ANNEXURE

PONDICHERRY UNIVERSITY
PONDICHERRY

Course structure and syllabi

MTech

Environmental Engineering & Management

Centre for Pollution Control & Energy Technology
Pondicherry University
Kalapet, Pondicherry – 605 014
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PONDICHERRY UNIVERSITY
MTech *Environmental Engineering & Management*
Course Structure

Semester I

Hard core courses			*Credits*
CPET	611	Environmental sampling and analysis	3
CPET	613	Unit operations and processes in water and wastewater treatment	4
CPET	614	Air and noise pollution and control	4
CPET	615	Solid and hazardous waste management	3
Soft core courses (atleast one to be taken)			
CPET	612	Biology and microbiology for environmental engineering	3
CPET	616	Numerical methods and computer programming	3
CPET	617	Pollutant transport modelling	4
Electives (atleast one to be taken)			
Elective I			3
Elective II			3
			Total 20 (minimum)

Semester II

Hard core courses			*Credits*
CPET	621	Design and operation of water and wastewater treatment systems	4
CPET	623	Environmental biotechnology and nanotechnology	3
CPET	624	Environmental analysis lab	2
Soft core courses (atleast one to be taken)			
CPET	622	Environmental impact assessment, environmental audit, and LCA	4
CPET	625	Industrial wastewater management	4
CPET	626	Transport of water and wastewater	4
Electives (atleast two to be taken)			
Elective I			3
Elective II			3
Elective III			3
			Total 19 (minimum)
CPET	711	Summer Training	3

Semester III

Hard core courses			
CPET	712	State-of-the-art review and seminars	3
CPET	713	Specialization course (directed study)	5
CPET	714	Project work : preparatory and consolidation phase	8

Semester IV

CPET	721	Project work: advanced phase	8
CPET	722	Thesis and viva-voce	8
			Grand Total 74 minimum)

MTech in Environmental Engineering & Management

Proposed eligibility and admission criteria, and proposed intake

Eligibility: BE/BTech or equivalent qualification in civil/chemical metallurgical/mining/mechanical/environmental engineering or in biotechnology/industrial microbiology OR MSc in physical/chemical/mathmetical/life/environmental sciences, with at least 55% marks in the qualifying degree. Candidates holding full-time jobs should take leave of absence if selected for the course; 10% of such candidates in order of merit may be permitted to do the course on a part-time basis, in a maximum of 6 semesters.

Admission: Will be based on an entrance test. Applicants can view the provisional MTech syllabus on www.prof-abbasi.com. The entrance test will consist of questions designed to test the ability of the applicant to do justice to the syllabus.

Initial intake **:** 15

Hard core

CPET 611 **Environmental Sampling and Analysis**

(3-0-3)

Unit 1: General considerations (8 contact hours)

Accuracy, reproducibility, and precision, Significant figures. Different expressions of concentration and their equivalence. Measuring glassware, and Primary and secondary standards, and the do's and don'ts associated with their use. Clean lab practice.

Unit 2: Analytical instruments (10 contact hours)

Conductivity meter, pH meter, atomic emission absorption, and fluorescence spectrometers, molecular absorption spectrometers (spectrophotometers), ICP, and GLC.

Unit 3: Sampling techniques (8 contact hours)

Techniques for the collection of grab/pooled samples of water, air soil, and solid waste; sampling of micro and macro flora and fauna; preservation and storage of samples.

Unit 4: Analysis of water and wastewater (9 contact hours)

Sampling of water/wastewater and the determination of pH, EC, acidity, alkalinity, hardness, sulphate, iron, BOD and COD.

Unit 5: Analysis of air, soil, and solid wastes (10 contact hours)

Determination of SPM, NOx, CO, dioxin, and other air pollutants; noise pollution monitoring; analysis of TS, VS, and major/minor elements in soil and solid waste.

Recommended reading:

- *Water Quality, Sampling and Analysis,* S. A. Abbasi, DPH, New Delhi, 1998.
- *Methods in Environmental Analysis: Water Soil and Air,* P. K. Gupta, Agrobios, Jodhpur, 2010.
- *Fundamentals of Environmental Sampling and Analysis,* Z. Chunlong, Wiley Interscience, Germany 2011.
- *Standard Methods for the Examination of Water and Wastewater,* American Public Health Association, 2011.

Soft core

CPET 612 **Biology and Microbiology for Environmental Engineering**

(3-0-3)

Unit 1 Systematics (6 Contact hours)

Plant and animal kingdoms. Classifications and their basis.

Unit 2: Cell and molecular biology (12 conduct hours)

Prokaryotic and eukaryotic cells, cell structure and function, cell cycle and cell division; mitosis and meiosis, senescence and apoptosis.

Overview of genetic engineering: recombinant DNA technology, transgenic organisms

Unit 3: Ecology (12 contact hours)

Biotic and abiotic components in the environment and their interaction. Physiographic and edaphic influences. Soil formation and erosion, soil conservation. Definition, characteristics, and functions of a typical ecosystem. Types of ecosystems. Energy flow and material cycling. Food webs. Biogeochemical cycling of carbon, nitrogen, phosphorous, and sulphur. Ecological succession. Ecological efficiency. Biodiversity. Overview of wetland, marine, forest, grassland and desert ecosystems. Use of Microcosms and mesocosms in ecological engineering.

Unit 4: Microbiology and biochemistry (8 contact hours)

Microbial diversity, microbial growth and metabolism. Photosynthesis and nitrogen fixation. Metabolic pathways and their regulation. Electron transport, oxidative phosphorylation, alpha and beta oxidation.

Unit 5: Microbiology in environmental pollution and its control (10 contact hours)

Microorganisms in water and wastewater; indicator organisms and their quantification. Algae in water supplies: problems and control. Biodegradation of pollutants: mechanism of aerobic and anaerobic digestion.

Recommended reading

- *Biology,* N. A. Campbell, J. B. Reev, M. Moller, L. Avrry, and R. Heyden, Benjamin Cummings, 2010.
- *Fundamentals of Ecology*. P. Odum and G. W. Barrett, Brooks/Cole, UK, 2011.
- *Microbiology – An Introduction,* G. J. Tortora, B. R. Funke, C. L. Case, Pearson Education, 2010.
- *Microbiology for Environmental and Public Health Engineers,* J. N. Lester. Routledge, 2011.

Hard core

CPET 613 **Unit Operations and Processes in Wastewater Treatment**

(4–0–4)

Unit 1: Introduction (2 contact hours)

Overview of unit operations and unit processes associated with water and wastewater treatment. Schematic flow diagrams. Treatment requirements and standards.

Unit 2: Unit operations - I (15 contact hours)

Need for flow equalization, sizing of flow equalization tanks. Screening: types of screens, estimation of head loss due to flow-through screens. Sedimentation: settling theory-type 1 settling; settling velocities in the laminar, transitional and turbulent regions. type 2 settling. Sedimentation basins: computation of removal efficiency. Mixing and flocculation: velocity gradients and power requirement. Dissolved air floatation.

Unit 3: Unit operations - II (16 contact hours)

Filtration: Carmen-Kozeny equation; computation of head loss; backwash hydraulics. Membrane filtration: membrane process classification, membrane operation, recovery rate, membrane area calculation. Aeration: two film theory; oxygen transfer rates; factors affecting transfer rates, application of correction factors; aerator performance. Adsorption: adsorbents used in water and wastewater treatment; adsorption isotherms; design of granular activated carbon beds-height of mass transfer zone, time to 33breakthrough.

Unit 4: Chemical unit processes (15 contact hours)

Coagulation; stability of colloids, destabilization of colloids; types of coagulants. Precipitation: solubility product and nucleation. Disinfection: characteristics of an ideal disinfectant; types of chemical disinfectants. Factors influencing disinfection: contact time (Chick's law), disinfectant concentration. Disinfection with chlorine: breakpoint chlorination.

Unit 5: Biological unit processes (16 contact hours)

Aerobic and anaerobic fermentation. Suspended and attached growth systems. Rates of substrate utilization and biomass growth in suspended and attached growth systems. Activated aerobic sludge process and its variants. Trickling filter and rotating biological contactor. Stabilization ponds. Anaerobic sludge digesters. Activated anaerobic sludge process; anaerobic filters; upflow anaerobic sludge blanket, anaerobic expanded/fluidized bed, and hybrid reactors. Biological nitrification and denitrification: microbiology, stochiometry, growth kinetics, and environmental factors. Phosphorous removal. Biological removal of toxic and recalcitrant organics and heavy metals. Combined biological treatment processes.

Recommended reading:

- *Wastewater Engineering – Treatment and Reuse,* Metcalf & Eddy, Inc., Revised by G. Tchobanoglous, F. L. Burton, and H. D. Stensel. Tata McGraw-Hill Publishing Company Limited, New Delhi, 2011.
- *Unit Operations and Processes in Environmental Engineering,* T. D. Reynolds, P. Richards. PWS Series in Engineering, Boston, 2010.
- *Environmental Pollution and its Control,* S. A. Abbasi, DPH, New Delhi 2010.
- *Manual on Water Supply and Treatment.* CPHEEO, Ministry of Urban Development, GoI, New Delhi, 1999.

Hard core

CPET 614 **Air and Noise, Pollution and Control**

(4-0-4)

Unit 1: Air pollution and its effects (8 contact hours)

Air Pollutants: sources, classification, effect on animal health, vegetation, materials, and atmosphere. Chemical and photochemical reactions in the atmosphere and their effects: smoke, smog, acid rain and ozone layer depletion. Green house gases, global warming and its implications. Air pollution legislation and standards.

Unit 2: Air pollution dispersion and modeling (16 contact hours)

Meteorology and air pollution: atmospheric stability and inversions, behavior of air pollutant plumes as effected by nature of source, meteorology, obstacles and terrain; maximum mixing depth. Effluent dispersion theories: models for point and line sources based on Gaussian plume dispersion and their limitations: models for heavy gas dispersion. Box model for area sources. Prediction of effective stack height: Holland's and Briggs equations. Issues of indoor air quality.

Unit 3: Air pollution prevention and control – I (16 contact hours)

Reduction in the generation of particulate matter by process modification, good house keeping, and other means. Control of SPM: concepts and the design elements of gravitational settlers, centrifugal collectors, wet collectors, electrostatic precipitators, fabric filters, condensers.

Unit 4: Air pollution prevention and control – II (16 contact hours)

Sources of air pollution from fossil fuels and industrial processes. Prevention and reduction of emissions, cleaner production. Air pollution control by absorption, adsorption, condensation, incineration, bioscrubbers, biofilters, etc. Design and performance equations, case studies.

Unit 5: Noise pollution and its control (8 contact hours)

Generation and propagation of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources; multiple sources; outdoor and indoor noise propagation; psycho-acoustics and noise criteria. Effects of noise on health. Annoyance rating schemes; noise standards and limit values. Noise pollution measuring instrumentation and monitoring procedure. Noise pollution prevention and control.

Recommended reading:

- *Introduction to Environmental Engineering and Science*, G. M. Masters, Prentice-Hall of India, New Delhi, 2011.
- *Air Pollution Control Engineering,* N. de Nevers. McGraw Hill, Singapore, 2011.
- *Environmental Noise Pollution*, P. E. Cunniff, McGraw Hill, New York, 1987.
- *Fundamentals of Air pollution,* R. W. Boubel, D. L. Fox, and A. C. Stern, Academic Press, NY, 2011.

Hard core

CPET 615 **Solid and Hazardous Waste Management**

(4-0-4)

Unit 1: Introduction (6 contact hours)

Solid wastes- definition, types, sources, characteristics, and impact on environmental health. Waste generation rates. Concepts of waste reduction, recycling and reuse.

Unit 2: Collection, segregation and transport of solid wastes (14 contact hours)

Handling and segregation of wastes at source. Collection and storage of municipal solid wastes; analysis of Collection systems. Transfer stations - labelling and handling of hazardous wastes. Public participation and the role of NGOs.

Unit 3: Solid waste management (20 contact hours)

Solid waste processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: composting. vermicomposting, termigradation, fermentation. Incineration of solid wastes. Disposal in landfills: site selection, design, and operation of sanitary landfills; secure landfills and landfill bioreactors; leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation.

Unit 4: Hazardous waste management (20 contact hours)

Hazardous wastes: definition, sources and characteristics: handling, collection, storage and transport. Hazardous waste treatment technologies. Physical, chemical and thermal treatment of hazardous waste: solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: site selection, design and operation. Biomedical, plastic and e-waste: waste categorization, generation, collection, transport, treatment and disposal.

Unit 5: Legislation on solid waste handling (4 contact hours)

Elements of integrated waste management: Legislations on management and handling of municipal solid wastes, biomedical wastes, and other hazardous wastes.

Recommended reading:

- *Handbook of Solid Waste Management,* F. Kreith, G. Tchobanoglous, 2009.
- CPHEEO, *Manual on Municipal Solid waste management,* Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.
- *Pollution Control, Climate Change and Industrial Disasters*, Abbasi, T. and Abbasi, S.A. Discovery Publishing House, New Delhi (2010).
- *Hazardous Waste Management,* M. D. LaGrega, P. L Buckingham, J. C. Evans, 2nd edition. McGraw-Hill, 2011.

Soft core

CPET 616 **Numerical Methods and Computer Programming**

(3 -0-3)

Unit I: (10 Lectures)

Representing numbers in a computer – machine precision - errors and approximations – concept of computer language – Fortran language syntax – Matlab syntax – Mathematica syntax – flow chart.

Unit II: (10 Lectures)

Matrices and linear system of equations – Gauss-Jordan elimination method _ Gauss method to compute the Inverse – LU decomposition – Cholesky decomposition – QR decomposition, Gauss-Seidel iterative method – eigen values and eigen vectors of a real symmetric matrix by Jacobi's method.

Unit III: (5 Lectures)

Numerical differentiation and integration – trapezoidal rule – Simpson' rule – Gaussian quadrature formula.

Unit IV: (10 Lectures)

Numerical solution of ordinary differential equations solution by Taylor's series – Euler's method – Runge Kutta method with Runge's coefficients. Numerical solution of partial differential equations using finite difference method.

Unit V: (10 Lectures)

Random number generator – Importance sampling – Metropolis algorithm – Monte Carlo simulation.

Recommended regarding:

- *Numerical methods in Science and Engineering,* M. K. Venkataraman, National Publishing Company, Madras
- *Introductory Methods of Numerical* Analysis S. S. Sastry, Prentice Hall
- *Numerical methods analysis,* James B, Searborough Oxford-IBH

Soft core

CPET 617 **Pollutant Transport Modelling**

(4-0-4)

Unit: I (14 contact hours)

Transport phenomenon: diffusion, dispersion, advection, adsorption. Conservative and non-conservative pollutants. Sources and sinks of point and non-point.

Unit: II (14 contact hours)

Governing Equations for flow and transport in pollution air, water, and soil. Chemical and biological process models. Simplified models for lakes, streams, estuaries, and sub-surface plume movements.

Unit: III (14 contact hours)

Selection and development of models. Model resolution. Coupled and uncoupled models, Linear and nonlinear models. Solution techniques. Data requirements for calibration and validation.

Unit: IV (11 contact hours)

Numerical models: finite difference, finite elements and Finite volume techniques. Explicit vs. implicit methods, Numerical errors and stability. High resolution techniques.

Unit: V (11 contact hours)

Environmental systems modeling with various tools: QUAL, SUTRA, DGADIS, HEGADIS, etc.

Recommended reading

- *Surface Water quality modeling,* S. C. Chapra. McGraw-Hill., New York, 2007.
- *Numerical Mathematical Analysis,* J. B. Scarborough. Oxford & IBH, 2011.
- *Handbook of Environmental and Ecological Modelling*, B. Halling-Sorensen, S. N. Nielsen and S. E. Jorgensen. Lewis Publishers Inc, 2010.
- *System Analysis and Design*, R. J. Aguilar. Prentice Hall, Englewood Cliffs, 2011.
- *Fundamentals of Atmospheric Modelling*, M. Z. Jacobson, Kluwer Academic Press, 2011.

Hard core

CPET 621 **Design and Operation of Water and Wastewater Treatment Systems**

(4 – 0 – 4)

Unit 1: Water treatment (12 contact hours)

Aeration systems- types of aerators, design of cascade, spray and multiple tray aerators. Chemical dosing tanks, rapid mix units- mechanical, gravity, hydraulic and pneumatic device based operation. Flocculators- gravitational, hydraulic and mechanical flocculators. Sedimentation tanks- horizontal flow tanks. Clariflocculators. Filters- slow sand, rapid sand filters. Disinfection units

Unit 2: Wastewater treatment (primary) (14 contact hours)

Design of screens: considerations of hydraulics, velocity and head loss, disposal of screenings. Design of grit chambers based on settling velocity, surface overflow rate, detention time, scour and flow-through velocities, and velocity control devices, grit disposal. Design of sedimentation tanks based on surface, solids and weir loading rates and detention time, sludge and scum removal, sizing of circular and rectangular tanks. Chemical aided sedimentation: mixing, flocculation and settling.

Unit 3: Wastewater treatment (secondary) (16 contact hours)

Design of activated sludge process: completely mixed and plug flow systems; considerations of HRT, MLSS, Percentage BOD removal, SRT, oxygen and aerator power requirement. Aerobic attached growth process (trickling filters): design based on hydraulic and organic loading rates and recirculation ratio, NRC and Eckenfelder equations. Design of rotating biological contactor on the basis of hydraulic and influent substrate loading rates and hydraulic retention times; speed, area available for biological growth and submergence of disc. Stabilization ponds: consideration of organic loading rates, detention time, flow regime, depth, and sludge accumulation.

Sludge thickening: design of gravity thickening beds based on hydraulic and solids surface loading rates. Sludge drying beds: bed area and bed layers dimensions. Filter (belt) press Anaerobic sludge digestion: low and high rate digestion, design based on volatile solids loading rate, SRT, operating temperature, digester dimension, freeboard and dept, floor slope.

Unit 4: Wastewater treatment (tertiary) (14 contact hours)

Removal of nitrogen and phosphates. Granular activated carbon adsorbers: sizing based on contact time, hydraulic loading rate, carbon depth, number of contactors. Membrane filtration: membrane area calculation. Softening and demineralization systems.

Unit 5: Operation and maintenance (8 contact hours)

Management, administration, legal and financial aspects of water and wastewater treatment plants. Operational problems encountered in treatment plants: typical problems arising in various units, trouble shooting. Operation and maintenance of plant operations. Training of operating personnel.

Recommended reading:

- *Manual on Water Supply and Treatment.* CPHEEO, Ministry of Urban Development, GoI, New Delhi, 1999.
- *Manual on Sewerage and Sewage Treatment.* CPHEEO, Ministry of Urban Development, GoI, New Delhi, 1993.
- *Wastewater Engineering – Treatment and Reuse, Metcalf* & Eddy, Inc., Revised by G. Tchobanoglous, F. L. Burton, and H. D. Stensel. Tata McGraw-Hill Publishing Company Limited, New Delhi, 2011.

Soft core

CPET 622 **Environmental Impact Assessment, Environmental Audit and LCA**

(4-0-4)

Unit 1: Overview (6 contact hours)

Environmental Impact Statement (EIS), Environmental Risk Assessment (ERA). Legal and Regulatory aspects of EIA in India. Types and limitations of EIA. Terms of Reference in EIA. Issues in EIA; national, cross sectoral, social, and cultural.

Unit 2: Components and methods of EIA (20 contact hours)

Components: screening, setting, analysis, prediction of impacts - mitigation. Matrices - Networks - Checklists. Importance assessment techniques - cost benefit analysis - analysis of alternatives - methods for Prediction and assessment of impacts - air - water - soil - noise - biological - cultural - social - economic environments. Standards and guidelines for evaluation. Public Participation in environmental decision making: public hearings.

Unit 3: Quality control, documentation and monitoring of EIA (12 contact hours)

Trends in EIA practice and evaluation criteria - capacity building for quality assurance. Expert System in EIA - use of regulations and AQM. Document planning - collection and organization of relevant information - use of visual display materials – team writing - reminder checklists. Preparation of environmental Management Plan.

Unit 4: Environmental audit and environmental management systems (20 contact hours)

Concepts of environmental audit, objectives of audit. Management of audits: waste management contractor audits. Introduction to environmental management system (EMS). Principles & elements of successful environmental management; ISO principles; creating an environmental management system in line with ISO: 14000. Benefits of an environmental management system. Principles and elements of successful environmental management: leadership, environmental management planning, implementing an environmental management system, measurement & evaluations required for an environmental management system, environmental management reviews & improvements. Legal and regulatory concerns; Integrating ISO 9000 & ISO 14000. TQM.

Unit 5: Life cycle assessment (LCA) (6 contact hours)

Elements of LCA - Life Cycle Costing - Eco Labelling

Recommended reading:

- Environmental Impact Assessment, L. W. Canter, Mc Graw Hill, New York, 2010.
- Handbook of Environmental Impact Assessment Vol I and II, J. Petts, Blackwell Science, London, 2010.
- The Theory and the Practice of Environmental Impact Assessment, S. A. Abbasi and N. Ramesh, DPH, New Delhi, 2003.
- *Complete Guide to ISO 14000,* R. B. Clements. Simon & Schuster, 2011.

Hard core

CPET 623 **Environmental Biotechnology and Nanotechnology**

(3-0-3)

Unit 1: Past, present, and future of environmental biotechnology (9 contact hours)

Environmental biotechnology down the ages: historical methods of biotechnological waste treatment and resource recovery, modern and post-modern developments in environmental biotechnology, future trends. A recap of biotechnological methods covered in CPET 613. Bioreactors: batch, semi-batch, plug-flow, continuously stirred, packed bed, expanded/fluidized bed and hybrid reactors. Immobilization. Aseptic and septic bioreactors.

Unite 2: Biotechnological pollution control methods – I (10 contact hours)

Desulphurization of coal and oil. Pest control with whole organism and semiochemical approaches. Biosubstitution. Bioremediation: *in situ and ex situ t*echniques-biosparging, bioventing, injection recovery, land farming, soil banking, and soil slurry reactor techniques. Biotechnological approaches to hazardous waste treatment.

Unit 3: Biotechnological pollution control methods – II (10 contact hours)

Phytotechnoloty: Plants as bioreactors. Phytoremediation: phytoextraction, rhizofiltration, phytostabilisation, phytodegradation and phytovolatilisation. Phytomining. Macrophyte-based wastewater treatment systems. Algal effluent treatment systems and their limitations.

Unit 4: Biotechnological pollution control methods – III (9 contact hours)

Composting: mechanism, operation, monitoring, and control of composting process. Animal-based solid-waste treatment systems: vermicomposting and termigradation. Genetic manipulation for developing pollution monitoring and control systems. Transgenic plants.

Unit V: Introduction to nanotechnology and its applications in environmental engineering (10 contact hours)

Origin and definition of nanotechnology. Distinguishing attributes of nanosystems. Introduction to nanomaterial preparation. Methods of environmental monitoring and pollution control using nanotechnology. Risks associated with the use of nanomaterials.

Recommended reading:

- *Environmental Biotechnology theory and application, G. M. Evan, J. C. Furlong, John Wiley & Sons, Ltd,-/2503*
- *Environmental Biotechnology Principles and Applications, B. E. Rittmann, P. L. Mc Carty, Mc Craw-Hill International Editions/Singapore, 2011.*
- *Environmental Biotechnology, B. C. Bhattacharrya, and R. Banerjee, Oxford University Press, India, 2011.*
- *Nano: The Essentials,* T. Pradip, Tata McGraw Hill, 2007.

Hard core

CPET 624 **Environmental Analysis Lab**

(0-4-2)

Unit I: Water/wastewater

Sampling of water/wastewater and the determination of pH, EC, acidity, alkalinity, hardness, sulphate iron, BoD and CoD.

Unit II: Air

Sampling of air with high volume sampler; determination of SPM, NOx, and SOx.

Unit III: Metals

Determination of common metal pollutants by AAS, AES, and ICP.

Unit IV: Soil and solid waste

Sampling of soil; analysis of soil for pH, EC, C,N,P,K. Determination of TS and VS of solid wastes.

Unit V: Flora and fauna

Sampling of terrestrial flora and fauna by quadrat and line transect methods. Sampling and identification of plankton in water samples.

Recommended reading:

- *Water Quality, Sampling and Analysis,* S. A. Abbasi, DPH, New Delhi, 1998.
- *Methods in Environmental Analysis: Water Soil and Air,* P. K. Gupta, Agrobios, Jodhpur, 2010.
- *Fundamentals of Environmental Sampling and Analysis,* Z. Chunlong, Wiley Interscience, 2011.
- *Standard Methods for the Examination of Water and Wastewater,* American Public Health Association, 2011.

Soft core

CPET 625 **Industrial Wastewater Management**

(4-0-4)

Unit 1: Overview (14 Contact hours)

Major industries (dairy, distillery, sugar, textile, tannery, pulp & paper, metal finishing, petroleum refining, pharmaceutical and fertilizer; thermal power), their water requirements, and the typical quantities and characteristics of wastewaters generated. Environmental consequences of wastewater discharge and the regulatory requirements for treatment and disposal. Treatment costs.

Unit2: Unit operations and processes for industrial Wastewater treatment – I (14 contact hours)

Effluent mixing, equalization, neutralization, separation of oil and grease, flotation, screening, flocculation, and sedimentation. Removal of metallic pollutants by precipitation and of refractory organics by adsorption.

Unit 3: Unit operations and processes for industrial Wastewater treatment -II (14 contact hours)

Chemical processes. Ion exchange and membrane technologies. Biosorption and biodegradation techniques. Sludge management: characterization, thickening, conditioning, digestion, dewatering, and disposal of industrial sludges.

Unit 4: Water minimization, recycling, and reuse (12 contact hours)

Waste minimization with process modification and cleaner production techniques. Benefit-cost optimization with common effluent treatment plants. Recycling, reuse, and recovery strategies.

Unit 5: Management and audit (10 contact hours)

Process optimization for waste minimization. Flowsheet analysis. Energy and resource audits for efficient usage and conservation. Waste audits, emission inventories, and waste management hierarchy. Case studies of re-engineering for waste minimization.

Recommended reading:

- *Industrial Water Pollution Control,* W.W. Eckenfelder. Mc-Graw Hill, 2009.
- *Wastewater Treatment for Pollution Control,* S. J. Arceivala, Tata McGraw Hill, 1998.
- *Pollution Prevention and Abatement Handbook – Towards Cleaner Production,* World Bank Group, World Bank and UNEP, Washington D.C, 2011.

Soft core

CPET 626 **Transport of Water and Wastewater**

(4-0-4)

Unit 1: Fluid flow (14 contact hours)

Fluid flow: continuity, energy and momentum principles ; frictional head losses in free and pressure flow, major and minor head losses and their estimation. Pumping of fluids and selection of pumps. Flow measurement.

Unit 2: Water transmission and distribution (14 contact hours)

Planning factors. Water transmission main design. Pipe material and economics; water distribution pipe networks, and methods for their analysis and optimisation. Laying and maintenance of pipelines; in situ: lining, appurtenances and corrosion prevention.

Unit 3: Wastewater collection and conveyance (16 contact hours)

Design of sanitary sewer; partial flow in sewers, economics of sewer design ; sewer appurtenances ; material, construction, inspection and maintenance of sewers ; design of sewer outfalls: mixing conditions; conveyance of corrosive wastewaters.

Unit 4: Storm water drainage (10 contact hours)

Run-off estimation, rainfall data analysis, storm water drain design. Rainwater harvesting.

Unit 5: Software applications (8 contact hours)

Use of computer automated tools in water transmission, water distribution and sewer design. LOOP, SEWER, BRANCH, and other tools.

Recommended reading:

- *Manual on water supply and Treatment.* CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.
- *Manual on Sewerage and Sewage Development.* CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1993.
- *Practical Hydraulics Hand Book,* B.A. Hauser. Lewis Publishers, New York, 2011.
- *Water and Wastewater Technology,* M.J. Hammer. Regents/Prentice Hall, New Jersey, 2011.

Hard core

CPET 711 **Summer Training**

(0-6-3)

This course, with credit equivalent of 96 hours of experimental/field work will be conducted during the summer vacation and would actually involve a minimum of double of this quantum of work, spanning atleast 25 working days.

During this period the student shall work either in an industry, a relevant governmental institution (eg. a pollution control board, a public health department, an R&D laboratory), a consultancy firm, or one of the sponsored R&D/consultancy projects of this centre. The purpose would be to get hands-on experience of some of the 'live' problems relating to environmental engineering and management.

During this period the student will also have an initiation into the specific sub-area of his/her thesis work and would begin his/her studies which will lead to CPET 712 and subsequent specialization courses.

Hard core

CPET 712 **State-of-the-art Review and Seminars**

(0-6-3)

In this course the student is expected to make a very comprehensive *and critical* review of the state-of-the-art of his/her specialization topic. The objective would be to answer the questions: why this study; in what terms it is a better approach than the ones attempted by others; where exactly it breaks away from the general run; what does it aim to do which is newer and better? The student would comprehensively survey the work done till date, on the basis of reference books, theses/reports, *and* journal publications. He/she would then critically comment on the positive attributes and shortcomings of the past work, and put his/her own plans of work in this perspective.

The preparation of the state-of-the-art report shall accompany two seminars. The first one will be given after the student has drafted his/her report. After the seminar, and based on the advice given, he/she will develop the report further and submit it. It will be followed by a second seminar.

Hard core
CPET 713 **Specialisation Course**
(4-2-5)

This course would provide the necessary breadth to go with depth aimed by the other courses of Semesters III & IV.

The syllabi will be framed around the thesis topic by the concerned supervisor and will be vetted by all the faculty participating in the MTech programme. The objective would be to provide the student an opportunity to study all the sub topics and advancements associated with his/her own specific line of project work. An illustrative specialization course, the one proposed for a student who aims at doing his/her thesis in a specific area of process safety, is given below. If more than one student happens to choose different aspects of process safety for his/her thesis work, they all would take this course. The same philosophy shall be followed in respect of all other varients of CPET 713.

Illustrative Specialization Course : Process safety and loss prevention

Unit 1: Introduction

Overview of accidents in process industries. Case histories. Past accident analysis (PAA).

Unit 2: Explosions

Deflagration and detonation. Types of explosions, their defining characteristics and mechanisms. Vapour cloud explosion, BLEVE, dust explosion, 'physical' explosion. Overpressure, missiless, fireballs, and toxic dispersions associated with explosions. Empirical and analytical models for assessing explosion energy, overpressure, number, range and velocity of missles, fireballs *etc* associated with different chemicals and containers. Strategies for the prevention/damage control of explosions.

Unit 3: Fires

Types of fires: jet fire, pool fire, flash fire, momentum/buoyancy driven fireballs associated with explosions. Empirical and analytical models for assessing the duration and heat load of fires. Prevention of fires. Strategies for minimization of damage when fires do break out.

Unit 4: Toxic dispersion

Generation of liquid and gaseous plumes as a consequence of accidents. Estimation of release rates. Models for charting plume dispersion.

Unit 5: Risk assessment

Hazard vs risk. Techniques for risk assessment. Qualitative, reconnoitery, rapid, and comprehensive risk assessment techniques : checklists, indices, HAZOP, maximum credible accident analysis, fault tree analysis, past accident analysis, FMEA, (Failure mode and effect analysis). Quantitative Risk Assessment. Domino effect and its assessment.

Unit 6: Prevention and control of accidents

Accident prevention and damage control strategies. OSHA. Legal provisions. Inherently safer design and cleaner/safer production. Computer-automated tools for process safety.

Recommended reading:

- *Loss Prevention in Process Industries,* F. P. Lees**,** Buttarworth, London, 1996 and 2005.
- *Risk Assessment in Process Industries: Advanced techniques,.* F. I. Khan and S. A. Abbasi, Discovery publishing house, New Delhi, 2004.
- *Boiling Liquid Expanding Vapour Explosions ,* T. Abbasi and S. A. Abbasi, Springer-Verlag, 2007.

Electives

BIOT 603	Bioprocess technology
COMS 611	Design and analysis of algorithms
COMS 652	Knowledge engineering
COMS 653	Evolutionary algorithms
COMS 656	Design Patterns
COMS 666	Neural networks
PHYS 415	Instrumentation
PHYS 416	Numerical methods and computer Programming
DPIS 412	Global Peace, security and development
DIPS 421	International organizations
ECOL 424	Eco tourism
ECOL 471	Integrated coastal zone management
ECOL 477	Environmental law, justice, and policy
ECOL 480	Remote sensing and GIS
ECOL 505	Global environmental changes
ECOL 572	Natural resources
ECOL 577	Industrial ecology
BTMA 516	Data warehousing and data mining
SOCL 411	Fundamentals of sociology
SOCL 412	Research methodology
ENGL 442	Environmental aesthetics
PHYS 427	Renewable energy sources
	Sustainable Development