

Master drainage plans – issues to be concentrated upon – typical content of an urban drainage master plan – interrelation between water resources investigation and urban planning processes – planning objectives – comprehensive planning – use of models in planning.

Basic approaches to urban drainage – runoff quantity and quality – wastewater and stormwater reuse – major and minor systems.

Elements of drainage systems – open channel – underground drains – appurtenances – pumping – source control.

Stormwater Analysis Calculation of runoff and peak – Design of storm water network systems.

Best Management Practices – Detention and retention facilities – Swales-constructed wetlands.

Operation and maintenance of urban drainage system – interaction between stormwater management and solid waste management, Various model available for stormwater management.

Legal aspects

Readings:

1. Geiger W. F., J Marsalek, W. J. Rawls and F. C. Zuidema, Manual on Drainage in Urbanised area – 2 volumes, UNESCO, 1987
2. Hall M J , Urban Hydrology, Elsevier Applied Science Publisher, 1984
3. Stahre P and Urbonas B , Stormwater Detention for Drainage, Water Quality and CSO Management, Prentice Hall, 1990
4. Wanielista M P and Eaglin ,Hydrology – Quantity and Quality Analysis, Wiley and Sons, 1997

CE5765	APPLICATIONS OF SOFT COMPUTING TECHNIQUES	DEC	3 – 0 – 0	3 Credits

Pre-requisites: NONE

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

Detailed syllabus:

Introduction, need for soft computing techniques, components of soft computing

Artificial Neural Networks (ANN), types of ANN and learning algorithms, tasks performed by ANN

Basic concepts of feed forward neural networks, perceptron learning rule, back propagation learning algorithm, application of feed forward ANN for function approximation and prediction, limitations of feed forward neural networks, applications of feed forward neural networks in Hydrology, Water Resources and Environmental Engineering

Hebbian learning and Hopfield networks, pattern association, radial basis function networks, Kohonen networks and self organisation maps, applications of ANN in pattern classification

Information and uncertainty, Chance versus ambiguity, Classical sets and fuzzy sets, Logic and reasoning, Fuzzy set operations and fuzzy relations, Membership Functions, fuzzy numbers and fuzzy arithmetic

Fuzzy Systems, fuzzy relations, fuzzy inference systems, Decision Making with Fuzzy Information, Fuzzy Classification and Pattern Recognition, Neuro-Fuzzy Systems

Evolutionary computing, concepts of genetic algorithm, components of genetic algorithm, Hybrid soft computing techniques, Applications in Civil Engineering.

Reading:

1. Haykin, *Neural Networks: A Comprehensive Foundation,* Prentice Hall India, New Delhi, 2008
2. Jang, J.R, Sun Chuen-tsai, and Mizutani Eiji, *Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence*, PHI Learning, 2009
3. Rajasekaran, S., and Vijayalakshmi Pai, G.A., *Neural Networks, Fuzzy Logic and Genetic Algorithms – Synthesis and Applications*, Prentice-Hall India, New Delhi, 2003

CE5341	Seminar – I	PCC	0 – 0 – 2	1 Credits

Pre-requisite: NONE

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

CO1	Select a topic relevant to planning, analysis and design of a Environmental Engineering systems
CO2	Undertake a critical review of the literature on the chosen topic
CO3	Prepare and present a technical report

CE5391	Seminar – II	PCC	0 – 0 – 2	1 Credits

Pre-requisite: NONE

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

CO1	Select a topic relevant to planning, analysis and design of a Environmental Engineering systems
CO2	Undertake a critical review of the literature on the chosen topic
CO3	Prepare and present a technical report

CE6342	Comprehensive Viva	PCC	0 – 0 – 0	2 Credits

Pre-requisite: NONE

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

CO1	Assimilate knowledge of different courses studied
CO2	Develop overall comprehension about Environmental Engineering
CO3	Analyze real life environmental problems with theoretical knowledge learned
CO4	Interpret and articulate solutions to real life environmental problems

CE6349	Dissertation Part – A	PCC	0 – 0 – 0	9 Credits

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

CO1	Identify and define a topic relevant to planning, analysis and design of a environmental engineering systems based on the social, economical and environmental considerations
CO2	Make a critical review of the available literature on the topic
CO3	Conduct independent research to formulate and solve the chosen problem
CO4	Prepare technical report on the study carried out and publish the results

CE6399	Dissertation Part – B	PCC	0 – 0 – 0	18 Credits

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

CO1	Identify and define a topic relevant to planning, analysis and design of a environmental engineering systems based on the social, economical and environmental considerations
CO2	Make a critical review of the available literature on the topic
CO3	Conduct independent research to formulate and solve the chosen problem
CO4	Prepare technical report on the study carried out and publish the results