Veermata Jijabai Technological Institute

Master of Technology - M.Tech
With Specialization in Environmental Engineering
2009

Department of Civil and Environmental Engineering
VJTI
Mumbai
# Scheme of Teaching and Evaluation

M Tech (Semester I)

(Civil Engineering with Specialization in Environmental Engineering)

## Theory Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hr/Week</th>
<th>Credits</th>
<th>Examination Scheme (Evaluation in % Weightages)</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>CE0311</td>
<td>Environmental Chemistry</td>
<td>3</td>
<td>-</td>
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<tr>
<td>CE0312</td>
<td>Environmental Microbiology</td>
<td>3</td>
<td>-</td>
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<tr>
<td>CE0313</td>
<td>Advanced Hydraulics</td>
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<td>CE0314</td>
<td>Air, Noise Pollution &amp; Control</td>
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<tr>
<td>HM0311</td>
<td>Communication Skills I</td>
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Total: 17 - - 15

## Laboratory Courses

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<th>Hr/Week</th>
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<tr>
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<td>Water Laboratory</td>
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<tr>
<td>CE1312</td>
<td>Air pollution &amp; Microbiology Laboratory</td>
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<tr>
<td>CE1313</td>
<td>Sampling &amp; analysis Laboratory</td>
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<tr>
<td>CE2311</td>
<td>Seminar</td>
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Total: - - 12 6

## Co-curricular Activities

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<th>Hr/Week</th>
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<td>Industry Interaction</td>
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<td>Internet</td>
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Total: - - 6 -

Total for Semester: 17 - - 18 35 21
## Scheme of Teaching and Evaluation

**M Tech (Semester II)**  
(Civil Engineering with Specialization in Environmental Engineering)

### Theory Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hr/Week</th>
<th>Credits</th>
<th>Examination Scheme (Evaluation in % Weightages)</th>
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<tr>
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<tr>
<td>CE0321</td>
<td>Advanced water treatment</td>
<td>3 - - 3</td>
<td>20 20 60</td>
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<tr>
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<td>Advanced waste water treatment</td>
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<td>20 20 60</td>
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<td>20 20 60</td>
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<td>CE0324</td>
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<td>20 20 60</td>
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<tr>
<td>- Elective</td>
<td></td>
<td>3 - - 3</td>
<td>20 20 60</td>
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### Laboratory Courses

<table>
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<tr>
<th>Course Code</th>
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<th>Hr/Week</th>
<th>Credits</th>
<th>Examination Scheme (Evaluation in % Weightages)</th>
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<tr>
<td>CE1321</td>
<td>Waste water &amp; Solid waste laboratory</td>
<td>- - 3 1.5</td>
<td>50 50</td>
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<td>CE1322</td>
<td>Computer Applications</td>
<td>- - 3 1.5</td>
<td>50 50</td>
<td>100</td>
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<tr>
<td>CE1323</td>
<td>Design laboratory</td>
<td>- - 3 1.5</td>
<td>50 50</td>
<td>100</td>
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<tr>
<td>CE2321</td>
<td>Seminar</td>
<td>- - 3 1.5</td>
<td>50 50</td>
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### Co-curricular Activities

<table>
<thead>
<tr>
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<th>Hr/Week</th>
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<table>
<thead>
<tr>
<th>Total for Semester</th>
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<th>T</th>
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<th>Total Hours</th>
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Scheme of Teaching and Evaluation  
M Tech (Semester III & IV)  
(Civil Engineering with Specialization in Environmental Engineering)

### Project Course

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hr/Week</th>
<th>Credits</th>
<th>Examination Scheme (Evaluation in % Weightages)</th>
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<tbody>
<tr>
<td>CE3331</td>
<td>Stage –I Presentation</td>
<td>-</td>
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<tr>
<td>CE3341</td>
<td>Stage –II Presentation</td>
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<tr>
<td>CE3342</td>
<td>Presentation and Viva</td>
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### Elective Courses

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<th>Course Name</th>
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<tbody>
<tr>
<td>CE0351</td>
<td>Environmental Legislation</td>
</tr>
<tr>
<td>CE0352</td>
<td>Environmental Management</td>
</tr>
<tr>
<td>CE0353</td>
<td>EIA and Audit</td>
</tr>
<tr>
<td>CE0354</td>
<td>Operation &amp; Maintenance of Treatment Facilities</td>
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<tr>
<td>CE0355</td>
<td>Rural water supply &amp; sanitation</td>
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<tr>
<td>CE0356</td>
<td>Water resources management</td>
</tr>
<tr>
<td>CE0423</td>
<td>Advanced Project Management</td>
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<tr>
<td>CE0457</td>
<td>Risk &amp; Disaster Management</td>
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<tr>
<td>CE0461</td>
<td>Managerial Decision Making</td>
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### Abbreviations:

- L: Lectures, T: Tutorial, P: Practical, TA: Teacher Assessment, 
- IST: In Semester Test/s, MST: Mid Semester Test, 
- ESE (P): End Semester Practical Examination, ESE (O): End Semester Oral Examination, ESE (W):End Semester Written Examination, ESE (W) (hrs): End Semester Written Examination duration, ESE (O) (hrs): End Semester Examination Practical (duration), 
- P/NP: Pass/Not Pass

### Notes:

- TA for Theory and Laboratory courses shall carry 50 marks 
- IST: One mid semester test (20 marks, one hour duration). 
- ESE(W) shall be of 100 marks and of 3 hours, ESE(P) and ESE(O) shall be decided as per course requirement. ESE(O) and ESE (P) shall together carry 50 marks.
SEMESTER – I

CE 0311 ENVIRONMENTAL CHEMISTRY

1. Basic principles: Chemical equations, types of chemical reactions, stoichiometric calculations, solutions, chemical thermodynamics, fundamentals of process kinetics, Gas laws, ways of shifting chemical equilibria.

2. Acid base equilibria: equilibrium calculations, equilibrium diagrams, alkalinity, acidity, buffers, buffer index, measurement of alkalinity.

3. Solubility equilibria: Solubility equilibrium for slightly soluble salts, effect of other solutes on salt solubilities, competing acid-base equilibria, effect of complex ions, hydrolysis, computing total soluble species concentration, computing solid phase equilibria, equilibrium diagrams.


5. Colloidal chemistry: fundamentals, coagulation, mechanisms of coagulation, effect of turbidity and alkalinity, chemistry of coagulants.

6. Nuclear Chemistry: basic concepts
   Adsorption: basic concepts, factors affecting adsorption, isotherm studies.

7. Ion exchange, reverse osmosis, fluoride removal iron and manganese removal:-
   basic concepts of water and wastewater analysis: basic concepts of quantitative analytical chemistry, instrumental methods of analysis, determination of turbidity, colour, pH, acidity, alkalinity, hardness, residual chlorine and chlorine demand, chlorides, dissolved oxygen demand, nitrogen, solids, iron and manganese, fluoride, sulphate, phosphorus and phosphate, grease, volatile acids, gas analysis, preparation of standard solutions.

8. Drinking water standards

9. Trace organics and trace inorganics

Recommended books, periodicals etc.

5. Standard methods for the examination of water and wastewater joint publication of APHA, AWWA and WEF

CE 0312 ENVIRONMENTAL MICROBIOLOGY & ECOLOGY

1. Life support system: Role of life science in environmental engineering as useful, nuisance causing and harmful organisms.
2. The microorganism: Cell structure, eukaryotes, prokaryotes, viruses. Their detection and quantification.
4. Chemical composition of cell and nature of organic matter used by microorganisms.
5. Metabolic classification of microorganisms: phototrophs, chemotrops, application in environmental field.
7. ATP formation, : energy generation in cell.
9. Kinetics of biological growth bacterial growth in terms of numbers and mass, growth curve, interpretation of curve, substrate limited growth, M onod's expression, substrate utilization and cell growth, effect of endogenous
metabolism, effect of temperature application of growth and substrate removal kinetics to biological treatment.


13. Indicator microorganisms: bacteria, algae, protozoa

14. Bacteriological tests: plate count, presumptive confirmed and completed tests for coliforms, fecal coliforms test, fecal streptococci test, bifido bacterium test, clostridium welchii test, MTD MF techniques, algae counting.

15. Ecology: basic principles, food chain, tropic structure, gross production to total community respiration ratio(P/R), biogeochemical cycles, limiting factors-Liebig's law, extended, ecological regulation, important ecosystems.

**Recommended books and periodicals**

4. Microbiology - Pelzar, Reid and Roger D. McGraw Hill
7. Standard Methods for examination of water and wastewater joint publication of APHA, AWWA, and WEF
8. Journal of Water Pollution Control Federation(now journal of Water Environment Federation).
CE 0313 ADVANCED HYDRAULICS


6. Time of concentration and time of inlet. Lengths of side weirs and street inlets. Investigation, design and layouts of sanitary and storm water storage system Maintenance of sewerage systems.

7. Sewage pumping-selection of pumps, Capacity of wet wells and dry wells. Design of pumping station.

8. Household Plumbing systems. Types and suitability of each system, fixture unit. Design and pipe sizes for water and wastewater. Storage tanks and fixtures.

9. Computer Applications
Recommended books and journals etc.

CE 0314 AIR, NOISE POLLUTION AND CONTROL

2. Sources of air pollution. Natural and man-made Major pollutants from different sources in Greater Mumbai area and other Indian cities. Emission factors.
3. Effect of air and noise pollution on human health, plants, animals, properties and visibility, CoH, CoHb.


8. Control devices: Principles, types, operations of each individual device.
   Hoods and ducts_ Hood specification, hoods of simple geometry, complex hood design, duct design, ventilation by dilution,
   Settling chambers_ Laminar flow, turbulent flow, economic sizing, dust removal, fractional and overall collection efficiency.
   Inertial devices_ Cyclone flow, collection efficiency in laminar and turbulent flow, pressure drop and power requirement ,economic sizing.
   Electrostatic precipitators_ Collection efficiency, electric field, particle charging, electrical operating point, corona discharge, corona onset voltage, sparking field strength, effect of temperature and resistivity of dust on collection efficiency. Pressure drop and power requirement. Sizing and costing of ESPs. Practical design considerations.
   Particulate scrubbers_ Interception and impaction collection efficiencies, pressure drop. Design criteria, Cyclone scrubber. Venturi scrubber.
   Filters_ Collection efficiency and pressure drop for packed filter bed and single layer filter, Bag filters and bag houses. Fabric filtration theory, design considerations, sizing and costing of fabric filters.
   Absorption towers_ Henry's law, mass transfer relations, equilibrium distribution curve, mass transfer coefficients, basic design of packed bed absorption tower, concept of height of transfer unit and number of transfer units. Pressure drop, Practical considerations of design.
   Incinerators_ for gaseous pollutants. Waste gas characterization, theoretical considerations, design considerations of thermal incinerators. Catalytic
incinerators. Flammable mixtures and flares, pressure drop considerations, capital and annual operating costs.

Other devices: Adsorption and condensation

9. Noise

Basic concept, measurement, various control methods.

**Recommended books, periodicals etc.**

Books:
3. "Air Pollution" by Wark and Warner
6. Government of India's publication of laws related to air pollution. Maharashtra Pollution control Board's (MPCB) publication of standards IS relevant to air pollution monitoring definitions, standards etc.

Handbooks

Journals
1. *Journal of Air & Waste Management Association* (formerly known as *Journal of Air Pollution Control Association*) published from USA.
HM 0311 COMMUNICATION SKILLS- I

2. Listening Skill: Barriers to listening, Listening & Note making.

Books Recommended:
Effective Technical Communication- M.Ashraf Rizvi (McGraw Hill)

CE 1311 WATER LABORATORY

1. Determination of Alkalinity
2. Determination of Hardness
3. Determination of Chlorides
4. Determination of Solids
5. Determination of Residual Chlorine
6. Determination of pH
7. Determination of Turbidity
8. Determination of Metals- Iron
9. Determination of Metals- Chromium
10. Determination of Metals- Manganese
11. Determination of Metals- Zinc
12. Determination of Optimum Dose of Alum Using Jar Test Apparatus
13. Determination of $\text{NO}_3^-$
14. Determination of Phosphates
15. Determination of Sulphates
CE 1312 AIR POLLUTION & MICROBIOLOGY LABORATORY

Air Pollution

1. Anderson Air Sampler
2. Ambient Air Monitoring using High volume Sampler
3. Anemometer
4. Velmeter
5. Paper Tape Air Sampler & Paper Tape Densitometer
6. Stack Monitoring Unit
7. Dust Jar Apparatus
8. Sound Level Meter
9. Industrial Bag Filter
10. Kitagawa Tubes

Microbiology

1. Preparation of Nutrient Broth
2. Preparation of Nutrient Agar
3. Effects of pH on Growth of Microorganisms
4. Effects of Heavy Metals on Growth of Microorganisms
5. Effects of Radiation on Growth of Microorganisms
6. Effects of Temperature on Growth of Microorganisms
7. Effects of Osmotic Pressure on Growth of Microorganisms
8. Effects of Dyes on Growth of Microorganisms
9. Effects of Heat on Growth of Microorganisms
10. Isolation of Microorganisms
11. Determination of MPN
12. Standard Plate Count
13. Fermentation of Milk
14. Effect of Catalytic Action on Growth of Microorganisms
15. Effect of Antibiotic on Growth of Microorganisms
16. Types of Microscopy
17. Staining Technique
18. Phenol Coefficient

Recommended books

1. Standard Methods for Examination of water and waste water, Joint Publication of APHA, AWWA & WEF.
2. Chemistry for Environmental Engineering, Sawyer & McCarty.
CE 1313 SAMPLING & ANALYSIS LABORATORY
1. Study of Standard procedure for collection of samples of water, waste water & Industrial wastes.
2. Methods for determination of sample size
3. Methods of testing hypothesis and drawing interferences.

CE 2311 SEMINAR- I
Students are required to select at least two research papers as a particular topic published in referred journal on the said topic. Students are expected to study and understand the contents and prepare a summary report about the contents of the papers and will present a seminar.
SEMESTER- II

CE 0321 ADVANCED WATER TREATMENT


3. Intake structures.


9. Principles of aeration, system parameters and mathematical model, Methods of aeration, Theories of adsorption, Freudlich equation, removal of taste and odour


11. Methods of Iron and Manganese removal, use of aeration, oxidation, ion-exchange and other methods and their control.

12. Theory of corrosion, and corrosion control.

**Recommended books, Journals etc.**

7. Operation and Control of Water Treatment processes C.R. Cox WHO Monograph Series No.49.
9. Journal Water Pollution Control federation (Now Water Environment Federation)
10. Transactions - American Society of Civil Engineers- Hydraulics Division and Environmental Engineering Division.
11. Manual of Water Supply and Treatment Ministry of Urban Development
12. Operation and control of water treatment processes - C.R. Cox WHO Monograph no.49
13. Water supply for rural areas and small communities - Wagner and Lanoix. WHO Monograph no.42.
15. Water Treatment Principles and Design-J.M. Montgomery-Wiley Interscience, Publication, N.Y.
16. Journal Water Environment Federation
18. Journal Indian Water Works Association
19. Journal of the Institution of Engineers (India)
CE 0322 ADVANCED WASTE WATER TREATMENT


**Recommended books and journals etc.**

5. Wastewater Treatment For Pollution Control S.J.Ariceivala Tata McGrawhill Publishing Co. Ltd. New Delhi.
6. Waste Stabilization ponds - E.F. Gloyne WHO Monograph no.60

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**CE 0323 INDUSTRIAL WASTEWATER TREATMENT**

2. Importance of planning location of industries and industrial estates, Common effluent treatment plants, their economics and management.
3. Treatability Studies: - Bench Scale & Pilot scale, Preparation of Feasibility Reports.
4. Detailed considerations of wastes from industries such as textile (Cotton, wool, rayon, synthetics), sugar, pulp and paper, distilleries, oil refineries, petrochemicals, pharmaceuticals, dairy, food processing, soaps and detergents, mining, iron and steel, pickling, plating, galvanizing, tanning, slaughterhouse, fertilizers, pesticides, dyes and dye intermediates, radioactive wastes.

6. Industrial water budgeting from Environmental angle.

7. Performance study of Wastewater Treatment Plants.

**Recommended books & periodicals.**

2. Nemerow, N.D. Theories and practices of industrial waste treatment
5. Proceedings of Industrial Waste Conference-Purdue University.
7. Eckenfelder W.W. Jr. & O'connor Biological Waste Treatment

**CE 0324 SOLID WASTES AND HAZARDOUS WASTE MANAGEMENT**

1. Solid wastes - sources, types, composition, physical, chemical and biological properties of solid wastes, sources and types of hazardous and infectious wastes in municipal solid wastes.
2. Solid waste generation and collection, Handling, storage, processing, transportation
3. Disposal of solid wastes - materials separation and processing, thermal conversion, biological and chemical conversion, recycling of material in municipal solid wastes, Land filling, Composting, gas generation, closure of landfills.
4. Industrial solid wastes-composition, bio-degradable, nonbiodegradable hazardous, toxic solid wastes, methods of detoxification, disposal on land, disposal into water bodies.
5. Legal aspects of municipal solid waste collection, conveyance, treatment and disposal.
6. Hazardous wastes - origin, quantity and quality parameters.
7. Treatment and disposal methods-physico-chemical and biological. stabilization and solidification, thermal methods, land disposal, site remediation.
**Recommended books and periodicals**

7. Infectious & Medical Waste Management by Peter A Reinhardt Judith G Gordon

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**HM 0321 COMMUNICATION SKILLS- II**

1. Interview: Pre-Interview Preparation, Interview Question Answer, Resume & Job Application, Group Discussion, Telephone Interviews.
2. Presentation Skills: Planning, preparing, Organizing, Delivery, Feed Back.
3. Seminar Presentation on the following Topics:
   - Time Management
   - Motivation
   - Negotiation & Conflict Management
   - Stress Management
   - IPR
   - Transactional Analysis
   - Leadership
   - Presentation Through Video conferences

**Books Recommended:**

Effective Technical Communication- M.Ashraf Rizvi (McGraw Hill)
CE 1321 WASTE WATER & SOLID WASTE LABORATORY

Wastewater
1. Determination of Dissolved Oxygen
2. Determination of BOD
3. Determination of COD
4. Determination of SVI
5. Determination of Detergents
6. Determination of Oil & Grease
7. Determination of Volatile Acids

Solid Waste
1. Determination of Moisture Content
2. Determination of pH
3. Determination of Total Organic Content
4. Determination of Na & K

Recommended Books:
1. Standard Methods for examination of water & waste water, Joint Publication of APHA, AWWA & WEF.
2. Chemistry for environmental Engineering: Sawyer & McCarty

CE1322 COMPUTER APPLICATIONS

Study of Software for analysis & Design for water supply, Sewerage & GIS systems Such as loop, Branch, Sewer, EPANET etc.

CE1323 DESIGN LABORATORY

Process & Hydraulic Designs of facilities like treatment plants, Water transmission & Distribution system, waste water collection systems etc. Storm drainage system. Exercises from selected topics from the above list.

CE 2321 SEMINAR II

Students are required to select a topic in relevant area (new equipment/new process/new design methodology etc.). Students should review literature through Journal Papers, Manufacturer’s catalogues etc., Prepare a report & present a Seminar.
ELECTIVE COURSES

CE0351 ENVIRONMENTAL LEGISLATION

1. Environmental acts-their need, historical background, national and international acts;
2. Genesis of environmental acts – general procedure followed in changing a bill into an act; implementation of an act using judiciary, executive and legislative powers and their limitations.
3. Main national acts – Environmental protection agency, air act, water act, water and sewerage Board’s Factory act, Municipal acts, acts dealing with hazardous and infections wastes.
4. Environmental impact assessment, environmental audit, general procedures followed in preparing reports incorporating EIA ES and EA.
5. Case laws- Principles of case laws, statutory interpretations, site selection, land use planning, town planning act.
6. ISO: 14000 – its need, procedure to be followed to obtain ISO: 14000 certification, implications of ISO.
7. Environmental management plan, environment management cells, rehabilitation and remediation, NGOs and their role.
8. Environmental and occupational health, industrial hygiene, risk assessment, disaster management plan, epidemiology..
9. Assessment of existing effluent treatment plants, trouble shooting, remedial measures.

Recommended books:
1. Pollution législation – A.K.Mhaskar ,M/s. Media Enviro, Pune
5. Various publications of Central Pollution Control Board, New Delhi.
CE 0352 ENVIRONMENTAL MANAGEMENT

General: Global and Indian Scenario, National Environmental Policy, Environmental Organisations for planning & implémentation, Sustainable development, Preventive and reactive strategies for environmental pollution control, Environmental impact & risk assessment,

CE0353 ENVIRONMENTAL IMPACT ASSESSMENT & AUDIT

Environmental impact assessment, Brief history, Significance, Objectives, Role in planning and decision making process, Environmental assessment process, Assessment methodologies, Socioeconomic impact assessment, air, noise, water, vegetation & wildlife and energy impact analysis, cumulative impact assessment, ecological impact assessment, risk assessment, Environmental impact statement, Basic concepts behind EIS, Various Stages in EIS production, Typical EIS outline, Rapid EIA, Environmental auditing, Aims & Objectives, Audit principles, Partial environmental audits, Scope of audit, Case studies.

CE0354 OPERATION & MAINTENANCE OF TREATMENT FACILITIES

CE 0355 RURAL WATER SUPPLY & SANITATION

Concept of environment and scope of sanitation, Magnitude of problems of water supply and sanitation, National Policy, Planning of water supply systems, Selection & development of preferred sources of water, Specific problems in rural water supply and treatment, Low cost treatment, Improved methods and compact systems of treatment, Water supply during fairs, festivals and emergencies, Treatment and disposal of waste water / sullage, Community latrines, Simple wastewater treatment systems, Disposal of solid waste, Biogas plants.

CE0356 WATER RESOURCES MANAGEMENT

Introduction, Water resources planning, Basic concepts of hydrology and hydrogeology, River monitoring, Ground water pollution, National water policy, Water resources planning and processes, Application of remote sensing, Reliability studies, Water resources conservation, Water resource development in coastal areas, Basic concepts of economics, Inter basin transfer of water.

CE0423 ADVANCED PROJECT MANAGEMENT

1. Project management: scope and framework, agencies involved, their relationships and scope
2. Project Planning: Plan development process, precedence diagrams with overlapping relationships, network analysis, master network and sub-nets
3. Resource scheduling: resource aggregation, allocation, concept of leveling and smoothening, line of balance, float factor, issues involved in multi project multi resource scheduling, time-cost tradeoff: simple and complex
4. Project organization: structure and development, resource organization, demobilization
5. Project monitoring: progress reporting, alarm reports, review meetings, updating plans
6. Project control: control system framework, baselines, codification
7. Scope control: extras, variations and additional work
8. Time control: reasons for schedule delays, productivity control measures
9. Cost control: variance analysis, s-curves, control measures
10. Quality control and assurance: tools and procedures
11. Safety: common causes of accidents, occupational health hazards, general measures to ensure safety and safe environment
12. Risk management: project risks, tools of assessment and methods of mitigation
13. Information systems: PMIS, integrated approach

**Recommended Books:**

1. Professional Construction management Barrie & Paulson
2. Project Management : Hira & Ahuja
3. Project Management : Chitkara, TATA McGrow Hill Publication

**CE 0457 RISK & DISASTER MANAGEMENT**

1. Risks: risks in construction, risk management framework
2. Risk identification: sources of risk, risk classification, risk effects, common tools and techniques of identification
3. Risk analysis: risk measurement, qualitative and quantitative techniques
4. Risk response: risk management plan, risk retention, risk reduction, risk transfer, risk avoidance, attitudes towards risk
5. Risks in construction projects: money, time and technical risks, contracts and risks, risks in the context of global project teams
6. Disasters, Disaster management framework, pre-disaster, during disaster and post-disaster activities

References:
Published books in the relevant areas to be supplemented by latest journal articles and papers, seminar and conference proceedings, in-house publications, monographs etc.

CE 0461 MANAGERIAL DECISION MAKING

1. Management Decision Making
   Management decision Making art of modeling, systems approach, concept of optimization, attitudes of decision maker.
2. Linear programming
   LP formulation, solution by graphical method, simplex method, duality, sensitivity and parametric analysis, transportation model, assignment mode, integer programming- branch and bound algorithm.
3. Network Model
   Network definition, shortest route problem, maximal flow problem.
4. Waiting lines
   Basic structure of queuing model, M/M/1 model
5. Dynamic programming
   Formulation of model and recursive equation, and applications.
   Group decision making.
   Behaviour of decision maker as an individual and in group, compromise and consensus decision making.
6. Decision theory and games
Decision under uncertainty and risk: decision trees, games theory

7. Simulation
Monte Carlo method, applications

References:

1. Shrivastava, Shenoy & Sharma, Quantitative Techniques for Managerial Decisions, Wiley
2. Taha Hamdy, Operations Research ,An Introduction