DEPARTMENT OF CIVIL ENGINEERING
HBTU, KANPUR

Course Structure, Evaluation Scheme
&
Detailed Syllabus of

M.Tech Environmental Science & Engineering (Full Time)

(Effective from Session 2019-20)

Department of Civil Engineering

Scheme of M.Tech (Environmental Science and Engineering)

Course code	Subject	Periods			Credits
		L	T	P	
Semester I					
ECE-551	Environmental Chemistry and Microbiology	3	1	2	5
ECE-553	Environmental Quality and Natural Processes/pollution	3	1	5	4
ECE-555	Air Pollution and Control	3	1	2	5
ECE-559 to 567	Elective I	3	1	5	4
Total credits in 1st semester					**18**
Semester II					
ECE-552	Design of Wastewater Treatment	3	1	5	4
BMA-564	Probability and Statistics for Engineers	3	1	5	4
ECE-554	Solid and Hazardous Waste Management	3	1	5	4
ECE-565 to 568	Elective II	3	1	5	4
Total credits in 2nd semester					**16**
Semester III					
ECE-651	Environmental System Analysis	3	1	5	4
ECE-653 to 661	Elective-III	3	1	5	4
ECE-671	Seminar/Minor project	-	-	2	2
ECE-697	Dissertation	-	-	8	4
Total credits in 3rd semester					**14**
Semester IV					
ECE-698	Dissertation	-	-	24	**12**
Total credits in M.Tech Programme					**65**

List of Electives

Elective Type	Course Code	Course Name
Program Elective I	ECE-559	Environmental Impact Assessment
	ECE-561	Surface Water Quality modeling and Control
	ECE-563	Toxicology and Environmental Risk Assessment
	ECE-565	Environmental economics, legislation and social impact
	ECE-567	Physico-Chemical Processes in Water and Wastewater
Program Elective II	ECE-560	Ground water flow and pollution modeling
	ECE-562	Advanced water and wastewater technologies
	ECE-564	Principles of Cleaner Production
	ECE-566	Industrial Waste Management and environmental Audit
	ECE-568	Occupational Health and Safety
Program Elective-III	ECE-653	Remote Sensing and GIS for Environmental Applications
	ECE-655	Environmental Hydraulics
	ECE-657	Application of soft computing techniques
	ECE-659	Transport of Water and Wastewater
	ECE-661	Water Resources Management

Detailed Syllabus of Courses for M.Tech (ESE)

Semester 1

Environmental Chemistry and Microbiology (ECE 551)

UNIT -1

BASIC CHEMISTRY- Fundamentals of chemistry of environmental engineering, concepts of general chemistry, oxidation and reduction equation, equilibrium, Le-chatleir principle, activity and activity co-efficient, ion product of water, consideration of acids and bases, solubility products.
PHYSICAL CHEMISTRY- Osmosis, dialysis, conductivity, chemical kinetics, adsorption.
EQUILLIBRIUM CHEMISTRY- Acids and bases, titration, buffers.
ORGANIC CHEMISTRY- Hydrocarbon, alcohol, detergents, pesticides, soap, trace organics.

UNIT -2

QUANTITATIVE CHEMISTRY-general operations, sampling, laboratory, detergents, precipitation, filtration, ignition, desiccation, analytical balance, gravimetric analysis, calometric analysis, volumetric analysis.

UNIT – 3

INSTRUMENTS METHODS OF ANALYSIS- Introduction
OPTICAL METHODS- Absorption method, elusion, dispersion, scattering.
ELECTRICAL METHOD- Potentiometer analysis, electrodes, polarographic analysis.
CHROMATOGRAPHIC METHODS- Gas chromatography, HPLC, ion chromatography.
OTHER INSTRUMENT METHOD- Mass spectrometry, x-ray analysis, NMRspectroscopy

UNIT – 4

DETERMINATION OF PHYSICAL CHARACTERSTICS- Turbidity, conductivity, color, odour.
CHEMICAL CHARACTERSTICS- Hardness, fluorite residual content, acidity, alkality, pH, settable solids, suspended solids, dissolved solids, sulphate chloride.

UNIT – 5

DETREMINATION OF BACTERIOLOGICAL CHARACTERSTICS- NPN, E- collide, field visit to water treatment plan, organic parameter, DO, BOD, COD, TKN (Total Kjeldal No.), rate kinetics constant to above reaction.

References

1. Sawyer, C.N., Mccarty, P.L. , and Parkin, G.F. "Chemistry for Environmental Engineering and Science , 5th edition, Mcgraw-Hill Book Company, 2553
2. Outlines of Biochemistry - Conn and Stump
3. Microbiology - Pelzar and Reid
4. Microbiology for Sanitary Engineers - Ray MaKinney

Laboratory Experiments

Experiment No.1: Estimation of Solids, 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 Dissolved Oxygen
Experiment No.9: Atomic Absorption Spectrophotometric Determination of Heavy Metals
Experiment No.15: Conducting Jar test for determining optimum dosage of coagulant
Experiment No.11: Estimation of Organic Compounds Using HPLC
Experiment No.12: Estimation of biological parameters

Readings:

1. Standard methods for the examination of water and wastewater, 21st Edition, Washington: APHA., 2512
2. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, 5th edition McGraw-Hill Inc., 2552
3. B. Kotaiah and Dr. N. Kumara Swamy, Environmental Engineering Laboratory Manual, Charotar Publishing House Pvt. Ltd., 1st Ed., 2557

Environmental Quality and Natural Processes (ECE 553)

Unit 1

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

Unit 2

ECOLOGY- Ecosystem, concept of ecosystem, structure and function of an ecosystem, energy flow of ecosystem, ecology succession, natural cycle- carbon, nitrogen and sulphur, population ecology- growth models, predator prey relationships.

Unit 3

Water pollution- sources and classification of water pollutants, composition of waste water, water quality standards, natural process – Dispersion, reaeration, sorption, adsorption, decay, self-purification capacity of stream, Streeter Phelps equation and its modifications, Wasteload Allocation, mass balance, water borne disease, population equivalent.

Unit 4

a) Air pollution- Sources and effects, meteorological aspects, control methods and equipments.
b) Land pollution- types of land pollution, Solid waste management.

UNIT-5

a) Natural resources- Water, energy, mineral, forest resources.
b) Environment protection- A role of government, legal aspects, initiative by NGO, environmental education, women education.
c) Environmental legislation- Introduction of various legislation related to water, air biodiversity, ozone depletion at nation 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, 2555
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.

Air Pollution and Control (ECE 555)

Unit-1

Air pollution: composition and structure of atmosphere, global implications of air pollution. classification of air pollutants: particulates, hydrocarbon, carbon monoxide, oxides of sulphur, oxides of nitrogen and photochemical oxidants. Indoor air pollution. Effects of air pollutants on humans, animals, property and plants.

Unit-2

Air pollution chemistry, meteorological aspects of air pollution dispersion; temperature lapse rate and stability, wind velocity and turbulence, plume behaviour, dispersion of air pollutants, the Gaussian Plume Model, stack height and dispersion.

Unit-3

Ambient air quality and standards, air sampling and measurements; Ambient air sampling, collection of gaseous air pollutants, collection of particulate air pollutants, stack sampling. Design of gravitational settling chamber, cyclone seperater, fabric filter, electrostatic precipitator,

Unit-4

Introduction to air pollution control, control devices for particulate contaminants: gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP).

Unit-5

Control of gaseous contaminants: Absorption, Adsorption, Condensation and Combustion
Control of sulphur oxides, nitrogen oxides, carbon monoxide, and hydrocarbons.
Automotive emission control, catalytic convertor, Euro-I, Euro-II and Euro-III specifications, Indian specifications.

References:

1. Peavy, Rowe and Tchobanoglous: Environmental Engineering.
2. Martin Crawford: Air Pollution Control Theory.
3. Wark and Warner: Air Pollution: Its Origin and Control.
4. Rao and Rao: Air Pollution Control Engineering.
5. Nevers: Air Pollution Control Engineering.
6. Mycock, McKenna and Theodore: Handbook of Air Pollution Control Engineering and Technology.Suess and Craxford: W.H.O. Manual on Urban Air Quality Management

Laboratory Experiments

1. To carry out ambient air quality sampling and analysis of SO_2.
2. To carry out ambient air quality sampling and analysis of NO2.
3. To carry out ambient air quality sampling and analysis of Suspended Particulate matter.
4. To carry out ambient air quality sampling and analysis of RSPM. (PM15, PM2.5)
5. To carry out ambient air quality sampling and analysis of Ozone (O_3).
6. To carry out ambient air quality sampling and analysis of carbon monoxide (CO).
7. To carry out measurement and analysis of ambient meteorological parameters (wind speed, direction, relative humidity, temperature)

Elective I (ECE 559-567)

List of Elective I

ECE-559	Environmental Impact Assessment
ECE-561	Surface Water Quality modeling and Control
ECE-563	Toxicology and Environmental Risk Assessment
ECE-565	Environmental Economics, Legislation and Social Impact
ECE-567	Physico-Chemical Processes of water and wastewater

Syllabus is given in the last

Semester 2

Design of Wastewater Treatment (ECE 552)

Unit I

Introduction to Wastewater treatment and Design

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

Introduction to 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 II

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

Unit III

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.
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 (ECE 554)

Unit-1

Solid waste: Public health and ecological impacts, Sources and types of solid wastes, material flow and waste generation in a technological society, factors affecting the generation rates, projections for futures, future challenges and opportunities.
Functional elements: Waste generation, storage, collection, Transfer and transport, processing and recovery, disposal.

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 equipments, screening equipments, densification, baling, cubing, pelleting equipments,

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

Fundamental- Hazardous waste, regulatory process, process fundamental, fate and transport of contaminants, toxicology
Current management practices- Environmental audit, pollution prevention, facility development and operation
Treat and disposal: Physio-chemical processes, biological methods, stabilization and solidification, thermal methods, land disposal
Site remediation- Quantitative risk assessment, site and subsurface characterization, contaminant, remedial alternative analysis.
References:

1. Tchobanoglous, G., Theisen, H., & Vigil, S.A; Integrated Solid Waste Management: McGraw Hill, New York

2. Solid Waste Engineering, Principle & Management issues by Ven Te Chow
3. Bhide, A.D., B.B. Sundaresan, Solid Waste Management in developing countries.
4. Manual on Municipal solid Waste Management, CPHEEO, Govt. of India.
5. Guidelines for Management and Handling of Hazardous wastes MOEF (1991), Govt. of India.
6. Datta, M; Waste Disposal in Engineered Land fills, Narosa Publishers, Delhi.
7. Waste Management "Asian and Pacific Center for Transfer of Technology (N.D.) India", September 1993.
8. Michael D. LaGrega, P.L. Buckingham, J.C. Evans and The environmental resource group
' Hazardous waste management' Mcgraw hill international edition, Singapore

Probability and Statistics for Engineers (BMA 564)

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.

List of Elective II (ECE 560-568)

ECE-560	Ground Water Flow and Pollution Modeling
ECE-562	Advanced Water and Wastewater Technologies
ECE-564	Principles of Cleaner Production
ECE-566	Industrial Waste Management and Environmental Audit
ECE-568	Occupational health and Safety

Semester 3

Environmental System Analysis (ECE 651)

Unit-1

Introduction to natural and man-made system. System modeling as applied to environmental systems, Nature of environmental system, the model building process,

System and 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, Computer Coding, Data Acquisition and Processing, Model Calibration, Model Validation and Verification, Sensitivity Analysis.

Introduction to water pollution and transport and atmospheric process. Strategies for analyzing and using environmental system models.

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, Marginal Values of Additional Resources, Sensitivity Analysis, Complications in Applying the Simplex Method, Application in resource allocation and, Water Quality and West water Treatment,

Unit 4

Application of Transportation Problems and Dynamic Programming in Water Supply Engineering.

Integrated management strategies addressing multi-objective planning: Optimization over time,

Unit 5

Application of Environmental Database and Environmental Software Packages, including systems optimization.

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 5-19-557398-3.
4. Barrat, Rod (2551). 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)

Elective- III (ECE 653 to 661)

List of Elective III

ECE-653	Remote Sensing and GIS Environmental Applications
ECE-655	Environmental Hydraulics
ECE 657	Application of Soft computing Techniques
ECE 659	Transport of water and wastewater
ECE 661	Water Resources Management

Seminar/Minor project (ECE 671)

The topic of seminar shall be based on area of Environmental Engineering & preferably considering new ideas, concepts, technologies & developments in the field of Environmental Sciences & Technologies. An oral presentation and submission of report in hard copy is expected. Prior to presentation, he/she shall carry out the detailed literature survey from Standard References such as International Journals and Periodicals, recently published reference Books etc. The assessment shall be based on selection of topic, its relevance to the present context, report documentation and presentation skills.

Dissertation (ECE 697)

Assessment of the dissertation shall be based on novelty of research, contribution to existing knowledge, quantum of work, potential of publishing in peer reviewed journals, presentation of material in the thesis, performance in examination etc.

Syllabus of Elective courses

Elective I **(3-1-5)**

Environmental Impact an Assessment (ECE-559)
Unit 1
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

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 impacts on the: air, surface water, groundwater, soil, noise environment, biological environment, archaeological environment, visual impacts, socio-economic 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

Books

Larry, W. Canter (2555). 'Environmental Impact Assessment' McGraw Hill, Civil Engineering Series, 2n edition, Singapore

Anjanayelu, Y. (2552). "Environmental Impact Assessment Methodologies", B.S. Publishers, Hyderabad

R.R. Barthwal. (2512). "Environmental Impact Assessment.", New Age International (P) limited publisher, New Delhi

Surface Water quality modeling and control (ECE 561)

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.
Time variable analysis: non dispersive steams, effect of dispersion.
Engineering controls; Derivation of steady state stream equations

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,
Lakes: Physical and hydrologic characteristics,-evaporation, temperature stratification.
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.

Toxicology and Environmental Risk Assessment (ECE 563)
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, hellucinogens, 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

Environmental Economics, Legislation and Social Impact (ECE 565)

UNIT – 1

Data requirement and survey topographical, geological, hydrological, socio-economic, technological market survey, identification of alternative options associated data requirements and survey.

Project feasibility, demand assessment, planning period and time horizon, economic-demographic projections, integrated and disaggregated analysis and model building, demand resilience and consumer behavior.

UNIT - 2

Basic economic concepts – present worth future worth, annuities, discounting techniques, production function and cost curves, components of cost curves, leaning curve, expansion path, long term and short term, estimation of project benefits and cost, tangible and intangible values, indifference curves.

UNIT - 3

Economics of environmental project – General mathematics, condition of project optimality, benefits cost analysis, project formulation, a social benefit cost approach, profitability analysis, environmental cost benefit analysis, decision methods for evaluation of alternatives, environmental valuation, approaches to valuation.

UNIT – 4

Environmental legislation, introduction to various legislation related to water, air, biodiversity, ozone depletion etc. at National and various International level, issues involved in the enforcement of environmental legislation, initiatives by NGO's, initiatives by governments, CPCD.
Contemporary issues – Emission trading, discharge permits, international resources sharing issues, climate change, international environmental treaties and protocol.

UNIT – 5

Sustainable development, environmental economics, environmental policy in planned, mixed and market economics.

Books
Anjanayelu, Y. (2552). "Environmental Studies", B.S. Publishers, Hyderabad
Kautrogiannis, A. "Modern Micro-economics"
Ahuja, H.L., "Advanced Economics"

Elective II

Elective Type	Course Code	Course Name
Program Elective II	ECE-560	Ground water flow and pollution modeling
	ECE-562	Advanced water and wastewater technologies
	ECE-564	Principles of Cleaner Production
	ECE-566	Industrial Waste Management and environmental Audit
	ECE-568	Occupational Health and Safety

Ground Water Flow and Pollution Modeling (ECE-560)

Unit 1

Introduction, hydrological cycle & definitions, Occurrence of ground water, hydro-geology & aquifers, Ground water movement, Darcy's law, flow-nets in isotropic medium.
Types of subsurface water, types of aquifers, storage coefficient, determination of aquifer constant, Sub surface water: Introduction, porosity and water content, measurement of soil water, vertical distribution of sub surface water, equation of unsaturated flow, groundwater recharge estimation, groundwater budgeting

Unit 2

Equations of ground water flow, radial flow in confined aquifer, Dupuits assumption, differential equation governing ground water flow in three dimensions derivation, Steady flow groundwater flow towards a well in confined and unconfined aquifers – Dupuit's and Theism's equations, Assumptions, yield of an open well interface and well tests, Unsteady flow towards a well – Non equilibrium equations – Thesis solution

Unit 3

Background: Ground water occurrence and movement, general introduction
System concepts and optimization: System component and constraints
Linear Programming: Graphical, Duality and Simplex Methods
Dynamic Programming: Principle of optimality, recursive equation representation, tabular method.
Non linear programming : Classical optimization techniques, constrained and unconstrained non linear algorithms, lagrange multiplier and Kuhu Tucker conditions.

Unit-4

Numerical Modeling of Ground Water Flow: Review of differential equations, finite difference solution, direct problem, inverse problem, Introduction to finite element method, stream-aquifer interflows

Unit-5

Planning of Ground water Development: Water balance, Assessment of recharge, utilizable recharge, Indian practice, Constraints on ground water development Feasibility check by ground water modeling, optimal ground water developments, simple cases of planning and development in canal commands areas.

Reference:

1. Graf, W.H., Hydraulics of Sediment Transport, McGraw Hill International
2. R.J. Garde and K.G. Rangaraju, Mechanics of sediment transportation and luvial stream
problems, Wiley Eastern Ltd.

3. Subramanya, K., Flow in Open Channels, Tata Mc Graw Hill
4. Change, H.H., Fluvial processes in river engineering, John Wiley and sons.
5. Todd, D.K., Ground Water Hydrology, John Wiley
6. Remson, I. Homberger, G.M, and Molz. F.J., Numerical Methods in subsurface Hydrology, Wley Inter Science, Newyork
7. Ruhston, K.R. and Redshaw, S.C., Numerical analysis by analog and digital methods, John Wiley
8. Huakom, P.S. and Pindar, G.G., computational methods in subsurface flow, Academic Press
9. R.A. wurbs and W.P. James, Water Resources Engineering, PHI

Advanced Water and Wastewater Technologies (ECE-562)

Unit 1

Gas transfer: Aeration systems, Energy requirement, Design of aeration systems. Membrane

Unit 2

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 3

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 4

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 5

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 6

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.

Principles for Cleaner Production (ECE 564)

Detailed Syllabus:

Introduction

Industrial Society- an overview; Resource Limitations - forests, water, air, soil, material resources; Environmental Problems - local problems such as population, energy, water, pollution etc, global problems such as global warming, climate change, ozone layer depletion, green house effect etc; Sustainable development - principles, environmental, economic and social dimensions of sustainable development by focusing on changing patterns of consumption, production and distribution resources

Thermodynamics

Definitions; Earth as a thermodynamic system; Thermodynamics of the technosystem; Thermodynamics and energy in society; Thermodynamics and environmental pollution; Towards a thermodynamically sustainable development.

Energy

The global energy situation; The energy system; Fossil energy, fuel cells; Renewable energy- biomass, photovoltaic, solar thermal, wind energy, future of renewable energy production, fusion; Net energy analysis- energy breeders

Engineering

Separation, supercritical extraction, membranes, reverse osmosis, ultrafiltration, electrodialysis, pervaporation, liquid membranes, adsorption, parametric pumping, biosorbents; Process development, centralization/decentralization/integration, engineering; photochemistry; Thermochemistry; Energy saving; Energy storage

Industrial And Hazardous Waste

Industrial waste types, characteristics of industrial wastes, pollution from major industries, effects of industrial effluents, cleaner production, treatment technologies; Hazardous wastes definition, sources of hazardous waste, transportation, - treatment and disposal methods and processes

System Analysis, Materials & Products

Flexible processes; Ecodesign; Material recycling; Biodegradable materials - degradation mechanisms, test methods, structural factors influencing biodegradability, microbial polymers, other natural polymers, synthetic and decomposable polymers, mixtures of decomposable and non-decomposable materials.

Readings:

1. Allan Johansson, Clean Technology, 1st edition CRC Press, 1992
2. Aswathanarayana U., Harikrishnan T., and Kadher-Mohien S. T.**,** Green Energy Technology, Economics and Policy, CRC Press, 2512
3. Bernard Ganne and Yveline Lecler, Pollution Prevention Handbook, CRC Press, 1995
4. T.T.Shen, Industrial Pollution Prevention, Springer, 1999.
5. Blackman, William C. Basic hazardous waste management, 3rd edition, CRC Press, 2551

Industrial Waste Management and Environmental Audit (ECE-566)

Unit 1

Water use in industry, Industrial water quality requirements, Deterioration of water quality, Classification and characterization of Industrial wastewater, Monitoring of wastewater flow in industries, Quality and quantity variations in waste discharge, Water budgeting.
Waste volume reduction, Waste strength reduction, Neutralization, Proportioning, Equalization. Reuse and recycling concepts.

Unit 2

Treatment techniques for removal of specific pollutants in industrial , wastewaters, e.g., oil and grease, cyanide, fluoride, calcium, magnesium,toxic organics, heavy metals, radioactivity
Treat ability aspects of raw industrial wastewater with domestic sewage, Partially treated industrial wastewater with domestic sewage, Completely treated industrial wastewater with domestic sewage. Stream and Effluent standards

Unit 3

Common Effluent treatment plant: Concept, Objectives, Methodology, Cost benefit analysis, Design, Operation and maintenance.

Unit 4

Classification of industries. Manufacturing processes, Water usage, Sources, Quantities, and characteristics of effluents, Pollution effects, Methods of treatment, utilization and disposal, in industries viz. sugar, distillery, dairy, pulp and paper mill, fertilizer, tanning, steel industry, textile, petroleum refining, chemical and power plant.

Unit 5

Environmental audit: Environmental Audit: Introduction , Environmental information Purpose & advantage of studies, General approach of environmental Auditing Environmental Audit ,

Audit programs in India, Auditing program in major polluting Industries , Reports of the Environmental audit studies .

References
1) Theories and Practices of Industrial waste treatment- Nelson Nemerow.
2) Waste water treatment: M.N.Rao & Datta.
3) IS Standard guide for treatment and disposal of various industries.

Occupational Health and Safety (ECE 568)

3rd Semester
Elective III (Open Elective)

Elective Type	Course Code	Course Name
Program Elective-III	ECE-653	Remote Sensing and GIS for Environmental Applications
	ECE-655	Environmental Hydraulics
	ECE-657	Application of soft computing techniques
	ECE-659	Transport of Water and Wastewater
	ECE-661	Water Resources Management

Remote Sensing GIS for Environmental applications (ECE-653)

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.

Wildlife Mapping and Modeling. Land Use Planning and Environmental Impact Assessment

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.

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, GIS-Based Wastewater Collection System Design and Management Applications, GIS-Based Decision-Support Systems 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.
Spatial techniques for Water Quality Monitoring and Modeling, GIS for Water-Quality Database Development, 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.

Environmental Hydraulics (ECE-655)

Unit 1
Basic concepts of open channel flows, conservation laws, continuity equation, momentum equation, Application of momentum and energy equations
Critical flow, its properties and application; location of critical flow and its computation

Unit 2
Uniform flow, flow resistance, equations of flow resistance, computation of normal depth,

Unit 3
Gradually varied flow, governing equations classification of water surface profiles

Unit 4
Rapidly varied flow, application of conservation laws, channel transition, supercritical flow, Hydraulic Jump

Unit 5
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,

Readings:
1. Kundu and Cohen, Fluid Mechanics, Academic Press, 2512

2. Cussler, E. L, Diffusion: Mass transfer in fluid systems, 3rd Ed., Cambridge University Press, 2557.
3. Chow, V.T. , Open channel flows, McGraw Hill, 2515
4. Chow, V.T. , Applied Hydrology, McGraw Hill, 2515

Open Channel Flow
Unit-1

Introduction: Basic concepts of free surface flows, velocity and pressure distribution, Mass, energy and momentum principle for prismatic and non-prismatic channels,
Review of Uniform flow: Standard equations, hydraulically efficient channel sections, compound sections,
Energy-depth relations: Concept of specific energy, specific force, critical flow, critical depth, hydraulic exponents, and channel transitions.

Unit-2

Gradually Varied Flow (GVF): Equation of gradually varied flow and its limitations, flow classification and surface profiles, Control sections,
Computation methods and analysis: Integration of varied flow equation by analytical, graphical and advanced numerical methods, Transitions of subcritical and supercritical flow, flow in curved channels.

Unit-3

Rapidly Varied Flow (RVF): Characteristics of rapidly varied flow, Classical hydraulic jump, Evaluation of the jump elements in rectangular and non-rectangular channels on horizontal and sloping beds, Hydraulic jump in gradually and suddenly expanding channels, submerged hydraulic jump, rolling and sky jump, use of jump as an energy dissipater,
Flow measurement: by sharp crested and broad crested weirs, critical depth flumes, sluice gate, Free overfall.
Rapidly varied unsteady flow: Equation of motion for unsteady flow, "Celerity" of the gravity wave, deep and shallow water waves, open channel positive and negative surge,

Unit-4

Spatially Varied Flow (SVF): Basic principles, Differential SVF equations for increasing and decreasing discharge, Classifications and solutions, Numerical methods for profile computation, Flow over side-weir and Bottom-rack.
Unit-5

Flow in channel of non-linear alignment and non-prismatic channel sections, Design considerations for sub critical and super critical flows, Design of culvert.

References:

1. Chow, V.T., Open channel Hydraulics, McGraw Hill International
2. Henderson, F.M., Open Channel Flow, McGraw Hill International
3. Subramanya, K., Flow in Open Channels, Tata McGraw Hill
4. Ranga Raju, K.G., Flow through open channels, T.M.H.
5. M. Hanif Chaudhry, Open Channel Flow, PHI
6. French, R.H., Open channel Hydraulics, McGraw Hill International

Applications of Soft computing techniques (ECE 657)

Unit 1
Need for soft computing techniques, components of soft computing.

Unit 2
Artificial Neural Networks (ANN), Types of ANN, Learning algorithms, Applications of ANN, Information and uncertainty, Chance versus ambiguity.
Unit 3
Classical sets and fuzzy sets, Logic and reasoning, Fuzzy set operations and fuzzy relations, Membership Functions, Fuzzy Systems, Decision Making with Fuzzy Information, Fuzzy Classification and Pattern Recognition, Neuro-Fuzzy Systems. Evolutionary computing, Genetic algorithm, Hybrid soft computing techniques,

Unit 4 and **Unit 5**
Applications of Soft computing tools in Environmental Engineering

Readings:

1. Haykin, Neural Networks: A Comprehensive Foundation, Prentice Hall India, New Delhi, 2558
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, 2559
3. Rajasekaran, S., and Vijayalakshmi Pai, G.A., Neural Networks, Fuzzy Logic and Genetic Algorithms – Synthesis and Applications, Prentice-Hall India, New Delhi, 2553
4. Sivanandam, S N and S N Deepa, Principles of Soft Computing, Wiley India, 2513
5. Karray, Fakhreddin O. and Clarence De Silva, Soft Computing and Intelligent Systems Design – Theory, Tools and Applications, Pearson Education Ltd., 2513