Course Structure and Syllabus

of

M. Tech Programme

in

Civil Engineering

Specialization: Environmental Science & Engineering

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
BURLA – 768 018, SAMBALPUR, ODISHA

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA
DEPARTMENT OF CIVIL ENGINEERING

VISION

To emerge as an internationally acclaimed Civil Engineering Department for imparting futuristic technical education and creation of vibrant research enterprise to create quality civil engineering and researchers, truly world class leader and unleashes technological innovations to serve the global society and improve the quality of life.

MISSION

The Department of Civil Engineering, VSSUT, Burla strives to create values and ethics in its product by inculcating depth and intensity in its education standards and need based research throughout

- Participative learning in a cross-cultural environment that promotes the learning beyond the class room.
- Collaborative partnership with industries and academia within and outside the country in learning and research.
- Encouraging innovative research and consultancy through the active participation and involvement of all faculty members.
- Facilitating technology transfer, innovation and economic development to flow as natural results of research where ever appropriate.
- Expanding curricula to cater broader perspectives.
- Creation of service opportunities for upliftment of the society at large.

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY: BURLA
CIVIL ENGINEERING DEPARTMENT
M.TECH – ENVIRONMENTAL SCIENCE & ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Apply basic principles of environment and their significance in the socio-economic development.

PEO2: Identify, formulate and design engineered solutions to environmental problems related to water, waste water, air and solid waste.

PEO3: Apply best management practices for sustainable development.

PEO4: Communicate and manage interdisciplinary teams in solving complex environmental engineering problems.

PEO5: Demonstrate leadership qualities and exhibit professional ethics.

GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs.

These Graduate Attributes are identified by National Board of Accreditation.

a. Engineering Knowledge
b. Problem Analysis
c. Design & Development of Solutions
d. Investigation of Complex Problem
e. Modern Tools Usage
f. Engineer and Society
g. Environment & Sustainability
h. Ethics
i. Individual & Team work
j. Communication
k. Lifelong Learning
l. Project management & Finance

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY: BURLA
CIVIL ENGINEERING DEPARTMENT
M.TECH – ENVIRONMENTAL SCIENCE & ENGINEERING

PROGRAM OUTCOMES (POs)

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

PO1: Analyze and interpret environmental pollution data

PO2: Design environmental engineering systems

PO3: Forecast and predict fate of pollutants in the environment.

PO4: Identify best waste management practices

PO5: Predict the environmental impacts of developmental projects and engineered solutions in global, and socio-economic context.

PO6: Pursue life-long learning as a means of enhancing the knowledge and skills in environmental modeling.

PO7: Model environmental systems using modern tools and techniques.

PO8: Engage in critical thinking and contribute to research in solving contemporary environmental problems with professional and ethical responsibility

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY: BURLA
CIVIL ENGINEERING DEPARTMENT
Curriculum for M.TECH – ENVIRONMENTAL SCIENCE & ENGINEERING
(REGULAR)

First Semester

Sub No.	Subjects	L	T	P	C
	Water Treatment Technology	4	0	0	4
	Waste Water Management	4	0	0	4
	Computational and Statistical Methods (same as M.Tech. - WRE)	4	0	0	4
	Elective – I(Group – A)	4	0	0	4
	Elective – II(Group – A)	4	0	0	4
	Environmental Monitoring Lab	0	0	6	4
	Seminar – I	0	0	3	2
	Comprehensive Viva Voce-I				2
	Total =	20	0	9	28

Second Semester

Sub No.	Subjects	L	T	P	C
	Air Pollution & Control	4	0	0	4
	Environmental Impact Assessment	4	0	0	4
	Solid and Hazardous Waste Management	4	0	0	4
	Elective – III (Group – B)	4	0	0	4
	Elective - IV(Group – B)	4	0	0	4
	Planning & Design of Environmental Engg. Structures	0	0	6	4
	Seminar – II	0	0	3	2
	Comprehensive Viva Voce-II				2
	Total =	20	0	9	28

Third Semester

Sub No.	Subjects	L	T	P	C
	Dissertation interim evaluation				10
	Comprehensive Viva Voce-III				3
	Seminar on Dissertation				2
	Total =				15

Fourth Semester

Sub No.	Subjects	L	T	P	C
	Dissertation Open Defense				5
	Dissertation evaluation				20
	Total =				25

Grand Total = 96

Electives for I-Semester in Group – A

1. Ground Water Flow through Porous Media (Same as M. Tech.- GTE)
2. Applied Chemistry & Microbiology
3. Quantitative Techniques
4. Global Warming & Climate Change
5. Environmental Chemistry
6. Energy & Environment
7. Environmental Hydraulics
8. Numerical Methods in Engineering (same as CE 15066)
9. Environmental Management (same as CE 15071)

Electives for II-Semester in Group- B

1. Industrial Wastewater Treatment
2. Water Resources Engineering
3. Geoinformatics (same as M. Tech.- GTE)
4. Advanced Environmental Geotechnics (same as M. Tech.- GTE)
5. Urban Drainage Sewage System
6. Ground Water Engineering (same as CE 15050)
7. Ground Improvement Techniques (same as CE 15046)
8. Stability Analysis of Slopes, Dams & Embankments (Same as M. Tech.- GTE)
9. Optimization Techniques (same as M.Tech. - TE)

Core Subjects: I Semester

1. WATER TREATMENT TECHNOLOGY (4-0-0), 4 credits

Course Objective:

- To make the students familiar with sources of water
- To provide the knowledge on demand of water and population forecast
- To understand the design of basic components of water supply lines
- To expose the students to understand the characteristics of water and its measurement
- To depict the information on water treatment processes and its design
- To provide adequate knowledge on water distribution system

Module I

Quantity of Water: Per-capita demand, design period, population forecast, fluctuation in demand

General requirement: Sources of water, necessity of treatment, water quality standards for various water uses, Intake structures – Different types & design criteria, pumping and transportation of water

Principles and design of aeration systems – two film theory, water in air system, air in water system

Module II

Principles of sedimentation: Types of settling and settling equations, design criteria and design of settling tanks. Principle of Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, and optimum dose of coagulant, design criteria and numerical examples

Filtration: Theory, types, hydraulics of filter bed, design criteria and design of filters, filter backwash, operational problems and trouble shooting.

Module III

Disinfection: different types, disinfectants, factors affecting disinfection, methods of disinfection, and chemistry of chlorination.

Water Softening: Ions causing hardness, Langelier index, various methods.

Fluoridation and de-fluoridation - Principles and design.

Module IV

Adsorption Process: Types, factors affecting adsorption, kinetics and equilibrium – different isotherm equations and their applications.

Advanced water treatment: Ion exchange, electro-dialysis, Reverse Osmosis, Ultra filtration

Distribution system design and analysis, distribution reservoirs and service reservoirs**.**

Course Outcomes: Upon successful completion of this course, students will be able to

- Understand the principles and operation of water treatment systems
- Appraise the suitability of the design of treatment plants and unit processes

- Evaluate process operations and performance
- Understand coagulation, flocculation, and sedimentation, filtration, and disinfection processes.
- Apply water distribution processes.

REFERENCES:

1. Peavy, H.S., Rowe and Tchobonoglous, G., (1985), "Environmental Engineering", McGraw Hill
2. Raju, B.S.N., (1995), "Water Supply and Wastewater Engineering", Tata McGraw Hill Pvt. Co. Ltd., New Delhi.
3. Fair, G.M., Geyer J.C and Okun, (1969) "Water and Wastewater Engineering" Vol II, John Wiley Publications.
4. Weber W.J., (1975) "Physico - Chemical Processes for Water Quality Control".
5. AWWA, (1971), "Water Quality and Treatment "McGraw Hill.
6. CPHEEO Manual, (1991), "Water Supply and Treatment", GOI Publications.

2. WASTE WATER MANAGEMENT (4-0-0), 4 credits

Course Objectives:

- To learn about the methods used for the treatment of wastewater biologically.
- To make the students understand modeling and design aspects of biological techniques available.

Module I

Objectives of wastewater treatment: flow variations , characteristics, analysis of BOD, COD, solids and volatile solids & their significance, BOD progression & its formulation, types of reactors and reactors analysis. Wastewater Treatment, Flow Diagrams and Hydraulic Profile.

Theoretical principles and design - screens, equalization basin, grit chamber, primary and secondary settling tanks.

Module II

Kinetics of biological treatment systems: bio-kinetic constants and their determination, batch and continuous systems.

Module III

Theoretical principles and design: Suspended growth system - conventional activated sludge process and its modifications. Theoretical principles and design – attached growth system – trickling filter, bio-towers and rotating biological contactors. Principles and design of stabilization ponds

Module IV

Sludge Processing: Separation, sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. Advanced Wastewater Treatment – Need and technologies used. Nitrification and Denitrification Processes, Phosphorous removal. Wastewater disinfection.

Course Outcomes: Upon successful completion of this course, students will be able to

- Get the concept of a unit operation and a unit process.
- Acquire fundamental scientific processes underlying the design and operation of wastewater treatment plant.
- Manage the residuals from water and wastewater treatment.
- Use the design of a water and wastewater treatment plant.

REFERENCES:

1. Peavy, H.S., Rowe and Tchobonoglous,G., (1985), "Environmental Engineering", McGraw Hill
2. Metcalf and Eddy Inc., (2003), **"Wastewater Engineering - Treatment and Reuse",** 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Benefield R.D., and Randal C.W., (1980), **"Biological Process Design for Wastewater Treatment"**, Prentice Hall, Englewood Chiffs, New Jersey.
4. Karia G.L., and Christian R.A., (2001**), "Wastewater Treatment Concepts and Design Approach",** Prentice Hall of India Pvt. Ltd., New Delhi.
5. Lee C.C., and Lin S.D., (1999), **"Handbook of Environmental Engineering Calculations",** McGraw Hill, New York.

3. COMPUTATIONAL AND STATISTICAL METHODS (4-0-0) 4 Credits

(same as M.Tech. – WRE - COMPUTATIONAL AND STATISTICAL METHODS)

Course Objectives:

- To understand the fundamentals of statistical methods.
- To develop competence in formulating statistical models and translating problem descriptions into mathematically solvable models.

Module I

Numerical Solution of Ordinary Differential Equations-Solution by Taylors's Series-Euler's Method- Runge Kutta Methods-Simultaneous and Higher Order Equations-Boundary Value Problems-Applications. Finite Difference Method-Finite Difference. Representation of Differential Equations-Stability-Consistency and Convergence of Partial Differential Equations-Time integration-Finite Difference Methods in Solution of Steady and Unsteady Problem-Jacobi's Method, Gauss Seidel Method, Successive Over Relaxation Method and Method of Characteristics-Application and Examples.

Module II

Finite Element Method-Basic Concepts – Solution of Discrete Problems-Steady State and Time Dependent Continuous Problems-Application of Finite Method through illustrative Examples.
Classification and Presentation of Data – Basic Concepts of Probability – Probability Axioms – Analysis and Treatment of Data – Population and Samples – Measures of Central Tendency – Measures of Dispersion- Measures of Symmetry – Measures of Peakedness.

Module III

Probability Distributions – Discrete and Continuous Probability Distribution Functions – Binomial, Poisson, Normal, Lognormal, Exponential, Gamma Distributions, Extreme Value Distributions – Transformations to Normal Distributions, Selecting A Probability Distribution, Parameter Estimation – Method of Moments, Method of Maximum Likelihood, Probability Weighted Moments and Least Square Method, Joint Probability Distributions.

Module IV

Regression Analysis – Simple Linear Regression, Evaluation of Regression – Confidence Intervals and Tests of Hypotheses – Multiple Linear Regression – Correlation and Regression Analysis

Course outcomes: Upon successful completion of this course, students will be able to

- Understand systems analysis concepts and techniques applied to engineering problems
- Effectively communicate systems methods and modeling results

- Solve challenging engineering problems that involve constrained resource allocation.

References:

1. Akai, T.J,(1994) “Applied Numerical Methods for Engineers”, John Wiley Inc., New York
2. Haan C.T. (1995), “Statistical Methods in Hydrology”,. East West Press, New Delhi
3. Huyorkon, P.S. and Pinder, G.F.: “Computational Methods in Subsurface Flow”, Academic Press, 1983.
4. Press, W.H., Flannery B.P. and Tenklsky, S.A. and Vetterling, W.T. “Numerical Recipes-The Art of Scientific Computing”, Cambridge University Paress, Ccmbridge, 1994.
5. Kosho, B (1997), “Neural Networks and Fuzzy Systems”, Prentice Hall of India, N Delhi
6. Rao V and H. Rao, (1996), “C^{++} Neural Networks and Fuzzy Logic, BPB Publications, New Delhi”

4. ENVIRONMENTAL MONITORING LAB (0-0-6), 4 credits

Course Objective:

- To impart practical knowledge about various environmental related processes.
- To understand the practical implications associated with the estimation of different parameters related to environmental engineering.

Complete physical, chemical and bacteriological analysis of water and wastewater. Analysis of Flue gas

Course Outcomes: Upon successful completion of this course, students will be able to

- The students gain better understanding about the processes.
- The students will have the capacity to develop experiments related to their field of research.

5. SEMINAR I

Course Objective:

- To provide exposure to the recent developments.
- To improve the students presentation skills.

Course Outcomes: Upon successful completion of this course, students will be able to

- Improve communication skills.

6. COMPREHENSIVE VIVA-VOCE I

Course Objective:

- Assessment of basic and fundamental knowledge gained on the subjects in the semester

Course Outcomes: Upon successful completion of this course, students will be able to

- Provide knowledge on the subjects.

Electives : I Semester

1. GROUND WATER FLOW THROUGH POROUS MEDIA (4-0-0), 4 credits

(same as M.Tech. – GTE – GROUND WATER FLOW THROUGH POROUS MEDIA)

Course Objective:

- Develop a conceptual model of how fluids flow through porous media subject to different boundary conditions,
- Understand Darcy's Law and how it applies to flow through porous media,
- Understand the principles of groundwater investigations, production and management.
- Mathematically model the movement of fluids through porous media using different analytical solutions to the partial differential equation,

Module I

Soil Water: Modes of occurrence of water in soils. Adsorbed water, capillary water, Capillary potential, Capillary tension and soil suction. Effective and Neutral pressures in soil ;

Module II

Flow through porous Media: Darcy's law and measurement of permeability in laboratory and field. Steady State flow solutions of LaPlace's equation, Plane problems, 3-dimensional problems,

Module III

Partial cut-offs, uplift pressure, consolidation theory –one and three dimensional consolidation Secondary consolidation ; Ground water Hydraulics: Water table in regular materials, Geophysical exploration for locating water table.

Module IV

Confined water, Equilibrium conditions, Non-equilibrium conditions, Water withdrawal from streams, Method of ground water imageing.

Course outcomes: Upon successful completion of this course, students will be able to

- Apply knowledge of mathematics, science and engineering,
- Identify, formulate, and solve engineering problems,
- Use the techniques, skills, and modern engineering tools necessary for engineering practice.

References:

1. D.K.Todd, *Groundwater Hydrology*, John wiley and Sons
2. H.M. Raghunath, *Ground Water*, Willy Eastern Ltd.
3. C.Fitts, *Ground Water Science*, Elsevier Publications, U. S. A.
4. P. P. Raj, *Geotechnical Engineering*, Tata McGraw-Hill
5. A. Jumikis, *Soil Mechanics*, East West Press Pvt Ltd.

2. APPLIED CHEMISTRY & MICROBIOLOGY (4-0-0), 4 credits

Course Objectives:

- To train for measurement of concentration and technology for environmental conservation
- To improve welfare and sustainability of our society by applying their chemical knowledge.

Module I
Importance of Environmental Chemistry: Types of reactions, redox reactions, chemical thermodynamics, chemical equilibrium, equilibrium constants and activity, reaction kinetics. acidity, alkalinity, carbonate system, solubility reactions, Electrochemistry and its applications.
pH – Principle, Measurement, Numerical Examples, Buffers and Buffer index.

Module II
Colloidal Chemistry: Properties of colloids, colloidal dispersions, stability of colloids and applications.
Applications of Organic Chemistry in Environmental Engineering.
Colourimetry: Principles and applications. Applications of Analytical Chemistry – emission and absorption techniques.

Module III
Microbiology: Microorganisms of importance in air, water and soil environment Principles and applications of microscopy, microscopic flora and fauna of importance.
Metabolism and metabolic pathways, Bio-concentration, Bio-magnification and Bioaccumulation.

Module IV
Bacteria :Morphology, typical growth curve and generation time, Measurement Techniques – APC, MPN (Probability and Thomas methods), MFT. Monod's equation and its applications. Algae - orphology, classification and their importance. Fungi - Protozoa - morphology, classification and their importance. Enzymes: classification, kinetics - Michaelis-Menten equation, factors influencing enzyme reaction.

Virology: Types, characteristics and enumeration methodology.

Course Outcomes: On completion of this course, students are able to

- Master a broad set of chemical knowledge concerning the fundamentals in the basic areas of the discipline (organic, inorganic, analytical, physical and biological chemistry).
- Demonstrate that microorganisms have an indispensable role in the environment, including elemental cycles, biodegradation, etc.

REFERENCES:

1. Sawyer C.N. and McCarty, P.L ., (2003), **"Chemistry for Environmental Engineering and Science**", 5th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. McKinney R.E.(1962) "**Microbiology for Sanitary Engineers**", Newyork McGraw Hill.
3. Pelczar M.J ,Chan ECS, Krieg, NR(1998) **"Textbook of Microbiology"** 5th edition Tata McGraw Hill Publishing Co. Ltd., New Delhi
4. Gaudy and Gaudy (1980), "**Microbiology for Environmental Scientists and Engineers**", McGraw Hill.
5. APHA, (2002), "**Standard Methods for Examination of Water and Wastewater**"; 21st Edition.
6. Stumn and Morgan(1970), "**Aquatic Chemistry",** John Willey & Sons Newyork

3. QUANTITATIVE TECHNIQUES (4-0-0) 4 Credits

Course Objectives:

- To apply mathematical and statistical models in the analysis of problems.
- To understand probability and decision making analysis, analysis under uncertain conditions, and network analysis.

Module I

Operation Research: Behavioral versus quantitative decision making, role of models. Linear programming, Graphical and Simplex procedures, sensitivity analysis; Transportation and Assignment problems, Application of linear programming in business and other systems.

Module II
Integer Linear Programming: Branch and Bound Algorithm, Zero-one Implicit Enumeration Algorithm,, Cutting Plane Algorithm, Introducing to queuing, Single and Multiple server models, finite population models, queuing costs and applications, Theory of games: optimal; solution of Two-Person zero sum games, solution of mixed strategy games. Minimal spanning tree algorithm, Shortest route problem.

Module –III
Probability: Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability multiplication rule, total probability, Baye's theorem, and independence.
Random variables: Discrete, continuous and mixed random variable, probability mass, probability density and commutative distribution functions, mathematical Expectations, moments, moment generating function, chebyshevi inequality.

Module IV
Special Distributions: Discrete uniform, Binomial, Geometric Poisson, Exponential Normal Distribution, Functions of a Random Variable, Joint Distributions: Joint marginal and conditional distributions, product moments, correlations, independence of random variables, bivariate normal distribution.

Course outcomes: Upon successful completion of this course, students will be able to

- Identify and diagnosed problems.
- Select the quantitative technique or model appropriate in problem solving and decision making situations.
- Apply various quantitative models in decision making situations.
- Interpret results and the impacts they have upon the problems being studied.
- Decide the appropriate course of action based on the quantitative analysis performed.
- Integrate the quantitative methods learned for making decisions within an organization.
- Explain decisions based on quantitative elements.

REFERENCES:
1. Taha, Operation Research, PHI
2. Jhon E. Freund, Mathematical Statics, PHI
3. Trivedi, Probability Statistics, PHI

4. GLOBAL WARMING AND CLIMATE CHANGE (4-0-0), 4 credits

Course Objectives:

- To understand the Earth's Climate System and the concept of Global Warming.
- To comprehend the impact of climate change on society and its mitigation measures.

Module I

Energy Issues and Climate Change , Alternate Energy Sources
Green-House Effect as a Natural Phenomenon, Green House Gases GHGs) and their Emission Sources

Module II

Quantification of CO_2 Emission, Global Warming Potential (GWP) of GHGs
Modeling Climate change, Ozone layer depletion and its control

Impacts of climate change – Global and India, Temperature Rise, Sea Level rise, Coastal Erosion and landslides, Coastal Flooding, Wetlands and Estuaries loss

Module III

Kyoto Protocol – Importance, Significance and its role in Climate Change
Carbon Trading - Mechanisms , Various Models (European, Indian) Global and Indian Scenario
Cleaner Development Mechanisms – Various Projects related to CO_2 Emission Reduction

Module IV

Alternatives of Carbon Sequestration – Conventional and non-conventional techniques , Role of Countries and Citizens in Containing Global Warming

Course outcomes: Upon successful completion of this course, students will be able to

- Measure climate factors and how they change
- Understand connections between global warming and human activities
- Identify effects of climate change on biodiversity and ecosystems in different biomes and aquatic systems
- Model possible scenarios for future climate change
- Achieve possible ways to deal with climate change.

References:

1. Barry R.G., and Chorley R.L., (1992), **"Atmosphere, Weather and Climate",** 4th Edition, ELBS Publication.
2. Bolin B., (Ed.), (1981), **"Carbon Cycle Modelling",** John Wiley and Sons Publications.
3. Corell R.W., and Anderson P.A., (Eds.), (1991), **"Global Environmental Change",** Springler Verlog Publishers.
4. Francis D., (2000), **"Global Warming: The Science and Climate Change",** Oxford University Press.
5. Frame B., Medury Y., and Joshi Y., (Eds.), (1992), **"Global Climate Change: Science, Impact and Responses".**
6. Linden E., (2006), **"The Winds of Change: Climate, Weather and the Destruction of Civilizations",** Simon and Schuster Publications.

5. ENVIRONMENTAL CHEMISTRY (4-0-0), 4 Credits

Course Objectives:

- To impart knowledge on chemistry aspects of environment.
- Analysis of chemical methods in environmental engineering.

Module I

Significance, Sources, Impact and Measurement of Physical, chemical and biological water quality parameters

Atmospheric chemistry, Soil chemistry

Module II

Water pollution: Water quality standards and parameters, Assessment of water quality, Aquatic Pollution, Freshwater pollution, Estuarine water quality, Marine pollution, Biochemical oxygen demand, Chemical oxygen demand, DO and BOD demand in streams, Transformation process in water bodies, Oxygen

transfer by water bodies, Turbulent mixing, water quality in lakes and preservers, Eutrophication, Ground water quality.

Module Ill

Air Pollution: Air pollutants - Air quality standards - Production, fate, effects of gaseous pollutants - Oxides of carbon, nitrogen and Sulphur - Organic air pollutants - photochemical reactions, photochemical smog, Climatic change, Green house effect, Acid rain and Ozone depletion

Noise Pollution: Physical properties of sound, Noise criteria, Noise standards, Noise measurement, Noise control.

Oils in fresh & marine water: Sources of oil pollution - chemistry and fate of hydrocarbons - oil in run off and ground water — biodegradation - effect on aquatic organisms and communities — treatment and disposal technology.

Module IV

Soil Pollution: Soil pollutants (Inorganic, organic, pesticides, radionuclides) - sources and effects on nature and properties of soil, claps, plants arid terrestrial animals.

Thermal pollution, Nuclear hazards

Other environmental Issues: Sustainable development, Bio gas, Natural gas, Biodiversity, Urban problems related to energy, water scarcity, Water conservation, rain water harvesting, artificial recharge, watershed management, carbon trading, carbon foot print

Course outcomes: Upon successful completion of this course, students will be able to

- Be familiar with basic concepts of chemistry to understand the fundamental underlying mechanism.
- Be familiar with sampling of wastes.

REFERENCES

1) Environmental Chemistry by Stanley E.Manahan, 5th Ed., Lewis, 1991.
2) Oil in Fresh Water - Ed., Vander Meulen and Hrudey, Pergamon , 1987.
3) Chemical Contamination in The Human Environment by Lippman and Schlesinger, Oxford, 1979.
4) Environmental Pollution by H.M.Dix., Wiley, 1981.
5) Environmental Chemistry by A.K.De,. 2nd Ed., Wiley Eastern 1989.
6) Water Treatment - Principles and Design by J.M.Montgomery., Wiley, 1985.
7) Pollution; Causes, Effects and Control by R.M. Harrison, 3rd Ed., Royal Society of Chemistry, London,1996.

6. ENERGY & ENVIRONMENT (4-0-0), 4 credits

Course Objectives:

- To learn about various energy sources available and their application
- Impart knowledge on conservation of energy

Module I

Introduction to energy sources: Global Energy, Environmental Resources, Energy necessity and energy crisis. Indian Energy Scenario: Energy Consumption, needs and crisis, energy sources and availability.

Renewable sources of energy and environment: Biomass – introduction, energy plantation, bio-mass conversion technologies (wet and dry process), photosynthesis, agricultural waste derived energy, urban waste derived energy. BIOGAS: Generation, factors affecting bio-digestion, advantages of anaerobic digestion, classification of bio-gas plants.

Module II
Hydropower: Site selection for hydroelectric power plants, classification of hydroelectric power plants, submergence, ecological imbalance, catchment area treatment, advantages and disadvantages of hydroelectric power plants. Submergence, Ecological Imbalance, Catchment Area Treatment.

Tidal energy: OTEC (Ocean Thermal Electric Conversion), methods of ocean thermal electric power generation, site selection. Energy from tides – basic principles of tidal power, components of tidal power plant.

Module III
Solar energy: Solar constants, solar radiation at earth surface, physical principles of conversion of solar radiation into heat. Concentrating collectors (focusing and non-focusing).

Wind energy: Introduction, basic principles of wind energy conversion. Site selection considerations. Basic components of wind energy conversion system. Wind energy collectors. Natural gas – classification and comparison of different gas turbine power plants, Associated Environmental Effects.

Module IV
Nuclear energy: necessity, general components of nuclear reactors, different types of reactors, breeding reactors, location of nuclear power plants, disposal of nuclear wastes, Associated Environmental Effects.
Geo-thermal energy: introduction, nature of geothermal fields, geo-thermal sources, binary fluid geo-thermal power system and arrangement for hybrid plants.

Course outcomes: Upon successful completion of this course, students will be able to

- Develop energy efficient process
- Focus on the conservation of energy while developing industrial processes

REFERENCES:

1. Mathur, A.N., and Rathore, N.S., "**Renewable Energy and Environment"** –Proceedings of the National Solar Energy, Himanshu Publications, Udaipur.
2. Rao and Parulekar B.B., (1977), **Energy Technology–Non-conventional, Renewable and Conventional",** 2nd Edition, Khanna Publishers.
3. Rai, G.D **, "Non-conventional Energy Sources",** Khanna Publications.
4. Saha, H., Saha, S.K., and Mukherjee, M.K., (1990), "**Integrated Renewable Energy for Rural Development",** Proceedings of the National Solar Energy Convention, Calcutta, India,
5. Wilber, L.C., (1989), "**Handbook of Energy Systems Engineering",** Wiley and Sons.
6. The Energy Research Institute (TERI), New Delhi, Publications.
7. Mintzer I.M., (Ed.), (1982), **"Confronting Climate Change, Risks, Implications and Responses"**, Cambridge University Press.
8. Srivatsava A.K., (2007), **"Global Warming",** APH Publications.
9. Wyman R.L., (Ed.), (1991), **"Global Climate Change and Life on Earth",** Chapman and Hall Publications.
10. Yadav, Chander and Bhan, (2005), **"Global Warming: India's Response and Strategy",** RPH Publications.

7. ENVIRONMENTAL HYDRAULICS (4-0-0), 4 credits

Course Objectives:

- To learn about well hydraulics and transport and transformation of contaminants in ground water.
- To provide the knowledge on pollutant transport processes in surface water
- To provide adequate knowledge on fluid flow and water distribution system
- To provide the knowledge on open channel hydraulics

Module I

Ground water and well hydraulics: steady and unsteady radial flows in aquifers (confined, unconfined and leaky), effect of well bore storage, multiple well systems, partially penetrating wells, bounded aquifers, characteristic well losses, and estimation of aquifer parameters.

Transport and transformation of contaminants in groundwater: processes, formulation of the governing equations and initial and boundary conditions, solutions for simple cases.

Module II

Introduction to pollutant transport processes in surface water, governing equations for flow and transport in surface water, advection, diffusion and dispersion, Mixing Mechanisms in rivers, Streeter Phelps Equation, Modification to Streeter Phelps Equation, Lake Water Quality Models

Module III

Fluid flow - continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow

Flow through Pipes: Major and minor losses of energy in pipes , Hydraulic gradient and total energy line, Flow through pipes in series, in parallel, equivalent pipe , Flow through branch pipe

Water Distribution network analysis – Hardy cross and Equivalent pipe method

Module IV

Open channel hydraulics: open channel flow and its classifications, and properties, energy and momentum principles, Critical flow computation and its applications, transitions with sub critical and super critical flows uniform flow, gradually varied flow, Most efficient channel section

Course outcomes: Upon successful completion of this course, students will be able to

- Use transport models for contaminant transport for ground water and surface water.
- Compute basic groundwater calculations.
- Apply basic fluid mechanics principles in the analysis and design of pipe flow.
- To solve pipe network problems.
- Apply open channel hydraulics for problems in open channel flow.

REFERENCES:

1. Fluid Mechanics, A.K. Jain, Khana Publishers.
2. Hydraulics and Fluid Mechanics, Modi and Seth, Standard Book House.
3. Open Channel Flow, Subramanya, Mcgraw-Hill Publishing Co.
4. Chrapra.C., "Surface water quality modeling," McGraw Hill, 1997.
5. Ground Water Hydrology, Raghunath, Wiley Eastern limited.

8. NUMERICAL METHODS IN ENGINEERING (4-0-0), 4 credits

(same as CE 15066 NUMERICAL METHODS IN ENGINEERING)

Course Objectives:

- To provide a basic knowledge of numerical methods including: root-finding, elementary numerical linear algebra, integration, interpolation, solving systems of linear equations, curve fitting, and numerical solution to ordinary differential equations.

Module I

Introduction to digital computers and programming-an overview, Errors-polynomial approximation interpolation: finite differences, Newton's formula for interpolation ,central difference interpolation formulae, interpolation with unevenly spaced points, divided difference and their properties, inverse interpolation and double interpolation
Numerical differentiation: errors in numerical differentiation, differentiation formula with function values.
Numerical integration: Trapezoidal rule, Simpson's 1/3rd & 3/8th rule, Romberg integration, newton cote's integration formula, Euler-maclaurin formula, Gaussian integration, numerical double integration

Module II

Solution of linear system - Gaussian elimination and Gauss-Jordan methods , necessity for pivoting, LU decomposition methods , Jacobi and Gauss-Seidel iterative methods sufficient conditions for convergence , Power method to find the dominant Eigen value and eigenvector Diagonal dominance, condition number, ill conditioned matrices, singularity and singular value decomposition. Banded matrices, storage schemes for banded matrices, skyline solver. Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton- Raphson method

Module III

Approximate solution technique, static condensation, Rayleigh-Ritz method, subspace iteration, Application of finite difference method, solution of equilibrium equations in dynamics, direct method, central difference method, Houbolts method, Wilson θ method, Newmarks method

Module IV

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method, Taylor's method and Runge-Kutta method for simultaneous equations and 2nd order equations - Multistep methods - Milne's and Adams' methods

Course outcomes: Upon successful completion of this course, students will be able to

- Assess the approximation techniques to formulate and apply appropriate strategy to solve real world problems.
- Use of numerical methods in modern scientific computing.
- Use numerical solution of integration, linear equations, ordinary differential equations, interpolations.

Text Book

Numerical methods for Scientists and Engineers by M.K. Jain, S.R. Iyengar & R.K. Jain, Wiley Eastern Ltd.

Numerical methods in engineering and science, Grewal, B.S., Khanna Publishers, Delhi.

Reference Books

Mathematical Numerical Analyis By S.C. Scarborough, Oxford and IBH Publishing Company.

Introductory methods in Numerical Analysis by S.S. Sastry, Prentice Hall of India.

Theory and problems in Numerical Methods by T. Veeranjan and T. Ramachandran, Tata McGraw- Hill Publishing Company, New Delhi-2004.

Numerical Methods for Mathematics Sciences and Engineering 2nd ed. By John H. Mathews, Prentice Hall of India, New Delhi 2003.

Advanced Engineering Mathematics by R.K. Jain & S.R.K. Iyengar, Narosa-200 &

Computational engineering: introduction to numerical methods, Schafer, Michael, Springer Verlag, Berlin,

Numerical Methods in Science & Engg., Rajasekaran, S Chand Publication, 1983

9. ENVIRONMENTAL MANAGEMENT (4-0-0), 4 credits

(same as CE 15071 ENVIRONMENTAL MANAGEMENT)

Course Objectives:

- To introduce the basic knowledge of current environmental management systems applied in both public and private sectors. Class discussions will cover conventional development of ISO 14001 Environmental Management Systems (EMS) for various levels of organizations.
- To understand environmental auditing, environmental label, and life cycle assessment, Total Quality Environmental Management (TQEM) requirements.

Module I

Principles of Environmental Management, Ecosystem Concepts, Environmental Concerns in India, Policy and Legal Aspects of Environmental Management, Introduction to Environmental Policies, Environmental Laws and Legislations, Environmental Legislations in India.

Module II

Environmental Impact Assessment (EIA), Impact Prediction, Evaluation and Mitigation, Forecasting Environmental Changes, Strategic Environmental Assessment (SEA), Environmental Clearance Procedure in India, EIA Documentation and Processes, EIA Monitoring and Auditing.

Module III

Environmental Auditing, Elements of Audit Process, Waste Audits and Pollution Prevention Assessments, EA in Industrial Projects. Life Cycle Assessment (LCA), Stages in LCA of a Product, Procedures for LCA, Different Applications of LCA. Sustainable approach towards Environment Management, Environmental Protocols

Module IV

Environmental Management System Standards, Implementation of EMS Conforming to ISO 14001. Environmental Economics: Introduction, economic tools for evaluation, Green GDP, Cleaner development mechanisms and their applications.

Course outcomes: Upon successful completion of this course, students will be able to

- Understand the principal environmental policy issues confronting managers in diverse geographical and culture situations.
- Get the awareness of the ethical and moral issues involved in seeking the wise and sustainable use of resources.
- Get relevant practical skills, particularly in the fields of impact assessment, audit and law.

Text Book:

1. Vijay Kulkarni and Ramachandra T.V., 2006. Environmental Management, Commonwealth Of Learning, Canada and Indian Institute of Science, Bangalore.

References:

1. Lohani B.N (1984)., “Environmental Quality Management”, South Asian Publishers, New Delhi

2. Chanlett, (1973)“Environmental Protection”, McGraw Hill Publication, Newyork.

3. Danoy G.E., and Warner R.F., (1969), “Planning and Design of Engineering Systems”,Unwin Hyman Publications.

4. MOEF, Government of India, “Carrying Capacity Based Developmental Planning Studies for the 6. National Capital Region”, 1995-96.

5. NEERI, Nagpur, Annual Reports 1995 & 1996.

6. UNEP / UNDP – “Environmental Sustainable Development”.

7. ISO 14001:2004 Environmental management systems -- Requirements with guidance for use

Core Subjects: II SEMESTER

1. AIR POLLUTION AND CONTROL (4-0-0), 4 credits

Course Objectives:

- Develop an understanding of the classification, sources and effects of pollutants
- Describe general air pollution problems, air transport equations
- To understand the fundamentals of meteorology
- Study the principles and equipment description of control technologies
- Introduction of major problems in indoor air pollution and control, regulations

Module I:

Introduction: sources, effects on – ecosystems, classification of atmospheric pollutants, air pollution episodes of environmental importance.
Meteorology - composition and structure of the atmosphere, wind circulation, solar radiation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth (MMD), Temperature Inversions, Windrose diagram.
General characteristics of stack emissions, plume behaviour, heat island effect.

Module II

Air Quality models - Gaussian convection-diffusion model for point, line and areal sources.
Air Pollution Control of particulate matter & gaseous pollutants from point & non-point sources – gravity settling chambers, centrifugal collectors, wet collectors, fabric filters, electrostatic precipitator (ESP). – adsorption, absorption, scrubbers, condensation and combustion. Dust suppression measures.

Module III

Indoor Air Pollution – sources, effects and control.
Noise - sources, measurements, effects and occupational hazards. Standards, Noise mapping, Noise attenuation equations and methods, prediction equations, control measures, Legal aspects of noise.

Module IV

Monitoring of particulate matter and gaseous pollutants – respirable, non-respirable and nano - particulate matter. CO, CO2, Hydrocarbons (HC), SOX and NOX, photochemical oxidants.

Course outcomes: Upon successful completion of this course, students will be able to

- Identify anthropogenic sources and atmospheric effects to pollutions
- Understand Regional, global pollution transport mechanisms
- Appreciate development of transport equations and applications, stack Learn theory and development of pollution control devices: Cyclone, electrostatic particle precipitator, packed towers, gravitational eparator, bag house.

REFERENCES:

1. Nevers N.D.(2000), Air Pollution Control Engg, McGraw Hill.
2. Peavy, H.S., Rowe and Tchobonoglous,G., (1985), “Environmental Engineering”, McGraw Hill
3. Seinfeld N.J., (1975), “**Air Pollution”,** McGraw Hill.
4. Wark K ., Warner C.F., and Davis W.T., (1998), “**Air Pollution - Its Origin and Control**”, Harper & Row Publishers, New York.
5. Lee C.C., and Lin S.D., (1999), **“Handbook of Environmental Engineering Calculations**”, McGraw Hill, New York.
6. Perkins H.C.(1974), “**Air Pollution**”, McGraw Hill.

7. Stern A.C., "**Air Pollution**", Vol I, II, III.
8. Stern A.C.(1968), (ed) Vol. V, "**Air Quality Management**".

2. ENVIRONMENTAL IMPACT ASSESSMENT (4-0-0), 4 credits

Course Objective:

- To learn about the importance of Environmental Impact Assessment.
- To understand the methods followed for the impact assessment.

Module I

National environmental policy act and its implementation: Terminology, Features of the National Environmental Policy Act, Screening in the EIA Process, Summary Statistical Information on EISs, EIA at the International Level, Utility of the EIA process, Expanded scope of EIA, Narrowed scope of EIA

Planning and management of impact studies: Conceptual Approach for Environmental Impact Studies, Proposal Development, Interdisciplinary Team Formations, Team Leader Selection and Duties, General Study Management, Fiscal Control

Module II

Simple method for impact identification: Background Information, Interaction Matrix Methodologies, Network Methodologies, Checklist Methodologies

Description of environmental setting: Conceptual Framework, Initial List of Factors, Selection Process, Documentation of Selection Process, Data Sources

Environmental indices and indicators: Background Information, Environmental-Media Index-Air Quality, Environmental-Media Index—Water Quality, Environmental-Media Index—Noise

Module III

Prediction and assessment of impacts on the Air environment: Basic Information on Air Quality Issues, Conceptual Approach for Addressing Air Environment Impacts

Prediction and assessment of impacts on the Surface-water environment: Basic Information on Surface-water Quantity and Quality, Key Federal Legislation, Conceptual Approach for Addressing Surface-Water –Environment Impacts

Prediction and assessment of impacts on the soil and ground-water environments: Background Information on the soil Environment, Background Information on Groundwater Quantity and Quality, Key Federal Legislation, Conceptual Approach for Addressing Soil and Groundwater-Environment Impacts

Module IV

Prediction and assessment of impacts on the noise environment**:** Basic Information on Noise, Key federal Legislation and Guidelines, Conceptual Approach for Addressing Noise-Environment Impacts

Prediction and assessment of impacts on the biological Environment: Basic Information on Biological Systems, Key Federal Legislation, Conceptual Approach for Addressing Biological Impacts

Environmental laws and policies – Environmental laws for managing Air, water, land, wastewater, solid waste, hazardous waste, natural resources

Course Outcomes: On completion of this course, students are able to

- Make decision based on the environmental consequences of proposed actions.
- Promote environmentally sound and sustainable development by identifying appropriate measures.

REFERENCES:

1. Canter L., (1995), "**Environmental Impact Assessment**", McGraw Hill.
2. Jain R.K., Urban L.V., Stacey G.S., (1977), "**Environmental Impact Analysis – A New Dimension in Decision Making**", Van Nostrand Reinhold Co.
3. Rau and Wooten, (1981), "**Environmental Impact Assessment Handbook**". McGraw Hill.
4. Environmental Law, Sengar, PHI.

3. SOLID AND HAZARDOUS WASTE MANAGEMENT (4-0-0), 4 credits

Course Objective:

- To provide comprehensive overview of solid, biomedical and hazardous waste management.
- To provide knowledge on solid waste management design aspects.
- To learn about the different methods of solid waste management.

Module I
Solid waste – sources and engineering classification, characterization, generation and quantification.
Transport - collection systems, collection equipment, transfer stations, collection route optimization.

Module II
Treatment methods - various methods of refuse processing, recovery, recycle and reuse, composting – aerobic and anaerobic, incineration, pyrolysis and energy recovery,
Disposal methods – Impacts of open dumping, site selection, sanitary land filling – design criteria and design examples, leachate and gas collection systems, leachate treatment.

Module III
Biomedical Waste management – sources, treatment and disposal
Hazardous Waste Management- Introduction, Sources, Classification, Physico-chemical, Chemical and Biological Treatment of hazardous waste, regulations.

Module IV
Thermal treatment - Incineration and pyrolysis.
Soil contamination and site remediation – bioremediation processes, monitoring of disposal sites.

Course outcomes: Upon successful completion of this course, students will be able to

- Know solid waste remedial measures and their importance.
- Undertake projects related to solid waste management.

REFERENCES:

1. Tchobanoglous G., Theissen H., and Eliassen R.(1991), **"Solid Waste Engineering - Principles and Management Issues**", McGraw Hill, New York.

2. Pavoni J.L(1973)., "**Handbook of Solid Waste Disposal**".
3. Peavy, Rowe and Tchobanoglous (1985), "**Environmental Engineering**", McGraw Hill Co. 4th Edition
4. Mantell C.L., (1975), "**Solid Waste Management**", John Wiley.
5. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.
6. WHO Manual on Solid Waste Management.
7. Vesiland A.(2002), "**Solid Waste Engineering**", Thompson Books.
8. Hazardous waste (management and handling) rules, 2001
9. Biomedical (Handling and Management) Rules 2008

4. PLANNING & DESIGN OF ENVIRONMENTAL ENGINEERING STRUCTURES (0-0-6), 4 CREDITS

Course Objective:

- To understand basics design of environmental engineering structures

Design of water supply systems: Selection of site for the source of water supply, design of units for sedimentation, coagulation, flocculation, Granular media filtration, disinfection, water softening, advanced tertiary treatments, design of city water supply pumping and distribution system.
Design of wastewater collection and treatment unit, Design of air pollution control devices.

Course outcomes: Upon successful completion of this course, students will be able to

- Design various environmental structures like water treatment plants, waste water treatment systems.
- Design air pollution control equipments

5. SEMINAR (0-0-3), 2 CREDITS

Course Objective:

- To provide exposure to the recent developments.
- To improve the students presentation skills.

Course outcomes: Upon successful completion of this course, students will be able to

- Get better employability and communication skills.

Electives : II SEMESTER

1. INDUSTRIAL WASTEWATER TREATMENT (4-0-0), 4 credits

Course Objective:

- To provide an understanding of the mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic industrial or commercial activities prior to its release into the environment or its re-use.
- To understand various terms used in industrial wastewater treatment and to acquaint with different steps involved in treatment of industrial wastewater.

Module I

Types of industries and industrial pollution, Characteristics of industrial wastes, Population equivalent, effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health

Environmental legislations related to prevention and control of industrial effluents and hazardous wastes

Module II

Industrial Waste survey **-** Process flow charts, condition of waste stream. Sampling – Grab, Composite and integrated samples. Continuous monitoring – pH, Conductivity, Biomonitoring

Waste management Approach, Waste Audit, Volume and strength reduction, Material and process modifications, Recycle, reuse and byproduct recovery, Zero effluent discharge

Module III

Sources, Characteristics, waste water treatment flow sheets for selected industries such as Textile, Tannery, Pharmaceutical, Dairy, Sugar, Pulp and Paper, Distillery, Steel plants, Oil refineries, fertilizer

Module IV

Industrial wastewater treatment: Waste minimization, Equalization, Neutralization, Oil separation, Flotation, Precipitation, Heavy metal Removal, adsorption, aerobic and anaerobic biological treatment, Sequencing batch reactors, high rate reactors, chemical oxidation, ozonation, Photocatalysis, Wet Air Oxidation, Evaporation, Ion Exchange, Membrane Technologies, Nutrient removal

Course Outcomes: On completion of this course, students are able to

- Learn physical/chemical/biological characteristics of and the evaluation technique for various industrial wastewater
- Understand the theory, engineering application, and design technique for the industrial wastewater treatment unit processes.

REFERENCES:

1. Eckenfelder(2000)- "**Industrial Water pollution Control"-** McGraw hill Company, New Delhi American Chemical Society, Washington D.C. USA
2. Mahajan (1984) –" **Pollution control in Process industries"**. TMH, New Delhi.
3. Rao and Dutta (2007)- "Waste Water Treatment"- Oxford & IBH Pulishing Co. Pvt. Ltd., New Delhi
4. Azad N. S.,– "**Industrial Wastewater Management Hand Book"** McGraw Hill book Co., Newyork.
5. Ross R.D. (1968)– "**Industrial Waste Disposal"**, Reinhold Environmental Series – New York.
6. Dickinson(1974**)**- **Practical Waste Treatment and Disposal Applied Science publication**, London.
7. Nemerow N.N., (1971) – "**Liquid Waste of industry theories,** "Practices and Treatment. Addison Willey New York.

2. WATER RESOURCES ENGINEERING (4-0-0), 4 credits

Course Objective:

- To deal with surface water, addressing both water quantity and quality, learning to understand human influences on the hydrological system, and apply tools, for the proper integration of hydrological knowledge and analysis in water resources planning and management.

Module I

Water resources of the world, India and Odisha, National Water Policy. Hydrology - Hydrologic cycle, estimation of missing precipitation and rain guage density. Hydrograph theory - Unit hydrograph – derivation, flow routing, low flow analysis.

Module II

Urban Hydrology - Run-off estimation – Design of Stormwater Drains. Basics and applications of Remote Sensing in water resources management.

Module III

Unsteady Flow through Conduits - Water hammer analysis, Water hammer protection methods - surge tanks.

Flow Measurements – Area –Velocity method, Weir method, flumes, end-depth method & chemical and radioactive tracers method

Module IV

Groundwater - Basic equations of flow, confined and unconfined aquifers, sea water intrusion, artificial recharge, groundwater pollution, borewells - types & design principles, open wells – types, yield tests.

Course outcomes

Upon successful completion of this course, students will be able to

- Understand theories and concepts in surface and subsurface hydrology, the physical, chemical and biological interactions between the hydrosphere, the lithosphere, the biosphere and the atmosphere
- Evaluate and analyze hydrological systems and processes at a wide range of scales in both space and time for the purpose of water resources assessment, natural hazard assessment and mitigation, and environmental planning and management.

REFERENCES:

1. Raghunath H.M.(1988), "**Advanced Hydrology**", Wiley Eastern Ltd New Delhi
2. Subramanya K.S(1994)., "**Advanced Hydrology".Tata Mc Graw Hill, New Delhi**
3. David Keith Todd(1980), "**Ground Water Hydrology**".2nd Edition John Wiley & Sons New Delhi
4. Sabins F.F(1997)., "**Remote Sensing – Principles and Interpretations**", W.H. Freeman & Co.
5. Anji Reddy, (2001), "**Remote Sensing and GIS**", B.S. Publications, Hyderabad.
6. Ven T. Chow (1988), "**Hand Book of Applied Hydrology",** 1st Edition Mc Graw Hill Publications
7. Hammer M.J, and Mackichan K.A.(1981), "**Hydrology and Quality of Water Resources**", Newyork:Wiley.
8. John Permankian, **"Water Hammer Analysis**".
9. Linsley, Franzini, Freyberg, Tchobanoglous G.(1992), "**Water Resources Engineering**", TATA McGraw Hill Series.
10. Linsley, Kohler and Paulhes(1975), "**Hydrology for Engineers**", McGraw Hill.
11. Mays L.W. (2004), **"Water Resources Engineering**", John Wiley and Sons Publications.

3. GEOINFORMATICS (4-0-0), 4 credits

(same as M.Tech. – GTE – GEOINFORMATICS)

Course Objective:

- To impart knowledge on principles and applications of remote sensing , GIS for environmental engineering
- To understand the usage of GIS software and processing of data

Module I

Remote Sensing: Physics of remote sensing, Remote sensing satellites and their data products, Sensors and orbital Characteristics, Spectral reflectance curves for earth surface features, methods of remotely sensed data interpretation – Visual interpretation and Digital image processing, Application of remote sensing in natural resources management

Geographic Information System (GIS): Basic concepts of geographic data, GIS and its components, Data acquisition, Raster and Vector formats, Data editing, Spatial modeling, Data output, GIS Applications

Module II

Photogrammetry: Aerial Photographs – Basic terms & Definitions, scales, relief displacements, Flight Planning, Stereoscopy, Characteristics of photographic images, Fundamentals of aerial photointerpretation.

Module III

Global Positioning System (GPS): Introduction, Satellite navigation System, GPS- Satellite constellation, Space segment, Control segment, User segment, GPS satellite signals, Receivers, Static, Kinematic and Differential GPS

Module IV

Optimal Routing of Solid wastes using GIS- Case study.
Environmental Siting of Industries and Zoning Atlas Development
Re-modelling of Water Distribution System using GIS- Case study
Sustainable Urban Development Planning using GIS
Environmental Degradation Assessment using RS and GIS
Ground water vulnerability modeling using GIS

Course outcomes

Upon successful completion of this course, students will be able to

- Apply remote sensing and GIS to solve problems pertaining to environmental engineering.

References:

1,, Anji Reddy (2001) 'Remote sensing and GIS', B.S. Publications, Hyderabad
2.. Burrough P.A. (1986), 'GIS for Land Resources Assessment', Oxford University Press, UK.
3.. Star, J.L, and Estes J.E., (1990) 'Geographic Information Systems: An Introduction',Prentice Hall Publications
4. Laurini R. and Thomson D. (1992), 'Fundamentals of Spatial Information Systems', Academic Press
5. Mishra H.C. (1997) 'GIS Handbook','GIS India, Shanti Nivas, Hyderabad
6. Floyd F. Sabins (1996), ;Remote sensing- Principles and Interpretations', W.H. Freeman & Co
7. Michael N. Demas (2000), 'Fundamentals of GIS', John Wiley & Sons, Inc.

4. ADVANCED ENVIRONMENTAL GEOTECHNICS (4-0-0), 4 credits

(same as M.Tech. – GTE – ADVANCED ENVIRONMENTAL GEOTECHNICS)

Course Objective:

- To impart knowledge on principles and applications of remote sensing , GIS for environmental engineering
- To undestand the usage of GIS software and processing of data

Module I

Introduction: Forms of waste, engineering properties (determination and typical values), subsurface contamination.

Module II

Selection of waste disposal sites: Site selection – selection criteria and rating; Solid waste disposal: Ash Disposal facilities- Dry disposal, waste disposal, Design of ash containment system, Stability of ash dykes;

Module III

Contaminant transport through porous media: mechanisms- advective and dispersion; Municipal and hazardous waste landfill: Types- Dry cell, wet cell, bioreactor, Design- clay liners, geosynthetic clay liners for waste containment, cover and gas collection system. ;

Module IV

Remediation: Principle- planning, source control, soil washing, bioremediation.

Course outcomes: Upon successful completion of this course, students will be able to

- Understand composition, soil structure and its behavior
- Identify contaminant transport mechanisms in soils
- Specify site investigation techniques for characterization of contaminated site
- Understand the principles of soil treatment techniques

References:

1. K. R. Reddy and H D Sharma, “Geoenvironmental Engineering: Site Remediation, waste containment, and emerging waste management technologies”, John Willey, 2004.
2. R N. Yong, “Geo Environmental Engineering: Contaminated Ground: Fate of Pollutions and Remediation”, Thomson Telford, 2000.
3. L N Reddy and H.I. Inyang, “Geoenvironmental Engineering: Principles and Applications”, Marcel Dek, 2000

5. URBAN DRAINAGE AND SEWERAGE SYSTEM (4-0-0), 4 credits

Course Objective:

- To understand the fundamental concepts and techniques of hydraulics and hydrology in the analysis, design, and operation of water resources systems.

Module I

Urban Hydrological Cycle, Effects of Urbanization on Catchment Hydrology, Need for Urban Drainage System, Planning Objectives, Interaction of Urban and Surrounding Areas, Approaches to Urban Drainage

Types of sewerage system: Combined system, Separate System, Partially separate system, Patterns of Collection System, Components of sewerage system, design and planning of sewerage systems

Module II

Quantity estimation of Sewage: Sources of Sanitary Sewage, Dry Weather Flow, Evaluation of Sewage Discharge, Design Period, Design Discharge, Population forecasting

Quantity Estimation of Storm Water: Factors Affecting the Quantity of Storm water, Storm hyetographs – Rainfall excess calculations, time of concentration, Methods for Estimation of Quantity of Storm Water

Module III

Hydraulic Design of Sewers and Storm Water Drains: Difference Between Water Supply Pipes and Sewer Pipes, Requirements of Design and Planning of Sewerage System, Hydraulic Formulae for Determining Flow Velocities, Minimum and maximum Velocity, Hydraulic characteristics of circular sewer running full or partially full

Design of Storm Water Drains for Separate System: Important points for design

Sewer materials, Laying of Sewer Pipes, Hydraulic Testing of Sewers

Module IV

Sewer Appurtenances: Manholes, Drop manholes, Lamp holes, Clean-outs, Street inlets, Catch basins, Flushing Tanks, Grease & Oil traps, Inverted Siphons, and Storm Regulators

Maintenance, cleaning and ventilation of Sewers

Sewage and Storm water Pumping Stations: Types of Pumps, Pumping System Design, Types of Pumping Stations

Course outcomes: Upon successful completion of this course, students will be able to

- Become familiar with urban hydrology.
- Familiar with drainage systems and wastewater sources and flow rates.
- Analyze and design a sanitary sewer system.
- Design storm water drains and sewer appurtenances.
- Design and select pumps (single or multiple) for different hydraulic applications.

References:

1. Hall M.J. (1984), “Urban Hydrology”, Elsevier Applied Science Publishers
2. Geiger, W.F. Marsalek, J.Zudima and Rawls, G.J. (1987 “Manual on Drainage in Urban Areas”, 2 Volumes, UNESCO, Paris.)
3. Garg, S. K. (2010), “Sewage Disposal and Air Pollution Engineering”, Khanna Publisher, New Delhi

4. Geiger, W.F. and Jayakumar, K.V. (Ed.) (1996) “Lecture Notes of the V International Course on Urban Drainage in Developing Countries”, Regional Engineering Collage, Warangal..
5. Wanielista, M.P. and Yousef, Y.A. (1993), “Stormwater Management”, John Wiley and Songs, Inc., New York.

6. GROUND WATER ENGINEERING (4-0-0), 4 credits

(same as CE 15050 GROUND WATER ENGINEERING)

Course Objective:

- To comprehend basic concepts of the water cycle and hydrology
- To be able to perform engineering hydrology computations

Module-I

Groundwater Occurrence: Groundwater hydrologic cycle, origin of groundwater, rock properties effecting groundwater, vertical distribution of groundwater, zone of aeration and zone of saturation, geologic formation as Aquifers, types of aquifers, porosity, Specific yield and Specific retention. Groundwater Movement: Permeability, Darcy’s law, storage coefficient. Transmissivity, differential equation governing groundwater flow in three dimensions, groundwater flow equation in polar coordinate system. Groundwater flow contours their applications.

Module – II

Analysis of Pumping Test Data – I: Steady flow groundwater flow towards a well in confined and unconfined aquifers – Dupuit’s and Theim’s equations, Assumptions, Formation constants, yield of an open well, well tests.

Analysis of Pumping Test Data – II: Unsteady flow towards a well – Non equilibrium equations – Thesis solution – Jocob and Chow’s simplifications, Leak aquifers.

Tube wells- Types, strainers, yield of a tube well, Interference of wells, causes of failure, optimum capacity, rehabilitation and maintenance of tube wells.

Module – III

Surface and Subsurface Investigation: Surface methods of exploration – Electrical resistivity and Seismic refraction methods. Subsurface methods – Geophysical logging and resistivity logging. Aerial Photogrammetry applications along with Case Studies in Subsurface Investigation.

Artificial Recharge of Groundwater: Concept of artificial recharge – recharge methods, relative merits, Applications of GIS and Remote Sensing in Artificial Recharge of Groundwater along with Case studies.

Module – IV

Saline Water Intrusion in Coastal aquifer: Occurrence of saline water intrusions, Ghyben- Herzberg relation, Shape of interface, control of seawater intrusion. Groundwater Basin Management: Concepts of conjunctive use, Case studies.

Course outcomes: Upon successful completion of this course, students will be able to

- Characteristics of porous media, hydrologic cycle
- Darcy's law of fluid flow in porous media
- Continuity principles
- Well hydraulics; aquifer and borehole testing

- Engineering applications of groundwater hydraulics
- Modeling of groundwater problems

Text Books:
1. Groundwater - H.M.Raghunath [Wiley Eastern Ltd.]

References :
1. Groundwater Systems Planning & Management - R.Willes & W.W.G.Yeh [Prentice Hall of India.]
2. Applied Hydrogeology - C.W.Fetta [CBS Publishers & Distributors]
3. Groundwater Hydrology - David Keith Todd [John Wiley & Son, New York.]

7. GROUND IMPROVEMENT TECHNIQUES (4-0-0), 4 credits

(same as CE 15046 GROUND IMPROVEMENT TECHNIQUES)

Course Objective:

- To introduce the various types of improvement methods of engineering properties soils.
- To introduce the application of engineering methods to ground improvement projects.

Module – I

Introduction, Necessity of ground improvement, Dewatering, methods, Analysis and design of dewatering systems. Grouting types, Properties, Method of grouting, Ground selection and control.

Module – II

Compaction, Methods of compaction, Engineering prosperities of compacted soil, Field compaction and its control.

Module – III

Soil stabilization, Use of chemical additives, Stone columns, Principle, design and method of installation.

Module – IV

Reinforced earth, Concept, Materials, Application and design, Use of geo-synthetics and geo-cells in construction work.

Course outcomes: Upon successful completion of this course, students will be able to

- Acquire the knowledge of laboratory and in situ tests for soil improvement projects
- Acquire the knowledge of surface compaction.
- Understand the concept of admixture stabilization
- Understand the concept of deep densification.
- Understand the concept of using consolidation and vertical drains for soft soil improvement.
- Understand the concept of insitu reinforcement

Text books:

1. Ground Improvement Technique, P. Purusothom Raj

Reference Book

1. Foundation Design and Construction, M.J. Tomlinson

2. Foundation Engineering, G.A. Leonard, Tata McGraw Hill

3. Modern Geotechnical Engineering, Alam Singh, IBT Publishers

8. STABILITY ANALYSIS OF SLOPES, DAMS & EMBANKMENTS (4-0-0), 4 credits

(Same as M. Tech.- GTE - STABILITY ANALYSIS OF SLOPES, DAMS & EMBANKMENTS)

Course Objective:

- Understanding the fundamental concepts of soil properties, earth and rock fill dams and instrumentation in the earthen dam.
- Understanding the Failures, Damages and Protection of Earth Dams.
- Explaining the fundamental concepts of Slope stability including the analysis part.
- Analyze the different slope stability methods for earthen dams or embankments.
- Understand the properties of rockfill dams and their stability.

Module I

Landslide phenomenon: Types and causes of slope failures, Practical applications ; Stability analysis of infinite slopes with or without water pressures ;

Module II

Stability analysis of finite and Infinite slopes: concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, friction circle method ; Method of slices, Bishop's method, Janbu's method ; Effect of seepage, submerged and sudden draw down conditions ;

Module III

Design of slopes in cutting, Embankments and Earth dams; Site Investigation: Reconnaissance,

Module IV

Preliminary and detailed investigation, Investigation for foundations ; Advances in stability analysis of slopes

Course outcomes: Upon successful completion of this course, students will be able to

- Describe the requirements earth and rockfill dams .
- Understand the instrumentation for the earthen dams.
- Evaluate the Failures, Damages and Protection of Earth Dams.
- Analysis & design of filters in earthen dams.
- Evaluate the different slope stability methods.
- Analyze the different earth pressure theories for Slope stability of different soils.
- Understand the concepts of soil reinforcement, treatment and protection.
- Understand the requirements materials and their stability of rockfill dams.

References :

1. L. W Abramson, T. S Lee, S Sharma and G M Boyce, Slope Stability and Stabilization Methods, Willey Interscience publications
2. B M Das, Principles of Geotechnical Engineering, Thomson Brooks/Cole
3. T W. Lambe and R V Whitman, Soil Mechanics, John Wiley & sons
4. V N S Murthy, Principles of Soil Mechanics and Foundation Engineering, UBS Publishers Private Ltd.

9. OPTIMIZATION TECHNIQUES (4-0-0), 4 credits

(same as M.Tech. - TE - OPTIMIZATION TECHNIQUES)

Course Objective:

- To introduce the fundamental concepts of Optimization Techniques;
- To make the learners aware of the importance of optimizations in real scenarios;
- To provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

MODULE I

Linear Programming: Introduction and formulation of models; Convexity; simplex method; Two phase method; Degeneracy, non - existent and unbounded solutions; Duality in L.P.P. Dual simplex method, Sensitivity analysis; Revised simplex method; transportation and assignment problems.

MODULE II

Non-Linear Programming: Classical optimisation methods; Equality and inequality constraints; Lagrange multipliers; & Kuhn Tucker conditions; Quadratic forms; Quadratic programming.

MODULE III

Search Methods: One dimensional optimisation; Fibonacci search; multi dimensional search methods; Univariate search; gradient methods; steepest descent/ascent methods; Conjugate Gradient method; Penalty function approach.

MODULE IV

Dynamic Programming: Principle of optimality; Recursive relations; solution of L.P.Problem; simple examples. Integer Linear Programming: travelling salesman problem

Course Outcomes: Upon successful completion of this course, students will be able to

- Formulate optimization problems;
- Understand and apply the concept of optimality criteria for various type of optimization problems;
- Solve various constrained and unconstrained problems in single variable as well as multivariable;
- Apply the methods of optimization in real life situation.

Text book:

1. Optimisation Theory and Applications - S.S.Rao; Wiley Eastern Ltd., New Delhi

Reference Books:

1. Introduction to Optimisation - J.C.Pant; Jain Brothers; New Delhi.
2. Optimisation Method - K.V.Mital; Wiley Eastern Ltd. New Delhi.

III Semester

Dissertation interim evaluation, Seminar on Dissertation and Comprehensive Viva Voce-III

It will be taken up by the student at the end of the second semester and the duration would be six months. This is aimed at training the students to analyse independently any problem posed to them. The work may be analytical, experimental, design or combination of these. The dissertation report is expected to exhibit clarity of thought and expression, critical appreciation of the existing literature and analytical and/or experimental or design skill. The evaluation of dissertation will be based on continuous internal assessment comprising two seminars, one internal Viva-voce and an external Viva-voce examination.

IV Semester

Dissertation evaluation & Dissertation Open Defense

It will be taken up by the student at the end of the third semester and the duration would be six months. This is aimed at training the students to analyse independently any problem posed to them. The work may be analytical, experimental, design or combination of these. The dissertation report is expected to exhibit clarity of thought and expression, critical appreciation of the existing literature and analytical and/or experimental or design skill. The evaluation of dissertation will be based on continuous internal assessment comprising three seminars, one internal Viva-voce and followed by open defense.