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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CPET 611</td>
<td>Environmental sampling and analysis</td>
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<tr>
<td>CPET 613</td>
<td>Unit operations and processes in water and wastewater treatment</td>
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</tr>
<tr>
<td>CPET 614</td>
<td>Air and noise pollution and control</td>
<td>4</td>
</tr>
<tr>
<td>CPET 615</td>
<td>Solid and hazardous waste management</td>
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</table>

**Soft core courses (atleast one to be taken)**
- CPET 612 Biology and microbiology for environmental engineering
- CPET 616 Numerical methods and computer programming
- CPET 617 Pollutant transport modelling

**Electives (atleast one to be taken)**
- Elective I
- Elective II

Total 20 (minimum)

### Semester II

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>CPET 621</td>
<td>Design and operation of water and wastewater treatment systems</td>
<td>4</td>
</tr>
<tr>
<td>CPET 623</td>
<td>Environmental biotechnology and nanotechnology</td>
<td>3</td>
</tr>
<tr>
<td>CPET 624</td>
<td>Environmental analysis lab</td>
<td>2</td>
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</tbody>
</table>

**Soft core courses (atleast one to be taken)**
- CPET 622 Environmental impact assessment, environmental audit, and LCA
- CPET 625 Industrial wastewater management
- CPET 626 Transport of water and wastewater

**Electives (atleast two to be taken)**
- Elective I
- Elective II
- Elective III

Total 19 (minimum)

**CPET 711 Summer Training** ................................. 3

### Semester III

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

### Semester IV

<table>
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<th>Course Title</th>
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<tr>
<td>CPET 721</td>
<td>Project work: advanced phase</td>
<td>8</td>
</tr>
<tr>
<td>CPET 722</td>
<td>Thesis and viva-voce</td>
<td>8</td>
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</table>

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
Unit 1: General considerations (8 contact hours)


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:

Unit 1 Systematics (6 Contact hours)
Plant and animal kingdoms. Classifications and their basis.

Unit 2: Cell and molecular biology (12 contact 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)

Unit 4: Microbiology and biochemistry (8 contact hours)

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

Recommended reading

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)


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)


Recommended reading:


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


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


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:

Unit 1: Introduction (6 contact hours)


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, termogradiation, 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)


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:

Unit I: (10 Lectures)


Unit II: (10 Lectures)


Unit III: (5 Lectures)


Unit IV: (10 Lectures)


Unit V: (10 Lectures)

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

Recommended regarding:

- *Numerical methods analysis*, James B, Searborough Oxford-IBH
Soft core
CPET 617 Pollutant Transport Modelling
(4-0-4)

Unit: I (14 contact hours)


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)


Unit: IV (11 contact hours)


Unit: V (11 contact hours)

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

Recommended reading

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. Clarifloculators. Filters - slow sand, rapid sand filters. Disinfection units

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


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)


Unit 5: Operation and maintenance (8 contact hours)


Recommended reading:

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)


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


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


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

Elements of LCA - Life Cycle Costing - Eco Labelling

Recommended reading:

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


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


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


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


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


Recommended reading:

- *Environmental Biotechnology theory and application*, G. M. Evan, J. C. Furlong, John Wiley & Sons, Ltd, /2503
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


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:

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.

Unit 2: 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)


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


Unit 5: Management and audit (10 contact hours)


Recommended reading:

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)


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:

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 at least 25 working days.

During this period the student shall work either in an industry, a relevant governmental institution (e.g., 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.
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.
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 variants of CPET 713.

**Illustrative Specialization Course: Process safety and loss prevention**

**Unit 1: Introduction**


**Unit 2: Explosions**

Deflagration and detonation. Types of explosions, their defining characteristics and mechanisms. Vapour cloud explosion, BLEVE, dust explosion, ‘physical’ explosion. Overpressure, missilless, 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**


**Unit 5: Risk assessment**


**Unit 6: Prevention and control of accidents**


**Recommended reading:**

# Electives

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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>BIOT 603</td>
<td>Bioprocess technology</td>
</tr>
<tr>
<td>COMS 611</td>
<td>Design and analysis of algorithms</td>
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<tr>
<td>COMS 652</td>
<td>Knowledge engineering</td>
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<tr>
<td>COMS 653</td>
<td>Evolutionary algorithms</td>
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<td>COMS 656</td>
<td>Design Patterns</td>
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<td>PHYS 415</td>
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<td>Numerical methods and computer Programming</td>
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<td>DPIS 412</td>
<td>Global Peace, security and development</td>
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<td>International organizations</td>
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<td>Integrated coastal zone management</td>
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<td>Remote sensing and GIS</td>
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Sustainable Development