N.E.P HoD

Scheme of Evaluation and Syllabus for M.Tech (Environmental Science and Engineering)

(Applicable from Academic Session 2023-24 onwards)

Department of Civil Engineering
Harcourt Butler Technical University, Kanpur
July 2023

Course Structure and Evaluation Scheme

of

M.Tech (Environmental Science & Engineering)

(Effective from Session 2023-24)

Department of Civil Engineering

HARCOURT BULTER TECHNICAL UNIVERSITY
KANPUR

Department of Civil Engineering

Course Structure for M.Tech (Environmental Science and Engineering)
(Applicable from Academic Session 2023-2024) (Revised Final)

Course Name	Course Code	Periods/Structure			Total Credits	
1st semester		**Lecture**	**Tutorial**	**Practical**		
Environmental Process Chemistry and Microbiology	NCE 501	3	0	2	4	Page 5
Environmental Quality and Pollution Management	NCE 503	3	1	0	4	Page 7
Air Pollution and Control Engineering	NCE 505	3	1	0	4	Page 8
Elective I	NCE 509/ 511/513	3	1	0	4	Page 14 to 17
				Total Credits (1st semester)	16	
2nd semester		**Lecture**	**Tutorial**	**Practical**		
Design of Wastewater Treatment Systems	NCE 502	3	1	0	4	Page 10
Solid and Hazardous Waste Management	NCE 504	3	1	-	4	Page 11
Environmental System Analysis	NCE 506	3	1	-	4	Page 13
Elective II	NCE 510/ 512/514	3	1	-	4	Page 18 to 25
				Total Credits (2nd semester)	16	
3rd semester		**Lecture**	**Tutorial**	**Practical**		
Elective III	NCE 601/ 603/605	3	1	0	4	Page 23 & 26
OEC	OCE 601/603/605	3	0	0	3	
Seminar	NCE 671	-	-	3	1	
Dissertation I	NCE 697	-	-	16	8	
				Total Credits (3rd semester)	16	
4th semester						
Dissertation II	NCE 698	-	-	32	16	
				Total Credits (4th semester)	16	
				Total Credits of the M.Tech Programme	64	

List of Programme Electives

Elective type	Course code	Course name	
Program Elective I	NCE 509 ✓	Environmental Impact Assessment	Page 15
	NCE 511	Surface Water Quality Modeling and Control	Page 14
	NCE 513	Remote Sensing and GIS for Environmental Applications	Page 17
Program Elective II	NCE 510	Industrial Wastewater Treatment	Page 21
	NCE 512	Groundwater Flow and Pollution Modeling	Page 18
	NCE 514	Probability and Statistics for Engineers	Page 25
Program Elective III	NCE 601	Life Cycle Analysis and Design for Environment	Page 23
	NCE 603 ✓	Transport of Water and Wastewater Systems	
	NCE 605	Geo-environmental Engineering	Page 26

Open Electives offered by the Department

Open elective	Course Code	Course Name
Open elective	OCE 601 ✓	Environmental Pollution Management
	OCE 603	Introduction to Infrastructure Engineering
	OCE 605	Introduction to Remote Sensing and GIS

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Environmental Process Chemistry and Microbiology NCE501

L T P C 3-0-2-4

Course Objective

On completion of the course the students will be able to understand basic concepts of physical chemistry, instrumentation techniques for the analysis of air and water environment and fundamentals of microbiology.

Syllabus

Unit-1

Physical Chemistry- Introduction- solutions- methods of expressing concentrations of solutions- molarity, molality, normality and mole fractions, ppm vapour pressure, Dalton's law, Henry's law, Graham's law, Raoult's law, law of mass action, chemical equilibrium, Le-Chatelier's principle.

Unit-2

Basic concept of chemical kinetics- order and molecularity, principle of solvent extraction- partition or distribution law Adsorption – types of adsorption, theory of ionization, pH and buffers, Henderson Hasselbalch's equation, colloids and their classification, properties and their stability, different colloidal dispersions, Zeta potential, destruction of colloids, basic method of coagulation, Behaviour of gases- ideal gas equation and van der waal's modification for real gases, Osmosis, reverse osmosis, electro dialysis.

Unit-3

Principles of Chromatography- IC, HPLC, GC, TLC, Chemistry of water and waste water – water pollution, pollutants in water, water quality requirement, potable water standards, wastewater effluent standards principles of determination of water quality parameters like pH, alkalinity, BOD, COD, hardness, lethal doses of pollutants – sulphides; chlorides, Ca, Mg, and analysis of minerals Fe, Mn, Ca, Mg in water. Soil chemistry- Acid base and ion exchange reactions in Soil, salt affected Soil and its remediation. Degradation of food stuffs, Detergents, Pesticides and Hydrocarbons.

Unit -4

Introduction to microbiology - microorganism and their characteristics classification. Characteristics of bacteria -observation of wet and stained preparation - Grams stain. Microbiology of water, wastewater, soil and air - water borne diseases and their causative organisms, bacteriological analysis of water and sewage, test for coliforms, their significance, bacteriological standards, MPN and membrane filter technique.

Unit -5

Applications of microbiology in Sanitary Engineering- Role of Aerobic and anaerobic organisms. Microbial production of industrial products, genetically modified organisms for environmental application, bioremediation, bio-energy conversion, Importance of sterilization, factors influencing sterilization, principles and methods.

List of Experiments

1. To determine the pH of water and wastewater samples.
2. To determine the Electrical Conductivity of water and wastewater samples.
3. To determine the turbidity of water and wastewater samples.
4. To determine the Total Solids concentration of water and waste water samples
5. To determine the acidity of water and wastewater samples.
6. To determine the alkalinity of water and wastewater samples.
7. To determine the hardness of water samples.
8. To determine the chloride concentration of water and wastewater samples.
9. To determine the optimum coagulant dosage.
10. To determine the Dissolve Oxygen (DO) concentration of water and wastewater.
11. To determine the Biological Oxygen Demand (BOD) of wastewater samples.
12. To determine the Chemical Oxygen Demand (COD) of wastewater samples

Text books

1. Clair N.Sawyer, PeryL.McCarty - Chemistry for Environmental Engineering (McGraw Hill)
2. G.W. Vanloon and S.J. Duffy "Environmental Chemistry – a global perspective, Oxford University Press, New York, 2000.
3. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry- Environmental Microbiology, third edition, Academic Press 2015
4. Microbiology by Pelczar Chan and Krieg, Tata Mc Graw Hill Publishers.

References books

1. Microbiology and Chemistry for Environmental Scientists and Engineers by **Jason Birkett**, CRC Press.
2. Environmental Chemistry Hardcover – Import, 23 March 2012 by Colin Baird (Author), MICHAEL CANN
3. Environmental Microbiology: From Genomes to Biogeochemistry 1st Edition, Kindle Edition by Eugene L. Madsen
4. Standard methods for the examination of water and wastewater, 21st Edition, Washington: APHA.

Course Outcomes

1. To analyze the principles and basic concepts of physical chemistry.
2. To understand the basic concept of chemical kinetics.
3. To understand the principles of Chromatography- IC, HPLC, GC, TLC and Chemistry of water & wastewater.
4. To understand and apply the fundamental concepts of the microbiology of water, wastewater, soil and air.
5. To understand and apply the concepts of applications of Environmental Microbiology.
6. To analyze and demonstrate the quality of water and wastewater sample.

DP

Environmental Quality and Pollution Management NCE 503

L T P C 3-1-0-4

Course Objective

The course is aimed at presenting an overview of the genesis of environmental pollution and its control starting with ecological disturbance, anthropogenic nature of pollution, types, processes, control including legislation as well.

UNIT-1

Ecology- Ecosystem, concept of ecosystem, structure and function of an ecosystem, energy flow of ecosystem, ecology succession, natural cycles

Unit 2

Impact of man on environment, consequence of population growth, population growth, climate change and global warming, effects of global warming, urbanization, automobile pollution, acid rain, ozone layer depletion

UNIT-3

Water pollution- sources and classification of water pollutants, natural process-Dispersion, reaeration, adsorption, self purification capacity of stream, water borne disease, physical, chemical, bacteriological characteristics of waste water, water quality standard, population equivalent.

UNIT- 4

Air pollution- Sources and effects, meteorological aspects, control methods and equipment.
Land pollution, Solid waste management.

UNIT-5

Environment protection- Role of government, legal aspects, initiative by NGO, environmental education, women education.
Environmental legislation- Introduction of various legislation related to water, air biodiversity at national and international level,

References

1. Odum, E.P., "Ecology", 2nd edition, Oxford and IBH publishing Co.Pvt.Ltd, 1975.
2. Dhamija, S.K., "Environmental Studies", Kataria and Sons Publishers, New Delhi, 2005
3. Peavy, Rowe and Tchobanoglous: Environmental Engineering.
4. Environmental Engineering: A Design Approach by A.P. Sincero and G.A. Sincero, Prentice Hall of India private ltd, New Delhi
5. Wastewater Engineering and Treatment, Disposal, and Reuse by Metcalf and Eddy Sewage Disposal and Air Pollution Engineering, by S.K Garg
6..Y. Anjanayelu, "Environmental Studies", B.S. Publishers, Hyderabad.

J-P. Nayak

RG

Air Pollution and Control

NCE 505

L T P C 3-0-2-4

Course Objective

The objective of this course is to familiarize the students with comprehensive understanding of air pollution, its causes, impacts, and management strategies, and equip them with the knowledge and skills necessary to contribute to sustainable solutions for improving air quality.

Syllabus

Unit I

Introduction to Air Pollution: Definition and concept of air pollution. The earth's atmosphere: structure and composition.

Air pollution: Types of air pollutants, causes, sources and effects. Effects of Air Pollution on surrounding ambient environmental conditions and human health exposure. Indoor air pollution. Global and regional Air Pollution issues.

Unit II

Air pollution meteorology: Air Pollution chemistry, meteorological aspects of air pollution, atmospheric stability and vertical mixing, temperature lapse rate and stability, temperature inversions, wind velocity and turbulence.

Air pollution monitoring: Air sampling and measurements, Ambient air sampling, collection of gaseous pollutants, stack sampling; grab sampling.

Unit III

Air Quality Modelling: Gaussian plume model and modifications; numerical models, urban diffusion models, calibration and sensitivity analysis; applications of public domain models and software, Dispersion modeling and source apportionment methods.

Unit IV

Air Pollution Control Techniques: ***Control of particulate Matter*****:** characteristics of particles drag force, impaction, interception and diffusion. Cyclones, Electrostatic precipitators, Fabric filter, Particulate scrubbers, spray-chambers, cyclone spray chambers, orifice and wet-impingement scrubbers, venturi and venture-jet scrubbers. Design of cyclones, fabric filters, ESP, baghouse

Air Pollution Control Techniques: ***Control of gaseous emissions*****:** gas-liquid and gas solid equilibrium, solubility, absorption, and kinetics. Gas absorption: physical and chemical absorption, isotherms, and absorption potentials.

Unit V

Environmental Legislations: Legislations, regulations and federal standards: Air Pollution Control Act, National Environmental Policy Act, Global and Indian Ambient Air Quality Standards.

Sustainable Transportation and Air Pollution: Impact of transportation on air quality; Alternative fuels and technologies: electric vehicles (EV), hybrid vehicles, and biofuels. Urban planning and transportation management strategies

Textbooks

1. Colls, J., Air Pollution: Measurement, Modeling and Mitigation, CRC Press, 2009.
2. Boubel, R. W., Vallero, D., Fox, D. L., Turner, B., & Stern, A. C. (2013). Fundamentals of air pollution. Elsevier.
3. Nevers: Air Pollution Control Engineering, 3rd Edition, 2016.
4. Rao and Rao: Air Pollution Control Engineering, TMH Edition, 2017
5. Peavy, Rowe and Tchobanoglous: Environmental Engineering, TMH Edition, 1986

Reference Books

1. Peavy, Rowe and Tchobanoglous: Environmental Engineering, TMH Edition, 1986
2. Martin Crawford: Air Pollution Control Theory, TMH Edition, 1986
3. Wark and Warner: Air Pollution: Its Origin and Control, 3rd Edition, 1998.
4. Mycock, Mckenna and Theodore: Handbook of Air Pollution Control Engineering and Technology, CRC Press Edition, 2000
5. Suess and Craxford: W.H.O manual on Urban Air Quality Management.

Other Useful Resources

1. Link to NPTEL course contents: https://nptel.ac.in/courses/105102089
2. Link to NPTEL course contents: https://nptel.ac.in/courses/105104099
3. Link to YouTube Video (Introduction to Air Pollution) https://www.youtube.com/watch?v=C5tXyMiOVas&pp=ygUqYWlyIHBvbGx1dGlvbiBjYXVzZXMgZWZmZWN0cyBhbmQgc29sdXRpb25z
4. Link to YouTube Video (Air Pollution Meteorology)https://www.youtube.com/watch?v=-61Vl_G17oE&pp=ygUZYWlyIHBvbGx1dGlvbiBtZXRlb3JvbG9neQ%3D%3D
5. Link to YouTube Video (Air Pollution Modelling) https://www.youtube.com/watch?v=jVl7uXZqPOU&pp=ygUXYWlyIHBvbGx1dGlvbiBtb2RlbGxpbmc%3D
6. Link to YouTube Video (Air Pollution Control) https://www.youtube.com/watch?v=5dukz1UOtkA&list=PLLy_2iUCG87BwOQUbS7WSdMVWHDXByk-w

Lecture Notes

https://classroom.google.com/u/7/c/NDY0NDk4ODY3NjE5

Course Outcomes

After successful completion of the course, the students will be able to:

CO1: To ***understand*** the fundamental principles of air pollution and ***identify*** the

different types and sources of air pollutants and their effects.

CO2: To ***understand*** the principle of air pollution chemistry and ***experimental*** techniques involved for air pollution monitoring.

CO3: To **understand** and **analyze** the fundamental principles of Air Quality modeling.

CO4: To ***apply*** and ***analyze*** the concepts of different air pollutant control technique measures for particulates and gaseous pollutants and their design.

CO5: To ***interpret*** the existing environmental legislations existing both globally and nationally and to ***justify*** the role of sustainable transportation in management of air pollution.

CO-PO Mapping / Course Articulation Matrix for Air pollution Control

	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO1	2	2	2	3	2	2	2	1	-	-	2	1
CO2	2	2	3	3	2	2	2	-	-	-	1	1
CO3	2	2	2	2	2	2	2	-	-	-	1	2
CO4	2	3	3	3	3	2	2	-	-	-	1	3
CO5	2	2	3	2	2	2	1	1	-	-	1	2
	2.0	**2.2**	**2.6**	**2. 6**	**2. 2**	**2**	**1. 8**	**0. 4**	-	-	1.4	**1. 8**

M.Tech 2nd semester

NCE 502

Design of Wastewater Treatment Systems

Unit I

Introduction: Physical, chemical and bacteriological characteristics of wastewater, water quality standards, Water borne diseases and their control, Composition of wastewater, Factors affecting the BOD rate of reaction, population equivalent

Unit II

Introduction to Wastewater treatment and Design

Concept, treatment methods-unit operations and unit processes, treatment systems-preliminary, primary, secondary, tertiary,

Basic design basic considerations: Strength and characteristics of wastewater, flow rates and their function, mass loading, design criteria.

General procedure for design calculation: Objective, types of treatment units sizing of units, calculation procedure,

Unit III

Wastewater Treatment

Preliminary and primary sewage treatment: Concept, functions and Design of approach channel, equalization basin, screen chamber, grit chamber, primary sedimentation tank.

Secondary treatment of sewage: Principles, functions and design of secondary treatment units-SST, ASP, TF, RBC, Extended aeration-oxidation ditch, aerated lagoon, waste stabilization pond.

Unit IV

Tertiary treatment: Introduction to removal of nitrogen, phosphorus, refractory organic, heavy metals, suspended solids and pathogenic bacteria.

Sludge treatment: Quantity and characteristics, concept, sludge digestion-aerobic and anaerobic, methods-sludge conditioning, dewatering, composting.

Design of sludge treatment units: Introduction, Treatment concept, Design essentials, Sludge digestion,

Unit V

Disposal of wastewater on land and water bodies

Introduction to Duckweed pond, vermiculture and root zone technologies and other emerging technologies such as UASB, Final polishing unit, River bank filtration, Zero valent iron, Phytoremediation, bioremediation, Sludge drying beds, Local wastewater treatment systems

Sewage treatment plant layout, concept of sustainable wastewater treatment.

Text books

1. Water Supply and Sewerage, by E.W.Steel
2. Environmental Engineering by H.S. Peavy, Rowe and Tchobanoglous.
3. Sewage Disposal and Air Pollution Engineering, by S.K Garg
4. Wastewater treatment: Concepts and design approach by G.L. Karia and R.A. Christian, Prentice Hall of India private ltd, New Delhi.
5. Environmental Engineering: A Design Approach by A.P. Sincero and G.A. Sincero, Prentice Hall of India private ltd, New Delhi
6. Wastewater Engineering and Treatment, Disposal, and Reuse by Metcalf and Eddy

Solid and Hazardous Waste Management

NCE 504

L T P C 3 1 0 4

Course Objective

To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

Syllabus

Unit-1

Solid Waste: Definitions, Characteristics, and Perspectives: Types of solid wastes, sources of solid wastes, properties of solid wastes, solid waste management: an overview, waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes- Public health and environmental effects.

Unit-2

Physical and chemical composition of municipal solid waste, integrated solid waste management, hierarchy of waste management options, different methods for generation rates.

Storage: movable bins, fixed bins. Collection: home to home collection, community bin system. Theory and design of hauled container system, stationary container system.

Transportation: handcart, tri-cycle, animal cart, tripper truck, dumper placer, bulk refuse carrier, railroad transport, water transport, conveyors, layout of routes. Engineering system for on-site handling and processing of solid waste: separators, size reduction equipment, screening equipment, densification, baling, cubing, pelleting equipment,

Unit-3

Landfilling: Site selection criteria, landfill layout, landfill sections, Occurrence of gases and leachate in landfills: composition and characteristics, generation factors, initial adjustment phase, transition phase, acid formation phase, methane formation phase, maturation phase of gases and leachate.

Unit-4

Composting: types of composting, process description, design and operational consideration of aerobic composting, process description, design and operational consideration of anaerobic composting. Thermal conversion technologies: incineration and pyrolysis system, energy recovery, system, electronic waste and Biomedical waste. Overview of solid waste management practices in India.

Unit-5

Hazardous waste: Definition, Identification and Classification of Hazardous Solid Waste,
Hazardous Waste Management: Waste Minimization; Waste Exchange; Recycling
Treatment Technologies: Biological, Chemical; Physico-Chemical Treatment: Incineration, Stabilization, Solidification, Disposal Of Hazardous Waste
Biomedical Waste Management: Sources; Generation; Classification; Storage; Transportation; Disposal; Waste Treatment: Disinfection, Irradiation, And Incineration.

Text Books

1. Integrated Solid Waste Management, Engineering Principles and Management Issues, Tchobanoglous G, Theisen H and Vigil SA, McGraw Hill Education, 2014, Indian Edition.
2. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition
1. Solid Waste Engineering, Vesilind PA, Worrell W and Reinhart D, Brooks/Cole Thomson Learning Inc., 2010, 2nd Edition

Reference Books

1. Environmental Engineering, Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, McGraw Hill Education, 2017, 1st Indian Edition
2. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition
3. Geotechnical Aspects of Landfill Design and Construction, Qian X, Koerner R M and Gray D H, Prentice Hall, 2002, 1st Edition
4. Hazardous Waste Management, LaGrega M.D., Buckingham P.L. and Evans J.C., Waveland Pr Inc., 2010, Reissue Edition 5. Hazardous Wastes - Sources, Pathways, Receptors, Richard J. Watts, John Wiley and Sons, 1998, 1st Edition.
5. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.

Course Outcomes: After successful completion of this course, the students would be able to understand

CO1: Identify various types of solid wastes and their sources
CO2: Examine the physical and chemical composition of wastes
CO3: Analyze the activities associated with the management of solid waste
CO4: Evaluate the techniques and methods used in recovery of materials and energy from solid wastes
CO5: Categorize and manage the hazardous waste

NCE 506

Environmental System Analysis

L T P C 3 1 0 4

Unit-1
Introduction to natural and man-made system, System modeling as applied to environmental systems, model building process,
System Analysis, Static and Dynamic System, models and modeling, Types of Models, Stochastic and Deterministic Models, Dynamic Simulation Modeling, Necessity of models in management of Environmental System, Steps followed in Modeling, Model Conceptualization, Model Development, Solution Methodologies.

Unit-2
Numerical, analytical and Monte Carlo methods of simulation, Data Acquisition and Processing, Model Calibration, Model Validation and Verification, Sensitivity Analysis. Introduction to water pollution and transport and atmospheric transport process.

Unit 3
Application of optimization methods such as search techniques, linear programming and integer programming.

Developing Linear Programming Models, Graphical Solution to LP Problems, The Simplex Method, Simplex Tableau for Maximization Problem,

.

Unit 4

Application of Transportation Problems
Integrated management strategies addressing multi-objective planning

Unit 5

Application of Environmental Database and Environmental Software Packages (simulation and optimization), including systems optimization, statistical analysis softwares, Introduction to QUAL2E, QUAL2K, WASP, MODFLOW, MT3D, LINGO etc.

References:

1. System Simulation By Geoffrey Gordon, Prentice Hall (Higher Education Division, PearsonEducation)
2. Peavy and Rowe: Environmental Engineering: (TMH publications)
3. Arya, S. Pal (1998). Air Pollution Meteorology and Dispersion, 1st Edition, Oxford University Press. ISBN 0-19-507398-3.
4. Barrat, Rod (2001). Atmospheric Dispersion Modelling, 1st Edition, Earthscan Publications. ISBN 1-85383-642-7.
5. Introduction to Hydrology by Warren Vissman, Jr and Gary L Lewis (Pearson education)
6. Heera and Gupta: Operation Research
7. Manuals of relevant EPA Models
3. Y. Anjaneyulu, Walli Manickam (B S Publications)

ELECTIVES I

NCE 511

Surface Water quality Modeling and Control

L T P C 3 1 10 4

Unit I

Introduction: Nature of problem, nature of input, mass loading rates-point and intermittent.

Overview of modeling: fundamentals, steps-conceptualization of problem, formulation of equation, coding, calibration, validation, sensitivity analysis, post audit.

Unit II

River hydrology and flow: low flow frequency analysis, Morphometry (hydraulic geometry), travel time, depth and velocity estimates, effect of land use o river flow.

Discharge of residual matter into rivers: Assumptions, mass balance at discharge points, water quality downstream of point source, water quality response to distributed sources, effect of spatial flow variation on water quality, multiple sources-principles of superposition.

Unit III

Estuaries, bays and harbours: physical aspects of estuaries, distribution of water quality in estuaries-water quality due to point source and distributed source, derivation of estuary equation,

Lake wide water quality response to input- lakes as completely mixed system, response to an impulse input, lakes in series.

Unit IV

Dissolved oxygen: Introduction, principal components of DO analysis, DO criteria and standards.

Sources and sinks of dissolved oxygen-oxygen demanding wastes, atmospheric reaeration, photosynthesis and respiration, sediment oxygen demand, oxidation of CBOD.

DO analysis in rivers: single point souce, multiple point source, distributed sources of DO and BOD.

Unit V

Ground water: Subsurface processes, unsaturated zone properties, soil moisture level, flow through unsaturated porous media.

Ground water contamination: sources and causes, hydrodynamic dispersion, multiphase contamination DNAPL, NAPL, VOC, site specific ground water quality problems in India, numerical models, contaminant transport modeling, application of emerging techniques in groundwater management.

Introduction to water quality models: QUAL2E, QUAL2K, WASP4, MODFLOW, GMS

Books

1. Thomann, R.V. and Mueller, J.A. "Principles of Surface water quality modeling and control", Harper & Row Publishers, New York

2. Chapra, S.C. (1997). "Surface water quality modeling", The McGraw Hill Companies, Inc., New York.

Course Outcomes

At the end of the course student will be able

1. to develop contaminant transport model for natural systems
2. to predict the quality of water in river, lakes and estuaries using specific models
3. to solve the transport equation using numerical techniques
4. to estimate the concentration of pollutant in ambient air using dispersion models

JPN

Environmental Impact and Assessment NCE 509

LTP 3104

Course Objectives: In this course, the students are exposed to learn the need, methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare environmental management plan.

Unit 1

Basic concept of EIA

Definition, Concept of sustainable development, Planning and management of impact studies Basic concept of EIA and Methodologies: Initial environmental Examination, Elements of EIA, factors affecting EIA Impact evaluation and analysis, preparation of Environmental Base map, Classification of environmental parameters.

Unit 2

EIA Methodologies

Methods of Impact identifications: Interaction-Matrix method, network methods, checklist methods Description of environmental setting (affected environment) Conceptual framework, Selection process- site visits, interdisciplinary team discussions, scoping; documentation, data sources. Environmental indices and indicators for describing the affected environment- media index for water quality, noise, ecological sensitivity and diversity, archaeological resources and quality of life, development of indices

Unit 3

Prediction and Assessment of Impact

Prediction and assessment of impacts on the: air, surface water, groundwater, soil, noise environment, biological environment, archaeological environment, visual impacts, socioeconomic environment

Unit 4

Decision methods for evaluation of alternatives: basis of tradeoff analysis, weighting of decision factors, scaling, rating, ranking, development of decision matrix, case studies, current trends, selection of methodology

Unit 5

Public participation in environmental decision making, Preparation of written document, environmental monitoring, Introduction to Environmental Impact assessment statement for various Industries-distillery, textile, tannery and pulp and paper

Environmental Audit: objectives of Environmental Audit, Audit protocol, stages of Environmental Audit, on-site activities, Evaluation of Audit data and preparation of Audit report

Text Books

1. Larry, W. Canter (2555). „Environmental Impact Assessment" McGraw Hill, Civil Engineering Series, 2n edition, Singapore
2. Anjanayelu, Y. (2552). "Environmental Impact Assessment Methodologies", B.S. Publishers, Hyderabad
3. R.R. Barthwal. (2512). "Environmental Impact Assessment.", New Age International (P) limited publisher, New Delhi

Reference Books

1. Environmental Impact Analysis Handbook – by Rau Whooten; McGraw Hill publications
2. Environmental Impact Assessment – by Larry Canter; McGraw Hill publications
3. Environmental Impact Analysis – A Decision Making Tool by R K Jain
4. Handbook of Environment Impact Assessment by Judith Petts; McGraw Hill publications

Course Outcomes

On successful completion of the course, the students will be able to:

CO1: To understand the concept, identify the objectives and scope of EIA.

CO2: To understand the different methods and instruments used to develop an EIA.

CO3: To apply various methods for predicting the Environmental impacts of projectbased on different environmental attributes

CO4: To evaluate the different alternatives by examining the benefits and drawbacks of them.

CO5: Illustrate the necessity of public participation in EIA studies and to evaluate environmental problems affecting the different EA practices.

NCE 513

Remote Sensing and Geographical Information System

L T P C 3 1 0 4

Syllabus

Unit-1

Definition of GIS, Cartography and GIS, GIS database: spatial and attribute date; Spatial models: Semantics, spatial information, temporal information, conceptual models of spatial information, representation of geographic information: point, line and area futures, top logy,

Unit-2

Raster and vector data, raster to vector data conversion, map projection, analytical transformation, rubber sheet transformation, manual digitizing and semi-automatic line following digitizer; Remote sensing data as an input to GIS data;

Unit-3

Attribute database: scale and source of inaccuracy; GIS functionality; data storage and data retrieval through query, generalization, classification, containment search within a spatial region;

Unit-4

Overlay: arithmetical, logical and conditional overlay, buffers, inter visibility, aggregation; Network analysis;

Unit-5
Applications of GIS in planning and management of utility lines and in the filed of environmental engineering, geotechnical engineering, transportation engineering and water resources engineering.

References

1. Lillerand, T.M. and Keifer, r.W., remote Sensing and image John Wiley & Sons.
2. A.M. Chandra and S.K. Ghosh, R S & GIS, Marosa Publication Delhi
3. M. Anji Redds, RS & GIS, R S Publication, Hyedrabad
4. Swain, P.H. & S.M. Davis, r S – The Quantitative Approach, McGraw Hill Publication.
5. Lyan, J.G. and Mc. Larthy, J., Wetland and Environmental Application GIS, Lavis Publication,
6. M , A.M.J. etal: Introduction to the use GIS for practical Hydrology, ITC, Methertends
7. Geographic Information Systems: A Management Perspective, by Stan Arnoff, WDL Publications.
8. Fundamentals of Spatial Information Systems by Robert laurini and Derek Thompson, Academic Press.
9. Geographical Information Systems, Vo. I and II edited by Paul Longely, M.F. Goodchild, et.al, Jhon Wiley and Sons, Inc. 1999.

Groundwater Flow and Pollution Modeling NCE - 512

L-T-P-C 3-1-0-4

Course Objectives: Students undergoing this course are expected to demystify the use of groundwater models by providing solid understanding of the principles, methods, assumptions, and limitations of groundwater models.

Syllabus

Unit- I
Introduction, assessment of groundwater availability in national and global scenario, Hydrologic Cycle, Aquifers, Darcy's Law and its limitations, Hydraulic head and fluid potential, Hydraulic conductivity and permeability, Heterogeneity and Anisotropy of hydraulic conductivity, Porosity and void ratio, Aquifers and aquitards, Transmissivity, Storativity, Compressibility, Effective Stress, Unsaturated Flow and Water Table.

Unit- II
Equation of groundwater Flow- steady state saturated flow, Transient saturated flow, Transient unsaturated flow, Boundary value problems, Radial Flow in groundwater flow, Confined and Unconfined aquifers- Dupuit's and Thiem's Equation.

Unit-III

Groundwater pollution: sources- Municipal, Industrial, Agricultural and Miscellaneous, Transport mechanism: Hydrodynamic dispersion, Diffusion, Advection- Dispersion equation, Sorption and Decay, Social and environmental impact of groundwater pollution.

Unit- IV

Groundwater modeling techniques, Introduction to physical models and their drawbacks, Introduction to analog models- viscous flow model, membrane model, thermal model and electrical analog model, Model based analytical formulas coupled with experience, Numerical models, Finite Difference method. Introduction to various groundwater flow models.

Unit- V

Groundwater recharge: Objectives and purpose of managed groundwater recharge (MGR), Methods and features of MGR systems, Artificial recharge strategy and identification of potential areas, Source water availability and assessment, Reuse and recycling wastewater, Recharge mounds, Management of groundwater quantity: Conjunctive use, Groundwater management techniques, Management of groundwater quality: Groundwater contaminants, Soluble salts, Sources of contaminants, Pollution control, Treatment contamination and monitoring of groundwater quality.

Text Books

1. Groundwater Hydrology: Engineering, Planning and Management, Karamouz, M.,Ahmadi, A., and Akhbari, M., CRC Press, Taylor et Francis Group, 2020
2. Numerical Groundwater Hydrology, Rastogi, A.K., Penram International Publishing Pvt. Ltd., 2012
3. Groundwater Hydrology, Chahar, B. R., McGraw Hill Education (India) Private Limited, New Delhi, 2015

Reference Books

1. Hydrogeology, Davis, S. N., and De Weist, R. J. M., John Wiley & Sons, New York, 2013
2. R.A. Freeze, J.A. Cherry, Groundwater, Prentice-Hall of India Pvt. Ltd.
3. Jacob Bear, Dynamics of Fluid in Porous Media, American Elsevier
4. Groundwater Hydrology, Todd, D. K., and Mays, L. W., John Wiley & Sons, Singapore, 2018

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

CO1: Assessment of groundwater flow budget with basic concepts.
CO2: Study the various groundwater flow and well hydraulics.
CO3: Identify various pollution sources and their modeling parameters.
CO4: Plan and formulate flow and transport models using numerical methods
CO5: Formulate and solve conjunctive use of surface water and groundwater resource utilization problems

Course Articulation matrix for Groundwater Flow and Pollution Modeling

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	1	2	-	1	1	2	2
CO2	3	2	2	2	1	2	1	-	2	1	1	1
CO3	3	1	2	2	2	1	2	2	1	2	1	1
CO4	2	1	1	2	1	2	1	-	2	1	1	1
CO5	1	2	2	1	1	1	1	-	1	1	1	1
Average	**2.4**	**1.6**	**1.8**	**1.6**	**1.4**	**1.4**	**1.4**	**0.4**	**1.4**	**1.2**	**1.2**	**1.2**

Advanced Water and Wastewater Technologies

L T P C 3 1 0 4

Unit 1

Gas transfer: Aeration systems, Energy requirement, Design of aeration systems. Membrane Filtration, Terminology, Process classification, Membrane configurations, Membrane operation for micro filtration, Ultra filtration and Reverse osmosis, Area requirement, Membrane fouling and its control, Application of membranes. Electro dialysis: Theory, Area and power requirement, Disposal of concentrate waste streams.

Unit 2

Grit removal: Types of grit chambers, Characteristics, quantities, processes and disposal of grit, Design of grit chambers, Flotation: Objective, Types of flotation systems, Design considerations, Chemical precipitation for removal of phosphorous, heavy metals and dissolved inorganic substances.

Unit 3

Microbial growth kinetics, Modelling suspended and attached growth treatment processes. Suspended growth processes for biological nitrification and de- nitrification, Biological nitrogen and phosphorous removal.

Unit 4

Anaerobic sludge blanket processes, Design considerations for Up flow Anaerobic Sludge Blanket process. Theory and design of Sludge treatment, sludge thickening, sludge drying, incineration, aerobic and anaerobic digestion of sludge.

Unit 5

Wetland and aquatic treatment systems; Types, application, Treatment kinetics and effluent variability in constructed wetlands and aquatic systems, Free water surface and subsurface constructed wetlands, Floating plants (water hyacinths and duckweed), Combination systems, Design procedures for constructed wetlands, Management of constructed wetlands and aquatic systems.

References

1. Wastewater Engineering treatment and reuse– Metcalf Eddy.
2. Theory and Practice of water and Wastewater treatment – Ronald Droste.
3. Physico-chemical processes of water purification – Weber
4. Wastewater Treatment for Pollution Control – Soli Arceivala.

ELECTIVE II

Industrial Wastewater Treatment

NCE 510

L T P C 3 1 0 4

Course Objective: The objective of this course is to familiarize the students with the mechanisms and processes used to treat industrial wastewaters

Syllabus

Unit I

Introduction: Classification of Different Industrial Wastes (like soluble organics, suspended solids, acid/alkali, thermal discharge,inorganics, coloring substances, nutrients, heavy metals etc.)

Industrial Waste Survey: possibility of minimization, variationof flow and characteristics, possibility of water conservation and reuse, strength to undergo different industrial waste treatment.

Unit II

Pre and Primary Treatment: Equalization Basin (objective, function, design principles), Neutralization (equalization basin, limestone bed, limestone tower), Floatation techniques (gravity and DAF methods). Derivation of C/A ration for DAF systems Waste Reduction, Volume Reduction, Strength Reduction

Unit III

Waste Treatment Methods: Removal of organics (ASP, UASB) Nitrification and De-nitrification Process – Nitrogen and Phosphorous removal, Heavy metals (discussion and removal techniques), Cementation/Recovery techniques, chemical oxidation (chlorine, ozone, hydrogen peroxide), Membrane Separation Techniques (Osmosis and Reverse Osmosis), Air Stripping and absorption Process. Disposal of Treated Industrial Wastewater

Unit IV

Characteristics and Composition of Industrial wastewater generated from Textile Industry. Characteristics and Composition of Industrial wastewater generated from Pharmaceutical Industry

Unit V

Combined Treatment Systems of Industrial wastewater anddomestic sewage – concept of Common Effluent Treatment Plants (CETP) – Location, Design, Operation and Maintenance Problems, Economic aspects. Local, Regional, National and International

Issues related to waste treatment.

Textbooks

1. Eckenfelder, W.W. Jr., Industrial Water Pollution Control, 3rd Edition, McGraw HillInternational Edition, Singapore, 2000.

2. Arceivala, S.J., Wastewater Treatment for Pollution Control, 2nd Edition, TataMcGraw Publishing Co. Ltd., New Delhi, 1998.

3. Metcalf & Eddy, "Wastewater engineering Treatment disposal reuse", 4th Edition, TataMcGraw Hill. Publishing Co. Ltd., New Delhi, 2004.

Reference Books

1. Nemerow, N.L. Industrial Waste Treatment – Contemporary Practise and Vision forFuture. Latest Edition, Butterworth-Heinemann Publishers, UK, 2007.

2. Gurnham, C.F., Principles of Industrial Waste Treatment —CRC Press, 1999

Other Useful Resources

1. Link to YouTube Video (NPTEL Course – Industrial Waste Treatment)
https://www.youtube.com/watch?v=in3GSRuooRs&t=12s&pp=ygUlaW5kdXN0cmlhbCB3YXN0ZXdhdGVyIHRyZWF0bWVudCBucHRlbA%3D%3D
2. Link to YouTube Video (Wastewater Treatment and Recycling)
https://www.youtube.com/watch?v=fHRxhuMQQnE&list=PLbRMhDVUMngdeOSgQOe39 9aBKqdxkxNCp

Lecture Notes

https://classroom.google.com/u/7/c/NDU3NDcxODc1ODA4

Course Outcomes: After successful completion of the course, the students will be able to:

CO1: To ***describe*** the different categories of industrialwaste generated and to ***explain*** the different waste surveys and sampling techniques carried out for their assessment

CO2: To ***understand*** the different pre and primarytreatment techniques and ***apply*** them for different industrial wastewater treatment systems

CO3: To *assess* and *analyze* the different treatment methods for industrial wastewater and their disposal.
CO4: To *assess* the characteristics and composition ofindustrial wastes generated from different industries
CO5: To *plan* and *design* for Common Effluent Treatment Plan for simultaneous treatment of industrial and domestic wastewaters.

Course Articulation matrix for Industrial Wastewater Treatment

Program Outcomes (PO) / Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	2	2	1	1	1	1	1
CO2	3	3	3	3	-	2	2	1	1	1	1	1
CO3	3	3	2	2	-	2	2	1	1	1	1	1
CO4	3	3	2	2	-	2	2	1	1	1	1	1
CO5	3	3	2	2	-	2	2	1	1	1	1	1
Average	**3.0**	**3.0**	**2.2**	**2.2**	**-**	**2.0**	**2.0**	**1.0**	**1.0**	**1.0**	**1.0**	1.0

Life Cycle Analysis and Design for Environment

NCE 601
L T P C 3 1 0 4

Unit 1
Industrial Ecology and Sustainability Framework
Definition, Goals, Analytical Components, and Tools, IPAT Equation, Population and Carrying Capacity, Consumption Patterns, Definitions and Drivers for Sustainability, Sustainability Indicators, Ecological/Environmental – Ecological Footprint, Economic – Genuine Progress Indicator (GPI), Social and Demographic – Equity

State of the Environment, the IE Metaphor, and Material Flow Analysis
Energy, Materials, and Water Resources
Metaphor: Food Webs and Industrial Ecoparks; and Biomimicry
Systems Analysis (Material and Energy Flows) and Metrics: MFA, LCA
System Definitions and Level of Analysis: Nation, Region, Product, Process, Substance, Natural vs Anthropogenic Pollutant Cycles, Material Flow Analysis

Unit 2
Life Cycle Assessment
Life Cycle Assessment (LCA): Components and Applications
Process Level LCA vs Economic Input-Output (EIO) LCA
Components: Goal Definition and Scoping, Life Cycle Inventory Analysis (LCI),

Life Cycle Impact Assessment (LCIA), Life Cycle Interpretation
Functional unit of analysis
Cases: Mid-sized vehicles; Beverage Containers

Unit 3
Life Cycle Inventory Analysis
System Boundaries, Process Flow Diagram, Input/Output Analysis
LCA Software: SimaPro Life Cycle Assessment Software
Energy and Transportation Modules: Energy, Primary energy, Feedstock, Process Fuels and Transportation Fuels, Electricity Generation, Emission Factors, Transportation Energy – Combustion and Precombustion (upstream processes), Emission Factors
Materials Production Phase: Non-renewable feedstocks, renewable feedstocks, Manufacturing Phase, Use Phase, End-of-Life Management Phase

Unit 4
Life Cycle Impact Assessment
Methodology, Classification, Characterization, Valuation, Impact Potentials -- GWP and ODP
Greenhouse Gases: CO2, CH4, N2O, CF4, C2F6, SF6, CFC substitutes
Acidification, Smog, and Others, Human Health and Ecosystem Health, Intake fraction
Human Toxicity Potential (HTP), Critical Volume Approach, Environmental Defense (ED)- Scorecard
Uncertainty Modeling in LCA
Sources, Methods for Estimating Uncertainty, Sensitivity Analysis and Tornado Diagrams
Monte Carlo Analysis in LCA

Unit 5
Life Cycle Design and Management
Life Cycle Management, Multistakeholders
Internal Elements: Environmental Management Systems
External Factors: Consumer preferences, Government regulations
Life Cycle Design Process: Product Life Extension
Material Oriented Strategies, Material Recycling, Material Selection, Material Intensiveness, Process Oriented Strategies, Distribution Oriented Strategies, Biomimicry

Life-Cycle Costing: Purchase, ownership, disposition, Private and social costs

Framework for Environmental Marketing and Labeling
First Party Environmental Marketing, Third Party Environmental Labeling, Mandatory Voluntary (Report Cards, Seals of Approval, Single Attribute Certification), LEED.

References

ISO 14040 International Standard, *Environmental management – Life cycle assessment – Principles and framework*, 1997-06-15.

Life Cycle Assessment: Inventory Guidelines and Principles (EPA 600/R-92/245).Cincinnati, OH: U.S. EPA, Office of Research and Development, Risk Reduction Engineering Laboratory, February 1993.

Guidelines for Life-Cycle Assessment: A "Code of Practice." Society of EnvironmentalToxicology and Chemistry, 1993.

Environmental Life-Cycle Assessment. Ed. Mary Ann Curran, McGraw-Hill: New York,1996.

Probability and Statistics for Engineers NCE 514

L T P C 3 1 0 4

Unit 1

Role of Statistics in Engineering

Data summary and presentation: Stem ad leaf diagram, frequency distribution, histogram, box plot, time sequence plot.

Unit 2

Probability: Bayes theorem, random variable

Discrete random variables and probability distributions: Binomial distributions, poisson distribution

Continuous random variables and probability distributions: normal, Gamma and Weibull distributions

Joint probability distributions: Marginal, conditional, joint, bivariate normal distributions

Unit 3

Parameter estimation: Statistical inference, random samples, method of maximum likelihood, confidence interval

Statistical inference for a single sample: Hypothesis testing, inference of the mean of a population with variance known and unknown, goodness of fit

Unit 4

Simple linear regression and correlation: empirical models, simple linear regression, SD, Hypothesis test (t-test analysis of variance), confidence interval, correlation coefficient

Unit 5

Multiple linear regression: MLR, Least square estimation of parameters, hypothesis test, confidence interval, polynomial regression, multi-collinearity

Non parametric statistics: sign test, Wilcoxin signal rank test, Wilcoxin rank sum test, non parametric method in analysis of variance-Kruskal-Wallis test, rank transformation

Books

Douglas C. Montgomery and George, C. Runger. 'Applied Statistics and Probability for Engineers' John Wiley & Sons, Inc, NY.

Geo-environmental Engineering

NCE 605
L T P C 3 1 0 4

Course Objectives
The course is aimed at understanding the soil contamination, its transport, sampling techniques and their characterization and remediation

Syllabus

Unit I
Basic concepts related to soil pollution; Sources of pollution- industrial, mining, agricultural, and municipal; types of contaminants; Impact of contamination- physical and chemical properties of soil;

Unit II
Retention behavior- governing factors, sorption characteristics, isotherms; Contaminant transport- saturated and unsaturated flow, pore size distribution characteristics;

Unit III
Site investigation- Soil sampling, sample handling, transportation, characterization, preservation and storage; Non-destructive techniques- electromagnetic, thermal and seismic,

Unit IV
Soil remediation- need and approach, Techniques- soil washing, permeable reactive barriers, solidification, vacuum extraction, electro kinetic remediation, thermal desorption; Bioremediation, phytoremediation, soil fracturing; Case studies on polluted sites and issues related to environment.

Unit V
Containment systems and basic principles – carbon dioxide sequestration, Grout curtains, Ground freezing, Compacted soil liners, Geosynthetic clay liners.

References
1. Rowe R.K., "Geotechnical and Geoenvironmental Engineering Handbook" Kluwer Academic Publications, London, 2000.
2. Reddi L.N. and Inyang, H. I., "Geoenvironmental Engineering, Principles and Applications" Marcel Dekker Inc. New York, 2000.
3. Yong, R. N., "Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation" CRC Press, New York, 2001.
4. Sharma H.D. and Reddy K.R., "Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies" John Wiley & Sons, Inc., USA, 2004.

Course Outcomes
At the end of the course student will be able
1. To identify the origin, nature, and extent of contamination in field.
2. To predict the retention and flow properties of contaminants.

3. To adopt suitable sampling techniques for geoenvironmental characterization.
4. To suggest the remediation techniques for decontamination.

Toxicology and Environmental Risk Assessment

L T P C 3 1 0 4

Syllabus

Unit 1

Introduction to Environmental Toxicology : Definition, classification, origin and general nature of toxicants in environment, factors affecting toxicity, nutritional and non nutritional food supplements and their effects, mutagenesis, teratogenesis, carcinogens, hellucinogers, phytotoxins and animal toxins.

Unit 2

Systematic and Eco-toxicology: Toxic response of different body systems likes respiratory, gastro-intestinal tract, Liver, kidney, immune system, reproductive system. Problems and approach, Environmental distribution of chemicals in air, water, sediments, soil and biota; Effects of toxicants on ecosystem, Detoxification of toxicants in resistant biota.

Unit 3

Experimental methods for measuring toxicity; Types of bioassays (Ames test, bioluminescence, algal toxicity, gene induction etc.), the interaction of chemicals with ecosystems; Methods for assessing the impacts of chemicals on ecosystems (toxicity tests, field assessment, special analyses such as biomarkers, bioaccumulation, mesocosm and microcosm studies).

Biotransformation, bioaccumulation and bio-magnification of toxicants ,Toxicants absorption and distribution of toxicants in animal body, Bio-transformation of toxicants, antidotes treatment and their detoxification of toxicants, Bio-accumulation, Bio-magnification.

Unit 4

Environment and health and environmental stress : Basic principles of environmental health, community health, impact of changing environment on biota, effect of stress on environment, adaptations and tolerance level of various organisms and stress factors, micro-organisms of extreme environment. Occupational health hazards: Stress, man, machine and environment, ergonomics and occupational physiology and Hazards of working environment safety management of occupational hazards.

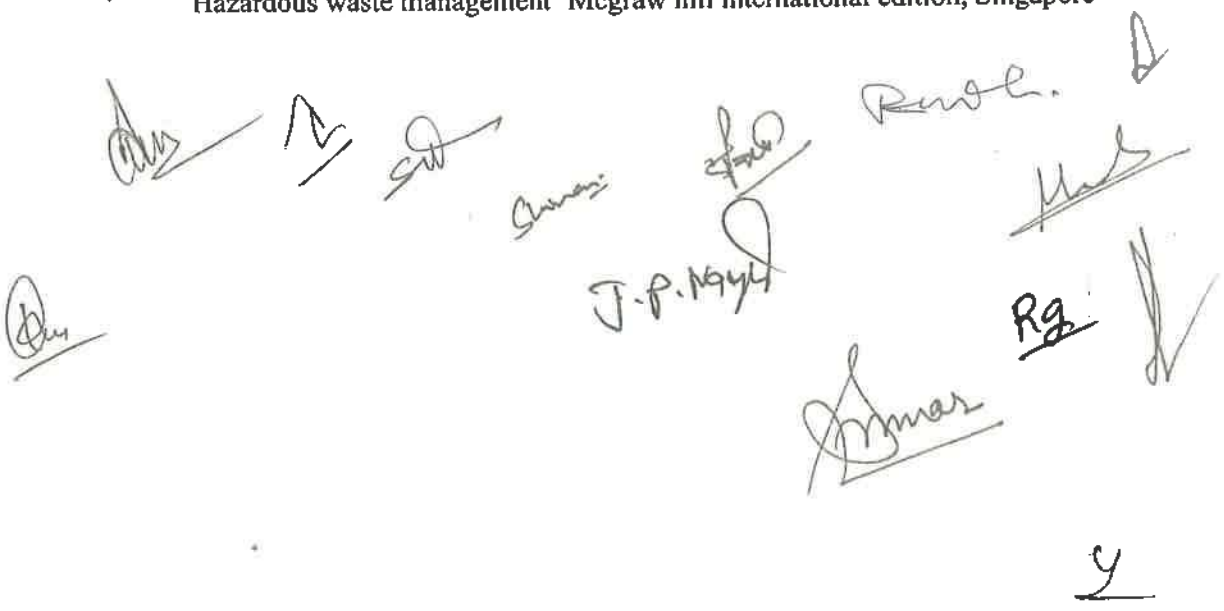
Unit 5

Ecological risk assessment process and evaluation of human exposure, Case studies related to accidental discharge of pollutants and their impacts on the ecology and inhabitants of the surrounding areas.

Quantitative risk assessment: risk, hazard identification, exposure assessment, toxicity assessment, risk characterization, risk communication, ecological risk assessment, Monte-Carlo methods, Case study

References

1. Principles of Ecotoxicology, Edited by : G. C. Butler
2. Basic Environmental Toxicology, Edited by: Cockerham, shane, CRC Press.
3. Environmental Toxicology by Wright.
4. A. P. H. A. Ed. 1992.
5. Modern Toxicology by Gupta and Salunkhe.
6. Michael D. LaGrega, P.L. Buckingham, J.C. Evans and The environment resource group
   Hazardous waste management' Mcgraw hill international edition, Singapore



M.Tech 3rd Semester (Programme Elective III)

Transport of Water and Wastewater Systems (NCE 603)

L-T-P 3-1-0

Unit I: General hydraulics and flow measurement: Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow; minor head losses. Carrying Capacity–Flow measurement.

Unit II: Water transmission and distribution: Need for Transport of water and wastewater-Planning of Water System –Selection of pipe materials, pipe thickness calculations. Water transmission main design- gravity and pumping main; Selection of Pumps- characteristics-economics; Specials, Jointing, laying and maintenance, water hammer analysis.

Unit III: Water distribution systems: Water distribution pipe networks, Methods, Design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses –Leak detection Storage reservoirs.

Unit IV: Wastewater collection and conveyance: Planning factors – Design of sanitary sewer; Partial flow in sewers, economics of sewer design. Handling and transport of slurry.Wastewater pumps and pumping stations- sewer appurtenances; material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters.

Unit V:Storm water drainage: Necessity- - combined and separate system; Estimation of storm water run off Formulation of rainfall intensity duration and frequency relationships-Rational methods.

REFERENCES:

1. Bajwa, G.S. Practical Handbook on Public Health Engineering, Deep Publishers, Simla, 2003
2. "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development. Government of India, New Delhi, 1999.
3. "Manual on Sewerage and Sewage Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1993.

Course Outcomes	CO1	To understand and apply the fluid properties, open channel flow and measurement of flow for solution of field problems
	CO2	To understand and apply the concepts of transport of water with focus of gravity and pipe mains
	CO3	To carry out the Analysis and design of water distribution systems
	CO4	To carry out the planning and design of sewerage systems
	CO5	To carry out the planning and design of storm water drainage systems

J. P. Nayak

OPEN ELECTIVES in 3rd semester of M.Tech (Environmental Science and Engineering)

ENVIRONMENTAL POLLUTION AND MANAGEMENT (OCE 601)

L T P C 3 0 0 3

Unit I

Impact of man on environment, consequence of population growth, population growth models, energy problem, pollution of air, water and land, Global environmental issues.

Unit II

Water pollution: Sources and classification of water pollutants, wastewater treatment, control strategies, Eutrophication of lakes, self-purification capacity of streams. Waste load allocation.

Thermal pollution: Sources, effects and control measures.

Unit III

Air pollution: Sources and effects, meteorological aspects, control methods and equipments,

Land pollution: Types of land pollution, solid waste management-generation, storage, collection, transport, processing and disposal.

Noise pollution: Sources, effects, preventive and control measures.

Unit IV

EIA: Planning and management of environmental impact studies; Impact evaluation methodologies: baseline studies, screening, scooping, checklist, overlays, Environmental impact assessment of water resources and environmental projects, Case study of power plant.

EA: Meaning, audit items, audit procedure, safety audit.

Unit V

Contemporary issues: Emission trading, discharge permits, international resource sharing issues, climate change, international environmental treaties and protocol.

Environmental legislation: Introduction to various legislations related to water, air, biodiversity, ozone depletion etc at National and International level; Institutions for governance.

References:

1. Principles of environmental studies (Ecology, economics, management and law) by C. Manoharachary and P. Jayarama Reddy, B.S. Publications.
2. Text of Environmental Engineering by P.V. Rao, Prentice Hall pvt ltd., Delhi
3. Environmental impact assessment methodologies by Y. Ananayulu and C.A. Sastry, B.S. Publications, Hyderabad

Course Outcomes	CO1	To understand the impact of man on environment in terms of population and pollution.
	CO2	To understand the sources, classification, processes and remedial measures of water pollution.
	CO3	To understand the air, land and noise pollution.
	CO4	To understand the techniques involved in Environmental Impact Assessment and Environmental Audit of various projects.
	CO5	To understand various contemporary issues and environmental legislations pertaining to environmental pollution.

INTRODUCTION TO INFRASTRUCTURE ENGINEERING (OCE 603)

L T P C 3 0 0 3

Unit I
Building
Elements- slab, beam, column, footing
Types- Residential, Institutional, Commercial, Industrial
Types of structure- Load bearing, framed, combined

Unit II
Water Supply and Wastewater Infrastructure
Water Supply- Source, demand, intake, transport, conduits, treatment, distribution, household plumbing
Waste Water- Collection, transport, treatment and disposal

Unit III
Transport Infrastructure: Road, rail and air
Road- Elements, types, traffic studies
Rail- Gauge, components
Air- Airport, Planning of a Runway, taxiway

Unit IV
Irrigation, hydropower and navigation
Dam, weir, barrage, canal, port, harbor, hydroelectric projects
Unit V
Miscellaneous
Introduction to architecture, land use planning, building byelaws

References:

1. S. Chandra, Building material and Constructions,
2. Water Supply Engineering by S.K. Garg (Khanna publishers, 33rd edition, 2010)
3. Water Supply, Waste disposal and Environmental pollution engineering by A.K. Chatterjee, (Khanna publishers, 8th edition, 2006)
4. S.K. Khanna and S. Justo, Highway Engineering
5. NPTEL E Learning course on Infrastructure Planning &Management.

Course Outcomes	CO1	To understand the various types of buildings and the RCC Elements
	CO2	To understand the principles of water and wastewater infrastructure
	CO3	To understand the Road, rail and air transport infrastructure
	CO4	To understand the Irrigation, hydropower and navigation infrastructure
	CO5	To understand the principles of architecture with focus on land-use planning and building bye-laws.

Introduction to Remote Sensing and GIS (AOCE 605)

L T P C 3 0 0 3

UNIT-1 FUNDAMENTALS OF REMOTE SENSING

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water, spectral signatures.

UNIT-II

EMR INTERACTIONS

Interaction with atmosphere Scattering of EMR Raleigh, Mie, Non-Selective and Raman Scattering Bach scattering Speckle EMR Interaction with water and Ozone Atmospheric windows and its significance EMR interaction with the earth surface materials Radiance, irradiance, Absorbed and Transmitting energy – reflectance- Specular- and diffuse surface- Spectral signature – and curves EMR interaction with soil Resolution Spectral, Spatial, Radiometric, and Temporal.

UNIT-III RESOURCES ENGINEERING

Characteristics of Digital Satellite Image Enhancement Filtering Applications of Aerial Photographs and Satellite Imageries – merits – Limitations – Water resources – watershed management – Urban Studies – Flood Management- Fishing Forestry etc.

UNIT-IV Geographic Information System

Introduction, Components of GIS. Organizational Context: Data: Spatial and NonSpatial – Maps, Types of Maps, Projection: Types of Projection, Data Input, Digitizer, Scanner Editing: Raster and Vector data structures, Comparison of Raster and Vector data structure, Analysis using Raster and Vector data: Retrieval, Reclassification, Overlaying, Buffering Data Output, Printers and Plotters.

UNIT V Application

Application of remote sensing and GIS for managing land and water resources, Integrated use of Remote sensing and GIS, Introduction to Arc view, Arc info, Map Info, MODFLOW software.

TEXTBOOKS

1. A.M. Chandra, S.K. Ghosh, "Remote Sensing and Geographical Information System", 1st Edition, Narosa Publishing house, 2007.
2. M. Anji reddy, "Remote Sensing and Geographical Information Systems", 3rd Edition, B.S. Publications, 2006.

Reference Books:

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.

3. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
4. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
5. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
6. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.

Course Outcomes	**CO1**	To remember and understand the principles and components of photogrammetry and remote sensing.
	CO2	To understand the data acquisition process of EMR Interaction and their characteristics.
	CO3	To understand and apply the aerial Photographs and Satellite Imageries for data acquisition of land use, environmental and water resources projects
	CO4	To understand the principle and concepts of GIS.
	CO5	To learn and apply the remote sensing and GIS softwares for managing land and water resources projects