M. Tech. DEGREE
ENVIRONMENTAL ENGINEERING

SYLLABUS
FOR
CREDIT BASED CURRICULUM
(2009 -2010)

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015, INDIA.
M. Tech. (ENVIRONMENTAL ENGINEERING)

The total minimum credits required for completing the M. Tech. Programme in Environmental Engineering is 64.

**SEMESTER – I**

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ELECTIVES (I Semester)

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ELECTIVES (II Semester)

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ELECTIVES (To be substituted whenever needed)

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Note: Student may also choose any other elective courses relevant to their degree with the consent of the course coordinator.
SEMESTER I

MA601 NUMERICAL METHODS AND APPLIED STATISTICS


Linear Programming – Graphical and Simplex methods – Measures of central tendency, dispersion, skewness and Kurtosis – Probability – conditional probability – Bayes’ theorem

Random variable – two dimensional random variables – standard probability distributions – Binomial Poisson and normal distributions - moment generating function

Sampling distributions – confidence interval estimation of population parameters – testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test – curve fitting-method of least squares


CE701 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY


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.MPN and MFT.

Ecotoxicology—toxicants and toxicity, factors influencing toxicity, effects—acute, chronic, concentration response relationships, test organisms, toxicity testing, bio concentration, bioaccumulation, bio magnification, bioassay, bio monitoring.

CE702 PHYSICO-CHEMICAL PROCESS FOR WATER AND WASTEWATER TREATMENT


Mixing, Clarification - Sedimentation; Types; Aeration and gas transfer – Coagulation and flocculation, coagulation processes - stability of colloids - destabilization of colloids-transport of colloidal particles, Clarification.

Filtration - theory of granular media filtration; Classification of of filters; slow sand filter and rapid sand filter; mechanism of filtration; modes of operation and operational problems; negative head and air binding; dual and multimedia filtration.

Adsorption, adsorption equilibria- adsorption isotherms, Disinfection - chlorine dioxide; chloramines; ozonation; UV radiation

Ion Exchange-processes, Application Membrane Processes, Reverse osmosis, Ultrafiltration, Electrolysis.


CE703 SOLID AND HAZARDOUS WASTE MANAGEMENT

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management - Legislations on management and handling of municipal solid wastes, hazardous wastes, and biomedical wastes.


Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations - labeling and handling of hazardous wastes.


Disposal in landfills - site selection - design and operation of sanitary landfills- secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – landfill remediation

Elements of integrated waste management


Department of Civil Engineering, National Institute of Technology, Tiruchirappalli – 620 015.
CE704 ENVIRONMENTAL QUALITY MEASUREMENT LABORATORY


Test on dissolved oxygen, BOD and COD

Ambient air quality Analysis: Determination of SPM, CO, NOx and SOx.

Soil Analysis: pH, Conductivity, Cation exchange capacity, Sodium Adsorption ratio

SEMESTER II

CE705 BIOLOGICAL PROCESS DESIGN FOR WASTEWATER TREATMENT


Design of wastewater treatment systems-Primary, secondary and tertiary treatments- Evaluation of Biokinetic Parameters- Activated Sludge and its process - Modifications, Biological Nitrification and denitrification.

Aeration- Fundamentals of gas transfer- Attached Growth Biological Treatment Systems- Trickling Filters- Rotating Biological Contactors- Activated Biofilters.

Waste stabilization Ponds and Lagoons: Aerobic pond, facultative pond, anaerobic ponds-polishing ponds, aerated Lagoons

Anaerobic processes-Process fundamentals-Standard, high rate and hybrid reactors, Anaerobic filters-Expanded /fluidized bed reactors-Upflow anaerobic sludge blanket reactors, - Expanded granular bed reactors- Two stage/phase anaerobic reactors, Sludge Digestion, Sludge disposal


CE706 TRANSPORT OF WATER AND WASTEWATER


Water Distribution systems – Hardy cross, Equivalent pipe and Newton Rapson methods, Distribution network analysis- methods of control and prevention of corrosion.

Sanitary sewage flow estimation – Sewer materials – Hydraulics of flow in sanitary sewers –
Partial flow – Sewer designs – Sewer layouts – Storm drainage.


CE707 AIR QUALITY MANAGEMENT


Atmospheric diffusion of pollutants - Transport, transformation and deposition of air contaminants - Air sampling & pollution measurement methods - Ambient air quality and emission standards - Air pollution indices - Air Act

Control principles – Removal of gaseous pollutants by adsorption, absorption, reaction and other methods.

Particulate emission control- settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation.

Biological air pollution control technologies - bioscrubers, biofilters, and Indoor air quality.


CE708 ENVIRONMENTAL MICROBIOLOGY AND ENGINEERING LABORATORY

ELECTIVES (I Semester)

CE711 WATER AND AIR QUALITY MODELS

Modeling approaches to water quality - classification – Mathematical Models for water quality.

DO. Models for Streams - Streeter Phelps model - oxygen 'sag' curve - deoxygenation and reaeration coefficients - Benthal oxygen demand - mass transport mechanisms –

Advective and diffusive mass transport - Models for Estuary and Lakes - Physical chemical and biological processes - water quality distribution - dispersion coefficient - temperature models.

Models for microorganisms decay.


CE712 INDUSTRIAL WASTEWATER MANAGEMENT

Sources and types of industrial wastewater – Environmental impacts – Regulatory requirements – generation rates – characterization – Toxicity and Bioassay tests.

Prevention vs Control of Industrial Pollution– Source reduction techniques – Waste Audit- Evaluation of pollution prevention options.


CE713 ENVIRONMENTAL SYSTEMS ANALYSIS


Role of optimization models - Deterministic models/Linear programming, Dynamic programming, Separable and Nonlinear programming models.

Formulation of objective functions and constraints for environmental engineering planning and design.

Probabilistic models - fuzzy models - Simulation models.


ELECTIVES (II Semester)

CE714 ENVIRONMENTAL IMPACT ASSESSMENT

Evolution of EIA – Concepts – Methodologies – Screening – Scoping – Base line studies - Mitigation – Matrices – Check list.

Rapid and Comprehensive EIA – Legislative and Environmental clearance procedures in India – Prediction tools for EIA.


Socio cultural environment – Public participation – resettlement and rehabilitation.

Documentation of EIA – Environmental Management plan – Post project monitoring – Environmental Audit – Life cycle assessment – EMS - Case studies in EIA.


CE716 ECOLOGICAL AND ECO SYSTEMS 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 – Multi seeded microcosms.

Interface coupling in ecological systems – Concept of energy – Determination of sustainable loading of ecosystems.


CE 717 ENVIRONMENTAL GEOTECHNOLOGY

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

Soil mineralogy; significance of mineralogy in determining soil behaviour; Mineralogical characterization.

Mechanisms of soil-water interaction: Diffuse double layer models; Force of attraction and repulsion; Soil-water-contaminant interaction; Theories of ion exchange; Influence of organic and inorganic chemical interaction.

Introduction to unsaturated soil mechanics; water retention property and soil-water characteristic curve; flow of water in unsaturated soil.

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

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

ELECTIVES (To be substituted whenever needed)

1. INDOOR AIR QUALITY

Indoor activities of inhabitants - Levels of pollutants in indoor and outdoor air- Design and operation of buildings for improvements of public health- IAQ policy issues- sustainability.

Air pollutants in indoor environments- private residences- offices- schools-public buildings- ventilation.

Control of several pollutant classes- radon- toxic organic gases- combustion byproducts- microorganisms such as molds and infectious bacteria.

Concepts and tools- exposure- material balance models- statistical models.


2. ENVIRONMENTAL ENGINEERING STRUCTURES

Structural design of Concrete- Prestressed Concrete - anchorage for pipes - massive outfalls.

Design of concrete roofing systems a) Cylindrical b) Spherical and c) Conical shapes using membrane theory.

Design of water retaining structures- Design of circular, rectangular, spherical and Intze type of tanks- Design of prestressed concrete cylindrical tanks.

Underground reservoirs and swimming pools- Intake towers- Structural design of settling tanks- clarifloculators- aeration tanks - effect of earth pressure and uplift considerations.

Identification of different types of structural and non-structural cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures.


3. CONTAMINANT TRANSPORT MODELING

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

Model complexity - model resolution - coupled and uncoupled models - linear and nonlinear models - Solution techniques – calibration - application and evaluation of environmental control – bioremediation –

Numerical models: FDM, FEM and Finite volume techniques - explicit vs. implicit methods - numerical errors - High resolution techniques –

Stream quality modeling using QUAL2K - Groundwater transport modeling using VISULA MODFLOW.


4. ENVIRONMENTAL BIOTECHNOLOGY

Environmental Biotechnology -Principles and concepts - usefulness to mankind.


Environmental effects and ethics of microbial technology – genetically engineered organisms-Microbial containment-Risk assessment.


5. DESIGN OF AIR POLLUTION CONTROL SYSTEMS

Industrial sources of air pollution- Emission factors-regulations- control strategies-policies.

Particulate Pollutant Control: Settling chambers - laminar and turbulent flow- Filtration – interception- Impaction- Convective diffusion- Collection of particles by cylindrical fibres and granular beds- Electrostatic precipitation - Cyclones - Wet collectors.
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Gaseous Pollutant Control: Gas absorption in tray and packed towers- Absorption with/without chemical reaction- Removal of SO₂ - Adsorption in fixed beds- Breakthrough.

Removal of HCs/ VOCs- NOₓ removal - Wet scrubbers.

Integrated air pollution control systems.


6. SURFACE AND GROUND WATER MODELLING


Unit Hydrograph & S curve hydrograph, Dimensionless unit hydrograph, GUIH, Watershed Model and Conceptual Models.


Pumping tests, Analysis for unconfined and non leaky and leaky confined aquifer and water table aquifer, Locating hydro geologic boundaries, Well design criteria.

Natural and Artificial Recharge of Ground water- Salt water intrusion, Application of Finite Difference in ground water.


7. RIVER ENGINEERING

Classification of free surface flow, velocity and pressure distributions, Uniform flow.

Dynamic equation for Gradually varied flow – Classification of flow profiles, Computational methods, Prismatic channels.

Energy and Momentum principles in open channel flow, Rapidly Varied Flow, Hydraulic jump – Analysis.

River Hydrology & Distribution of water quality in Rivers, Estuaries, Physical and Hydrological Characteristics of Lakes.


8. WATER RESOURCES SYSTEMS MANAGEMENT

Reservoir planning, Management, Multi reservoir systems, Real time operation, River basin planning, water logging, soil salinity, salinity control.

Design of Dams, Non gravity dams, Weirs and Barrages, Conjunctive use of Irrigation water, Quality of Irrigation water, Contaminants and their effects on various crops

Rainwater Harvesting and Management – Different Types and Methods of Harvesting in urban and agricultural areas.

Draught analysis, NCA classification, Direct and Indirect losses, Drought severity assessment, Drought Monitoring, Drought Management

Introduction to systems approach, Linear programming, Problem formulation, Solution by simplex method, Application to design and operation of reservoir, Non Linear Programming, Sensitivity analysis, Monte Carlo simulation.

1. Dilip Kumar Majumdar, “Irrigation Water Management (Principles & Practices)”, Prentice Hall of India (P), Ltd, 2004
3. Daniel P. Loucks “Water Resources systems Planning and Management(Studies and Reports in Hydrology) “, 2006