Modified Course Structure of M. Tech. Programme
in
Environmental Engineering
Department of Civil Engineering

Course No	Course Title	Credits (L-T-P-C)
	Semester – I	
CE 521	Process Chemistry for Water and Wastewater Treatment	3-0-2-8
CE 522	Physico-chemical Processes in Environmental Engineering.	3-0-0-6
CE 523	Air and Noise Pollution	3-0-2-8
XX xxx	Elective – I: *One course from Elective Group – A*	3-0-0-6
	Total in Semester – I	***12-0-4-28***
	Semester – II	
CE 524	Biological Processes in Environmental Engineering	3-0-0-6
CE 525	Solid and Hazardous Waste Management	3-0-0-6
XX xxx	Elective – II: *One course from Elective Group – B*	3-0-0-6
XX xxx	Elective – III: *Another course from Elective Group – B (excluding the course already selected as Elective II).*	3-0-0-6
	Total in Semester – II	***12-0-0-24***
	Semester – III	
CE 527	Design of Environmental Engineering Systems	0-0-2-2
CE 690	M Tech Project – I	0-0-24-24
	Semester – IV	
CE 691	M Tech Project – II	0-0-24-24
	Total	**24-0-54-102**
	Elective Group – A	
CE 601	Numerical Methods	3-0-0-6
CE 602	Optimization Methods	3-0-0-6
CE 560	Computational Methods in Hydraulics and Environmental Engineering applications	3-0-0-6
	Or any other course as approved by DPPC.	
	Elective Group – B	
CE 661	Air Quality Modeling	3-1-0-8
CE 662	Environmental Systems Engineering Laboratory	1-0-4-6
CE 568	Environmental Management	3-0-0-6
CE 663	Principles of Water Quality and Legislations	3-0-0-6
CE 664	Industrial Wastewater Pollution Control	3-0-0-6
CE 665	Water Distribution and Wastewater Collection System Design	3-0-0-6
	Or any other course as approved by DPPC.	

Detailed Curriculum

The detailed curriculum along with text and reference books are given below.

Semester – I

CE 521: Process Chemistry for Water and Wastewater Treatment (3-0-2-8)

Basic Principles: Chemical equations and thermodynamic equilibrium; Acid Base Equilibria: Alkalinity and acidity, Buffering in water system; Solubility Equilibria; Water stabilization: Corrosion, Langlier saturation Index, Cadwell-Lawrence diagram; Equilibria governing iron and manganese solubility; Oxidation Reduction Equilibria; Application of redox chemistry; Fundamentals of process kinetics: Reaction rates and order, Reactor design; Fundamentals of surface and colloidal chemistry; Adsorption – physical versus chemical adsorption, factors influencing adsorption, Adsorption isotherms, Design of adsorption column.

Laboratory: Works related with Water and Wastewater Quality Parameters.

Text books:

1. Sawyer, C.N., McCarty, P.L., Parkin, G.F., Chemistry for Environmental Engineering, Tata McGraw-Hill, 2000.
2. Manhan, S.E., Environmental Chemistry, Lewis Publishers, 2000, Seventh Edition.

Reference books:

1. Benefield, L. D., Judkins, J. F. and Weand, B. L., Process Chemistry for Water and Wastewater Treatment, Prentice Hall, 1982.
2. Faust, S.D. and Aly, O.M., Chemistry for Water Treatment, Ann Arbor Science Book, 1983.
3. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds) Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 1998, 20th Ed.

CE 522: Physico-chemical Processes in Environmental Engineering (3-0-0-6)

Physical and chemical quality of surface and sub-surface waters and wastewater; Theory and design of physicochemical unit operations: screening, grit chamber, equalization, sedimentation, Floatation, Coagulation, Flocculation, Filtration, Disinfection; Water softening; Adsorption and Ion exchange; Aeration and gas transfer; Membrane separation processes.

Text books:

1. Kawamura, S., Integrated Design and Operation of Water Treatment Facilities, John Wiley & Sons, 2000, 2nd Ed.
2. Sincero, A. P. and Sincero, G. A., Environmental Engineering: A Design Approach, Prentice-Hall India, 1999.
3. Montgomery, J. M., Water Treatment: Principles and Design, John Wiley & Sons, 1985.
4. Metcalf and Eddy Inc., Wastewater Engineering – Treatment and Reuse, Tata McGraw Hill India, 2003, 4th Edition.

Reference books:

1. Vigneswaran, S. and Visvanathan, C., Water Treatment Processes: Simple Options, CRC Press, 1995.
2. Droste, R. L., Theory and Practice of Water and Wastewater Treatment, John Wiley & Sons, 1996.
3. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G., Environmental Engineering, McGraw-Hill International Ed., 1985.
4. Weber, W. J., Physico-Chemical Processes for Water Quality Control, Wiley Inter Science, 1972.
5. Benefield, L. D., Judkins, J. F. and Weand, B. L., Process Chemistry for Water and Wastewater Treatment, Prentice Hall, 1982.

CE 523: Air and Noise Pollution (3-0-2-8)

Definitions and scope: Problems and issues, Classification of air pollutants, Sources and effects; Monitoring techniques: Sampling methods and measurements of air pollutants and meteorological parameters, Source monitoring of gaseous and particulate matter, Networking of monitoring stations, Analyses of air pollutants, i.e. analytical techniques; Control: Methods of air pollution control for defined sources; Meteorology: Meteorological parameters and their effects on urban air pollution, Wind rose; Atmospheric stability; Global air pollution: Acid rain, Ozone layer depletion, Global warming, Green house effect and Trans-boundary pollution, Kyoto protocol, Carbon credit and carbon trading; Legislations and regulations: Ambient air quality standards, Emission standards, emission inventory, and Acts; Noise: Definition, Sources, Effects, Noise scales, Decibels and levels, and Noise level monitoring techniques.

Laboratory: Measurement and analyses of primary air pollutants SO_2, NOx, and SPM using high volume sampler; Wind speed and wind direction measurements using Anemometer; Wind rose plotting based on the winds measurements; Noise level measurements using Sound level meter.

Text books:

1. Rao, M. N. and Rao, H. V. N., Air pollution, Tata McGraw-Hill Publishing Co; Ltd, New Delhi, 1993.
2. Nevers, N. D., Air Pollution Control Engineering, McGraw-Hill International Ed., 1993.
3. Pandey V., Noise Pollution, Meerut Publishers, 1995.

Reference books:

1. Wark, K. and Warner, C.F., Air Pollution, Its Origin and Control, Harper and Row, New York, 1981.
2. Wayne T. D., Air Pollution Engineering Manual, John Wiley & Sons, 2000.
3. Rao, C. S., Environmental Pollution Control Engineering, New Age Int. Pubs, 1991, Reprint, 2005.

Semester – II

CE 524: Biological Processes in Environmental Engineering (3-0-0-6)

Microbiological concepts: cells, classification and characteristics of living organisms, reproduction, metabolism – basic metabolic models, microbial growth kinetics; Chemistry of carbohydrates, proteins, fats and lipids; Theory and design of biological unit operations: aerobic suspended growth systems – activated sludge processes and its modifications, ponds and lagoons; aerobic attached growth systems; anaerobic suspended and attached systems; Biological nutrient removal; Sequential Batch Reactors; Theory and design of sludge treatment; Wastewater disposal systems.

Text Books:

1. Pelczar, M. J. (Jr), Chan, E C S and Krief, N. R., Microbiology, 5th Ed., McGraw-Hill, 1996.
2. Metcalf and Eddy Inc, Wastewater Engineering: Treatment and Reuse, TMH publication, 4th Edition, 2003.
3. Henze, M., Harremoes, P., Jansen, J. C. and Arvin, E., Wastewater Treatment: Biological and Chemical Processes, 3rd Ed., Springer Verlag, 2002.

Reference Books:

1. Heritage, J., Evans, E. G. V. and Killington, R. A., Introductory Microbiology, Cambridge Univ. Press, 1996.
2. Benefield, L. D. and Randall, C. W., Biological Principles in Wastewater Treatment, Prentice-Hall, 1980.
3. Grady, C. P. L., Daigger, G. T. and Lim, H. C., Biological Wastewater Treatment, Marcel Dekker, Inc., New York, 2nd Edition, 1999.
4. Arceivala, S. J., Wastewater Treatment for Pollution Control, Tata McGraw Hill, 1999.

CE 525: Solid and Hazardous Waste Management (3-0-0-6)

Solid Waste: Origin, characteristics, Quantity and Analysis; Effects of Solid Wastes; Storage, Collection, Transportation of Solid wastes; Solid waste transformation; Product recovery processes; Sanitary landfills; Legislation in solid waste.

Hazardous waste: definition, generation, classification; Magnitude of problem; Risk assessment; Environmental Legislation; Characterization and site assessment; Waste minimization and resource recovery; Storage and Transportation of Hazardous wastes; Hazard in processing and treatment; Physical, Chemical, Thermal and Biological processes; Hazardous waste disposal; Landfill disposal and land storage; Ground water contamination; Containment; remedial alternatives.

Text Books:

1. Tchobanoglous, G., Theisen and Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, 1993
2. Vesilind, P. A., Worrel, W. A. and Reinhart, D. R., Solid Waste Engineering, Thomson Brooks/Cole, 1st Ed., 2002.

3. LaGrega, M. D., Buckingham, P. L. and Evans, J. C., Hazardous Waste Management, 2nd Ed., McGraw Hill, 2001.

Reference Books:

1. Bagchi, A., Design, Construction and Monitoring of Landfills, Wiley Interscience, 1994.
2. Haas, C. N. and Vamos, R. J., Hazardous and Industrial Waste Treatment, Prentice Hall, 1995.
3. Martin, E.J. and Johnson, J.H., Hazardous Waste Management Engineering, Van Nostrand, 1987.
4. Wentz, C. A., Hazardous Waste Management, 2nd Ed., McGraw Hill, 1995.
5. Lewandowski, G.A. and DeFilippi, L.J., Biological Treatment of Hazardous Wastes, John Wiley & Sons, INC., 1998.
6. Kuhre, W. L., Practical Management of Chemicals and Hazardous Wastes: An Environmental and Safety Professional's Guide, Prentice Hall, 1995.

Elective Group – A

CE 601 Numerical methods (3-0-0-6)

Linear and nonlinear equations, eigen value problems, Accuracy of approximate calculations, interpolation, differentiation and evaluation of single and multiple integrals, initial and boundary value problems by finite difference method, variation and weighted residual methods, fundamental of statistical distribution.

Text Books:

1. J. B. Scarborough, Numerical mathematical analysis, Oxford & IBH Publishing CO Pvt.
2. K. K. Jain, S. R. K Iyengar and R. K. Jain Numerical methods-problem and solutions, Wiley eastern limited.

Reference Books:

1. R.W. Hamming, Numerical methods for scientist and engineers, McGraw Hill.
2. J. H. Mathews and K.D. Fink, Numerical methods using MATLAB, Pearson Education. A. J. Hayter, Probability and statistics, Duxbury.

CE 602: Optimization Methods (3-0-0-6)

Basics of engineering analysis and design, Need for optimal design, formulation of optimal design problems, basic difficulties associated with solution of optimal problems, Classical optimization methods, Necessary and sufficient optimality criteria for unconstrained and constrained problems, Kuhn-Tucker conditions, Global optimality and convex analysis, Linear optimal problems, Simplex method, Introduction to Karmarkar's algorithm. Numerical methods for nonlinear unconstrained and constrained problems, sensitivity analysis, Linear post optimal analysis, sensitivity analysis of discrete and distributed systems. Introduction to variational methods of sensitivity analysis, shape sensitivity, Introduction to integer programming, dynamic programming, stochastic programming and geometric programming, Introduction to genetic algorithm and simulated annealing.

Text/Reference Books:

1. Deb, K., Optimization for engineering design: Algorithms and examples, PHI Pvt Ltd, 1998.
2. Arora, J.S., Introduction to optimum design, McGraw Hill International editions, 1989.
3. Hafta, R.T. and Gurdal, Z. Elements of structural optimization, 3rd Ed. Kluwer academic publishers, 1996.

CE 560: Computational Methods in Hydraulics and Environmental Engineering Applications (3-0-0-6)

Introduction – computing techniques –numerical methods - finite difference and finite element methods – applications in surface and ground water modeling, solute transport problems, pipe network analysis; artificial intelligence – applications.

References:

1. Chow, V. T., Maidment, D. R. and Mays, L. W., Applied Hydrology, McGraw Hill, 1988.
2. Chepra S. C. and Canele R. P., Numerical Methods for Engineers, McGraw Hill, 1990.
3. Segerlind, L. J., Applied Finite Element Analysis, John Wiley & Sons, 1984.
4. Todd, D. K., Ground Water Hydrology, Wiley, 1993.

Elective Group – B

CE 661: Air Quality Modeling (3-1-0-8)

Air pollution meteorology: Transport, dilution, modification and removal of pollutants; Wind velocity profiles, Atmospheric stability; Pasquill-Gifford stability classes; Inversions; Potential temperature gradient; Plume behavior; Mixing heights; Kinetics of air pollutants: Atmospheric advection-diffusion of pollutants; Fick's law of diffusion; No-flow boundary effect; Models for no-flow boundary conditions; Reynolds theory of turbulence; Atmospheric boundary layer; Modeling: Classification of air quality models, Gaussian plume model for a point source, Plume rise, Brigg's and Holand's equations for estimating plume rise; Dispersion coefficients; Buoyancy and flux parameters for plume rise; Gaussian approach to special cases of point, area and line sources of pollution; Pollutant concentration in the wake of building; Complex terrain effect; Deterministic models; Puff model; Box model; Special application of dispersion models; Advanced techniques in air quality modeling: Artificial Neural Networks (ANN), Hybrid modeling approach, Fuzzy logic theory (FLT), and Environmental wind tunnel (physical) models.

Text books:

1. Nevers, N. D., Air pollution and control engineering, McGraw Hills Publications, 2003.
2. Zannetti, P., Air Pollution Modeling, Computational Mechanics Publications, Southampton, Boston, 1990.
3. Barratt, R., Atmospheric Dispersion Modeling, Earthscan Publication Ltd, 2003.

Reference books:

1. Rau J. G. and Wooten D. C., Environmental Impact Analysis: Handbook, McGraw Hill Publications, 1985.
2. Khare, M. and Sharma P., Modeling the Vehicular Exhausts Emission, WIT press, UK, 2002.

3. Blackadar, A., Turbulence and Diffusion in the Atmosphere, Lectures in Environmental Sciences, Springer Publications, 1998.

CE 662: Environmental Systems Engineering Laboratory (1-0-4-6)

Detailed laboratory exercises related with physico-chemical and biological processes in Environmental Engineering: Sedimentation, Jar Test, Filtration, Chlorination, Adsorption and Ion Exchange (Batch and Column), Gas Transfer, Reaction Kinetics; Activated Sludge, Batch Anaerobic Reactor etc.

Texts/References:

1. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 1998, 20th Ed.
2. Metcalf and Eddy Inc, Wastewater Engineering: Treatment and Reuse, TMH publication, 4th Edition, 2003.
3. Droste, R. L., Theory and Practice of Water and Wastewater Treatment, John Wiley & Sons, 1996.
4. Benefield, L. D., Judkins, J. F. and Weand, B. L., Process Chemistry for Water and Wastewater Treatment, Prentice Hall, 1982.
5. Drum, D. A., Bauman, S. L. and Shugar, G. J., Environmental Field Testing and Analysis Ready Reference Handbook, McGraw Hill, 2000.

CE 568 : Environmental Management (3-0-0-6)

Environmental management- principles, problems and strategies; Review of political, ecological and remedial actions; future strategies; multidisciplinary environmental strategies, the human, planning, decision-making and management dimensions; environmental impact assessment (EIA), definitions and concepts, rationale and historical development of EIA, sustainable development, Initial environmental examination, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration, measurement of environmental impact, organization, scope and methodologies of EIA, status of EIA in India; Environmental audit, definitions and concepts, environmental audit versus accounts audit, compliance audit, methodologies and regulations; introduction to ISO and ISO 14000; Life cycle assessment; Triple bottom line approach.

Text Books:

1. Canter, L. W., Environmental Impact Assessment, McGraw-Hill, 2nd Ed., 1997.
2. Agarwal, N. P., Environmental Reporting and Auditing, Raj Pub., 2002.
3. Judith, P. and Eduljee, G., Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1994.

Reference books:

1. G. Burke, B. R. Singh and L. Theodore., Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000.
2. C. H. Eccleston, Environment Impact Statements: A Comprehensive Guide to Project and Strategic Planning, John Wiley & Sons, 2000.

3. J. G. Rau and D. C. Wooten, Environmental Impact Analysis Handbook, McGraw-Hill, 1980.
4. R. F. Fuggle and M. A. Rabie, Environmental Management in South Africa, Juta & Co. Ltd., 1991.
5. R. M. Harrison, Pollution, Causes, Effects and Control, 2nd Ed., Whitstable Lithop Ltd., 1990.
6. K. Whitelaw and Butterworth, ISO 14001 : Environmental System Handbook, 1997.

CE 663: Principles of Water Quality and Legislation (3-0-0-6)

Physical, chemical and biological quality of natural surface water and groundwater; Organic and inorganic pollutants in water and wastewater; water quality criteria for drinking, municipal, industrial, agricultural, recreational, wildlife and aquatic organisms; specific refractory substances in water and its impact on water usage; effluent discharge standards; Water quality Index; water quality related legislations.

Texts/Reference Books:

1. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G., Environmental Engineering, McGraw-Hill International Ed., 1985.
2. Tchobanoglous, G. and Schroeder E D, Water Quality: Characteristics, Modeling and Modification, Addison-Wesley Reading, MA., 1985.
3. Sawyer, C.N., McCarty, P.L. and Parkin, G.F., Chemistry for Environmental Engineering, Tata McGraw-Hill, 2000.
4. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 1998, 20th Ed.
5. Fuggle, R F and Rabie, M A, Environmental Management in South Africa, Juta & Co. Ltd., 1994.

CE 664: Industrial Wastewater Pollution Control (3-0-0-6)

Industrial wastewater versus municipal wastewater; Effects of industrial wastewater on receiving water bodies and municipal wastewater treatment plant; Bioassay test; Sampling techniques; Stream protection measures; Volume reduction, strength reduction, Neutralization, Equalization, Proportioning; Combined treatment of raw industrial wastewater with domestic sewage; Zero discharge concepts; Removal of specific pollutants in industrial effluents, e.g. oil & grease, phenol, cyanide, toxic organics, heavy metals; Characteristics and treatment of various industrial effluents.

Text Books:

1. Nemerow, N. L and Dasgupta, A., Industrial and Hazardous Waste Treatment, Van Nostarnd Reinhold (New York), 1988.
2. Eckenfelder, W. W., Industrial Water Pollution Control, McGraw-Hill, 2000.
3. Metcalf and Eddy Inc, Wastewater Engineering: Treatment and Reuse, TMH publication, 4th Edition, 2003.

Reference Books:

1. Nemerow, N. L., Zero Pollution for Industry: Waste Minimization through Industrial Complexes, John Wiley & Sons, 1995.

2. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D., Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 20th Ed., 1998.

CE 665: Water Distribution and Wastewater Collection System Design (3-0-0-6)

Components of water supply systems; Water use and demand estimation; Design period, population data and flow rates for water supply systems; Factors affecting water consumption and variation in demand; Design of water distribution systems, methods of analysis for optimal distribution network design; Types of reservoirs and design parameters and methods; Design of water pumping stations.
Design principles of wastewater collection systems: separate, combined and semi-combined sewers; Estimation of dry weather flows; Sewer pipe hydraulics: sizing of pipes and design; Manhole chambers and storm water overflows; Pumping stations, screens and inverted screens.
Maintenance of water supply and wastewater systems.

Text Books:

1. Garg, S. K., Water Supply Engineering, Khanna Publication, 2001.
2. Garg, S. K., Sewage Disposal and Air Pollution Engineering, Khanna Publication, 2005.
3. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G., Environmental Engineering, McGraw-Hill International Ed., 1985.
4. McGhee, T. J., Water Supply and Sewerage, McGraw Hill International, 1991.

Reference Books:

1. Central Public Health and Environmental Engineering Organization, Manual on Water Supply and Treatment, 2nd Ed, Ministry of Urban Development, New Delhi December 1991.
2. Central Public Health and Environmental Engineering Organization, Manual on Sewerage and Sewage Treatment, 2nd Ed, Ministry of Urban Development, New Delhi, December 1993.
3. AWWA/ ASCE, Water Treatment Plant Design, 3rd Edition- McGraw Hill, 1998.
4. Quasim, S. R., Motley E. M. and Zhu, G., Water Works Engineering- Planning, Design and Operation, Prentice Hall, 2000.

CE 527: Design of Environmental Engineering Systems (0-0-2-2)

It is expected that the student will learn complete design of Environmental Engineering Systems – be it in the area of water treatment, wastewater treatment, solid waste management and/or air pollution control. In the beginning of the semester (preferably within 2 weeks of the semester), the students will choose a design project in consultation with faculty members of the Environmental Engineering. Once the design project is selected, the students are required to develop the complete project including design calculations, appropriate detailed drawings and estimation of quantities. The students will be required to make periodic presentation for the purpose of evaluation of the course. This course will also help in improvement of communication and presentation skills.

CE 690: M Tech Project – I (0-0-24-24)

The third semester is completely devoted to dissertation work. It is expected that the student has carried out substantial research work including exhaustive literature survey, formulation of the

research problem, development/fabrication of experimental set-up (if any required) and testing, and analysis of initial results so obtained. The progress made during the semester may be evaluated through progress seminar(s). At the end of the semester, the students are required to submit written report followed by presentation and oral examination as per the Institute rules.

CE 691: M Tech Project – II (0-0-24-24)

The fourth semester is also completely devoted to dissertation work. It is expected that the student has completed most of the experimental/computation works and analyzed the results so obtained as decided in the formulation part of the research problem. The progress made during the semester may be evaluated through progress seminar(s). The students will be required to submit the research work in the form of dissertation as per the Institute rule. The final examination (presentation as well as oral) will be conducted by a duly constituted examination panel.