Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Two Year Postgraduate Programme Leading to
Master of Technology (M.Tech.) Degree in
Civil Engineering with specialization in Environmental Engineering

Implemented from the batch admitted in Academic Year 2014-15
VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Two Year Postgraduate Programme Leading to
Master of Technology (M.Tech.)
In

202 Civil Engineering (with Specialization in Environmental Engineering)
Scheme and syllabus for M. Tech. in Civil engineering with specialization in Environmental Engineering

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Programme Educational Objectives (PEOs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEO 1</td>
<td>Develop advanced competencies in understanding basics of environmental engineering</td>
</tr>
<tr>
<td>PEO 2</td>
<td>Develop a competent environmental professional to manage and lead the environmental issues</td>
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<tr>
<td>PEO 3</td>
<td>Expand career potential of individuals through applied learning experiences and analytical skills in the area of environmental engineering</td>
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<tr>
<td>PEO 4</td>
<td>Develop and honed up research and innovative approaches to solve environmental problems</td>
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Programme Outcomes (PO):

PO 1: Ability to apply knowledge of fundamentals of science and engineering to environmental engineering.

PO 2: An ability to identify, analyze, formulate and solve engineering problems.

PO 3: An ability to use knowledge in planning, design, construction, commissioning and operation & maintenance phases.

PO 4: Developing skills regarding quality, safety and legal aspects of environment.

PO 5: Developing research approaches to mitigate a problem.

PO 6: An ability to function on multi-disciplinary approaches/ teams.

PO 7: Developing managerial and leadership skills.

PO 8: An ability to engage in lifelong learning technological advances in environmental engineering.

PO 9: An understanding of professional integrity and ethical responsibility.

PO 10: An ability to listen and communicate effectively.

PO 11: An ability to use the techniques, skills, and modern engineering tools and softwares necessary for engineering practice and decision making process.
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<thead>
<tr>
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Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **IST**: In Semester Tests (comprise of average of two In semester tests), **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation
### List of Program Elective I Course

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<td>CE5103S</td>
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<tr>
<td>2</td>
<td>CE5122S</td>
<td>Groundwater Hydrology and Contamination</td>
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<tr>
<td>3</td>
<td>CE5106S</td>
<td>Energy Conservation in Facility Design and Construction</td>
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### List of Program Elective III Course

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<td>1</td>
<td>CE5123S</td>
<td>Industrial Wastewater Treatment</td>
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<tr>
<td>2</td>
<td>CE5124S</td>
<td>Operation and Maintenance of Treatment Facilities</td>
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<td>3</td>
<td>CE5107S</td>
<td>Operational Health &amp; Safety management</td>
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<td>4</td>
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### List of Program Elective IV Course

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<td>Environmental Legislation</td>
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<tr>
<td>2</td>
<td>CE5126S</td>
<td>Rural Water Supply and Sanitation</td>
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<tr>
<td>3</td>
<td>CE5109S</td>
<td>Integrated GIS &amp; GPS in Infrastructure</td>
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<td>4</td>
<td>CE5110S</td>
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### Computational Methods

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<tr>
<td>1.</td>
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<td>Computational Method</td>
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</table>

**Course Outcome:**

CO1 To understand different mathematical modeling strategies to simulate civil engineering systems.

CO2 To understand different computational techniques to analyze mathematical models.

CO3 To develop computational skills to solve problems in the field of civil engineering.

CO4 To develop ability to identify and define civil engineering problems, to gather data related to the problem, to select and implement the appropriate solution.

### Syllabus

1. **Mathematical Model**

   Model, Purpose of modeling, Types of model, Steps in modeling process - Problem definition, Purpose definition, Conceptualization, Selection of computer code, Model design, Calibration, Validation. Errors in engineering calculations (sources of errors, significant digits, rounding off, propagation of maximum error, propagation of variance, bias & precision)

2. **Interpolation and Extrapolation**

   Lagrange’s Interpolation, Newton’s Interpolation- Forward, Backward, Hermite Interpolation, Spline Interpolation - cubic, inverse interpolation, Extrapolation. Civil Engineering Applications- elevation contour map, isohyetal map, Noise Map, etc.

3. **Numerical Differentiation and Numerical Integration**

   Newton Raphson method, Modified Newton Raphson method and Successive approximation method. Trapezoidal rule, Simpson’s rule ( rd, th), Gauss quadrature method 2-point, 3-point, Double integration- Trapezoidal rule, Simpson’s rule ( rd) Civil Engineering Applications- Earthwork volume estimation, Estimation of pile capacity, etc.

4. **Curve Fitting and Errors**

   Curve fitting (Interpolation, function that fits given values - approximate and exact, find function where reaches min/max or a specific value, linear regression, higher order polynomial, Gaussian, quantifying errors in curve fitting) Civil Engineering Applications- Population Forecasting Methods, Reduction Rate Parameters for design of Treatment Units, Atmospheric dispersion of pollutant ( Gaussian Dispersion Model), Dispersion at sea outfall, etc.
5. **Finite difference and finite element method**


Finite Element Method (limited to 1D elements): Basic understanding of finite element method including element types and their formulation, Civil Engineering Applications- Groundwater modelling, Flood routing, Self Purification of Streams(Streeter Phelps Equation) Finite element methods for simple beam and truss problem, 1 D consolidation problem, etc .

6. **Optimization**

Concept of optimization, Linear programming. Civil Engineering Applications - Environmental Engineering, Water resources engineering, Structural engineering.

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**Recommended books, periodicals etc.**

Environmental Chemistry

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</table>

**Course Outcome:**

CO1 An ability to identify and define environmental problems, gathering data related to the problem, selecting and implementing the best treatment alternative.

CO2 An ability to use acquired knowledge in planning, design, O & M of the treatment and pollution control facilities.

CO3 Ability to apply basic and acquired knowledge in research and development.

**Syllabus**

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.


6. Nuclear Chemistry: Basic concepts


8. 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, color, pH, acidity, alkalinity, hardness, residual chlorine and chlorine demand, chlorides, dissolved oxygen, nitrogen, solids, iron and manganese, fluoride, sulphate, phosphorus and phosphate, grease, volatile acids, gas analysis, preparation of standard solutions.
9. Drinking water standards
10. Trace organics and trace in-organics

**Recommended books, periodicals etc.**

Environmental Microbiology

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Course Outcome:

CO1  An ability to identify and define environmental problems, gathering data related to the problem, selecting and implementing the best treatment alternative.

CO2  An ability to use acquired knowledge in planning, design, O & M of the treatment and pollution control facilities.

CO3  Ability to apply basic and acquired knowledge in research and development.

Syllabus

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.

6. Enzymes function, classification, kinetics, inhibitors and inhibition.

7. ATP formation: energy generation in cell.


13. Indicator microorganisms: bacteria, algae, protozoa

14. Bacteriological tests: plate count, presumptive confirmed and completed tests for coliforms, faecal coliforms test, faecal 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
### Hydraulics of Water and Wastewater

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**Course Outcome:**

- **CO1** Developing skills to identify the most economical and technically feasible solution to conveying systems.
- **CO2** An ability of analyze and design storm drainage and sewerage systems.
- **CO3** An ability to apply basic knowledge to analyze & design and use of software for large pipe networks and analyze Water Hammer.

**Syllabus**

1. Objectives of a public water supply, Design periods for water and wastewater structures, Population estimates, Estimate of water consumption and fluctuations in demand, Water Demand Surveys, Brief introduction of Hydrology of water resources - surface and ground water, Project Reports, Master Plans for water and sewerage project.

2. Transmission of water: Types and materials of conduits, Hydraulic characteristics-size, capacity, number and shapes of conduits and their location, Pumping of water, Types, design and selection of pumps, Economics of pump and pumping main selection, Water hammer, Water hammer controlling devices and their location on rising mains.

3. Distribution of water: Pressure and capacity requirements of system, Provision for fire fighting, Field and office analysis of distribution networks, Hardy cross method, Optimization of network by various methods, Service storage and equalizing storage capacity requirements, Leak Detection survey, Water Audit, Domestic and Bulk Water Meter.


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, Pumps in parallel and series, system head capacity curves, pump curves, economic diameter for force mains, present worth analysis.
8. Household plumbing systems, Types and suitability of each system, fixture unit, Plumbing in high rise buildings, Design and pipe sizes for water and wastewater, Storage tanks and fixtures.

9. Computer Applications

**Recommended books and journals etc.**

## Program Elective Course I: Risk & Value Management

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### Course Outcomes

- **CO1.** Able to conduct value management and risk analysis exercise.
- **CO2.** Able to predict life cycle costs.
- **CO3.** Able to gather requirements and generate alternatives to satisfy needs.
- **CO4.** Able to determine appropriate risk response.

### Syllabus

1. **Introduction:** Definitions: Value, value engineering, value analysis, value management, Habits, Roadblocks & attitudes and their relation to value engineering

2. **Function Analysis:** Function & its role in achieving value, function in terms of its cost & worth, Graphical function analysis, function analysis system technique

3. **Creative thinking:** creative people, creative processes, conducting creative session

4. **Life cycle costing:** purpose & implications, economic principles for life cycle costing, types of life cycle costs.

5. **Energy:** Energy resources & consumption, energy cost escalation, sources of energy supply, end use of energy, energy embodiment of construction materials, buildings, infrastructures facilities & energy systems, energy models, factors affecting energy consumption

6. **Risks:** risks in construction, risk management framework

7. **Risk identification:** sources of risk, risk classification, risk effects, common tools and techniques of identification.

8. **Risk analysis:** risk measurement, qualitative and quantitative techniques.

9. **Risk response:** risk management plan, risk retention, risk reduction, risk transfer, risk avoidance, attitudes towards risk.

10. **Risks in construction projects:** money, time and technical risks, contracts and risks, risks in the context of global project teams.
**Recommended books and journals etc.**

Value Analysis in Design and Construction, O’Brien, JJ, McGraw Hill
Techniques of Value Analysis and Engineering; L.D. Miles; McGraw Hill
Program Elective Course I: Managerial Decision Making

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**Course Outcomes**

CO1. Able to identify and formulate problems and identify suitable technique to solve the problem.

CO2. Able to apply linear programming, network models, dynamic programming and simulation tools.

CO3. Able to understand decision theories and issues involved in group decision making.

**Syllabus**

Management Decision Making

- Management decision making, art of modeling, systems approach, concept of optimization, attitudes of decision maker
  
  1. Linear programming
     - LP formulation, solution by graphical method, simplex method, duality, sensitivity and parametric analysis, transportation model, assignment model, Integer programming - branch and bound algorithm
  
  2. Network model
     - Network definition, shortest route problem, maximal flow problem
  
  3. Waiting Lines
     - Basic structure of queuing models, M/M/1 model
  
  4. Dynamic programming
     - Formulation of model and recursive equations, and applications
  
  5. Group decision making
     - Behavior of a decision maker as an individual and in a group, compromise and consensus decision making
  
  6. Decision theory and games
     - Decisions under uncertainty and risk: decision trees, game theory
  
  7. Simulation
     - Monte Carlo method, applications

**Recommended books and journals etc.**

Shrivastava, Shenoy & Sharma, Quantitative Techniques for Managerial Decisions, Wiley

Programme Elective Course I: Environmental Impact Assessment and Audit

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<tr>
<td>5</td>
<td>CE5103S</td>
<td>Environmental Impact Assessment and Audit</td>
<td>3-1-0=4</td>
<td>4</td>
<td>20</td>
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Course Outcome:

CO1. To understand EIA process and various government notification.
CO2. To understand the methodology for prediction and assessment of various impacts on environment.
CO3. To learn and apply various methods of environmental audit.

Syllabus

1. Fundamental Approach To EIA:

History of EIA: Evolution Environmental Laws in World & India, Development of EIA in India, Environmental Clearance Procedure in India.

Basic Concept of EIA: Introduction, EIA Procedure, Objective of EIA, Significances

Systematic Approach for Using EIA: Introduction, Identification of Study Area, Classification of Environmental Parameters, Terms of References, Preparation of EIA Report, Scoping in EIA,


5. Prediction and assessment of impacts on soil and ground water environment: introduction, soils and ground water, methodology for the prediction and assessment of impacts on soil and groundwater.


12. Environmental Audit: Aims & Objective, Audit Principles, Partial Environmental Audits, Scope of Auditing, Case Studies

<table>
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<tr>
<th>Recommended books:</th>
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</table>

**Course Outcome:**

- CO1: Be able to understand the principles of environmental management to carry out policy analysis and prepare environment management plan.
- CO2: Be able to apply the environmental management practices for infrastructural projects.
- CO3: Be able to apply the tools and develop strategies to have an environmentally sustainable project.

**Syllabus**

3. Environmental Policy Analysis- Macro level and Micro level, Methods of Policy Analysis, steps involved, Environmental Management Plan (EMP), Components of EMP, Preparation of EMP, Case Study

**Recommended books and journals etc.**

International editions.

## Programme Elective Course II: Air and Noise Pollution Control

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<th>SN</th>
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<tr>
<td>6</td>
<td>CE5121S</td>
<td>Air and Noise Pollution Control</td>
<td>3-0-0=3</td>
<td>3</td>
<td>20</td>
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</table>

### Course Outcome:

- CO1: An ability to identify and analyze air and noise pollution related environmental issues.
- CO2: Be able to identify the economical and technically feasible solutions to air and noise pollution problems.
- CO3: Developing competency in use of various air modeling software and noise mapping software.
- CO4: Ability to use the basic and advance air pollution knowledge in research and development.

### Syllabus

1. Composition of dry ambient air, properties of air, Definition of air pollution, Classification of air pollutants, Units for classification of air pollutants, History of air pollution - global and national, Scope of problem - general, urban, rural and specific.

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.

4. Meteorological aspects of air pollution - Large scale wind circulation: geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer, lapse rate, stability conditions, wind velocity profile, maximum mixing depth, topographic effects and plume patterns.

5. Plume dispersion, Gaussian model for predicting concentration downwind from a single source, line source, area source, Diffusion coefficients, Stability categories and graphs for dispersion estimates, Maximum ground level concentration, inversion effects, modification of model to predict particulate dispersion, Other mathematical models, Plume rise, Holland equation, ASME equations, Brigg's equation, Other models for plume rise, Comparative evaluation of various models, Design of tall stacks.

6. Methods and instruments for sampling and analysis of air for stack and ambient air monitoring of gaseous and particulate pollutants, Theory of sampling, Isokinetic sampling, Continuous monitoring, particle size analysis and mass analysis, IS methods of sampling analysis.


8. Control devices: Principles, types, operations of each individual device.
   - a. Hoods and ducts: Hood specification, hoods of simple geometry, complex hood design,
duct design, ventilation by dilution,
b. Settling chambers: Laminar flow, turbulent flow, economic sizing, dust removal, fractional and overall collection efficiency.
c. Inertial devices: Cyclone flow, collection efficiency in laminar and turbulent flow, pressure drop and power requirement, economic sizing.
d. 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.
e. Particulate scrubbers: Interception and impaction, collection efficiencies, pressure drop, Design criteria, Cyclone scrubber, Venturi scrubber.
f. 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.
g. 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.
h. 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,
i. Other devices: Adsorption and condensation

9. Noise: Basic concept, measurement, various control methods.

**Recommended books, periodicals etc.**

2. "Air Pollution" by Wark and Warner
4. Environ-Science Service Dirn. ERA Inc.USA
5. 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.
Program Elective Course II: Ground Water Hydrology and Contamination

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<th>SN</th>
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<td>6.</td>
<td>CE5122S</td>
<td>Ground water hydrology and Contamination</td>
<td>3-0-0=3</td>
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Course Outcome:

- CO1 Be able to understand the geology and hydraulics of groundwater.
- CO2 An ability to identify and define problems, generating and prioritizing a set of alternative solutions in ground water pollution control.
- CO3 Be able to identify economical and technically feasible solution for groundwater remediation.

Syllabus:

**Ground water hydrology and Contamination**

1. Introduction: Hydrological Cycle; Water Budgets


3. Well Hydraulics: Thiem and Theis Equations, Pump Tests and Slug Tests

4. Groundwater Pollution Control

   Fate of pollutants in the groundwater system
   - Pollutants (metals, VOCs, NAPL and DAPL) and Characteristics
   - Advection, dispersion and diffusion
   - Sorption and desorption
   - Chemical reaction and precipitation
   - Biological activities

5. Methods of groundwater remediation

6. Case studies of groundwater remediation

Recommended books

## Programme Elective Course II: Energy conservation in Facility design & construction.

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<tr>
<td>6.</td>
<td>CE5106S</td>
<td>Energy conservation in Facility design &amp; construction</td>
<td>3-0-0=3</td>
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### Course Outcomes

- **C01**: Able to do analysis of energy requirements for buildings
- **C02**: Able to do the planning of energy efficient building and landscaping.
- **C03**: Able to perform the thermal Analysis and design energy efficient building for human comfort.

### Syllabus:

1. **Importance of Energy in City Planning**


2. **Energy Conservation**


3. **Energy Efficiency**

   Energy in Building Design—Energy Efficient and Environmental Friendly Building—Climate, Sun and solar radiation—Psychometrics—Passive Heating and Cooling Systems—Analysis of results—Identification of wastage—Priority of conservative measures—Maintenance of Energy Management - Calculation of instantaneous heat gain through building envelope; Calculation of solar radiation on buildings; building orientation; Introduction to design of shading devices; Overhangs; Factors that affect energy use in buildings; Ventilation and its significance; Air-conditioning systems; Energy conservation techniques in air-conditioning systems Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air-tunnel
4. Energy Management

Energy management concept in building; Bioclimatic classification of India; Passive concepts appropriate for the various climatic zones in India; Typical design of selected buildings in various climatic zones; Thumb rules for design of buildings and building codes. Energy Efficient Landscape Design Modification of microclimatic through landscape element for energy conservation; Energy conservation through site selection, planning, and design; brownfield development; Energy Management of Electrical Equipment; Improvement of Power Factor; Management of Maximum Demand; Energy Savings; Applications; Facility Operation And Maintenance; Facility Modifications; Energy Recovery; Dehumidifier; Water Heat Recovery; Steam Plants and Distribution Systems; Energy Savings in Pumps, Fans, Compressed air systems; ApplicationS

Reference:

## Programme Elective Course II: International Construction Business

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<th>SN</th>
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<td>CE5116S</td>
<td>International Construction Business</td>
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### Course Outcomes:

- **CO1** Able to understand the business aspects for international construction business.
- **CO2** Able to know cultural environment of international business.
- **CO3** Able to assess the nations on different parameters and determine feasibility of entering into international business of construction.

### Syllabus

1. International economy  
   - International political system, economic system, multinationals, features of international trade & investment, national interest in international trade
2. International payments  
   - International monetary system, balance of international payments, transfer of international payments, foreign exchange rates and their determination
3. Theories of international trade
4. Developing countries in the world economy, international differences in technology, policy implications for host countries
5. Cultural environment of international business
6. Effect of culture, language, education, religion, value systems on business, impact on management styles in selected countries
7. Role of Indian construction industry in international business, role of foreign companies in Indian business, some case studies

### Recommended books and journals etc.

- *International Business*, Justin Paul, PHI
- *International business management*, Bholanath Dutta, Excel Books
- *International construction*, Mark Mawhiney, Wiley-Blackwell
### Solid and Microbiology Laboratory

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<td>CE5022P</td>
<td>Solid and Microbiology Laboratory</td>
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**Course Outcomes:**

- CO1: An ability to use acquired knowledge in O & M of treatment plants and in research.
- CO2: An ability to take samples, analyze and interpret the results.
- CO3: To understand the accuracy and precision of the analytical results.

**Syllabus:**

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

**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 Antibiotics 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 & WFF.
2. Chemistry for Environmental engineering, Sawyer & McCarty.
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<td>CE5024L</td>
<td>Water and Wastewater Laboratory I</td>
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**Course Outcome:**

CO1 An ability to take samples, analyze and interpret the results of water and wastewater samples.

CO2 An ability to use acquired knowledge in design and O & M of water and wastewater treatment plants and in research.

CO3 Able to understand the accuracy and precision of the analytical results.

CO4 Be able to use acquired knowledge in research.

**Practicals**

A) Sampling:
1. Study of standard procedure for collection of samples of water & wastewater.
3. Methods of testing hypothesis and drawing inferences.

B) List of Experiments:
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 NO$_3^-$
9. Determination of Phosphates
10. Determination of Sulphates
11. Determination of Dissolved Oxygen
12. Determination of BOD
13. Determination of COD

**Recommended books**

1. Standard Methods for Examination of water and waste water, Joint Publication of APHA, AWWA & WFF.
2. Chemistry for Environmental engineering, Sawyer & McCarty.
4. Industrial Effluents- Origin, characteristics, effects, analysis & treatment, N. Manivasakam, SAKTHI PUBLICATIONS
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<tr>
<td>9</td>
<td>CE5025L</td>
<td>Air and Noise pollution Control Lab</td>
<td>0-0-2=2</td>
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**Course Outcome:**

- CO1  An ability to analyze and interpret the results.
- CO2  To understand the accuracy and precision of the analytical results.
- CO3  To develop skills for noise mapping.
- CO4  Be able to use acquired knowledge in research.

**Syllabus**

1. Anderson Air Sampler
2. Ambient Air Monitoring using High volume Sampler
3. Anemometer
4. Velometer
5. Paper Tape Air Sampler & Paper Tape Densitometer
6. Stack Monitoring Unit
7. Dust Jar Apparatus
9. Determination of Frequency Analysis of Noise
10. Measurement of Noise Dose
11. Industrial Bag Filter
12. Kitagawa Tubes

**Recommended books**

3. Industrial Hygiene and Toxicology by Patty
Semester II:

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<td>1.</td>
<td>CE5006S</td>
<td>Research Methodology</td>
<td>3-1-0=4</td>
<td>4</td>
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</table>

Course Outcomes
- CO1  Be able to conduct disciplined research under supervision
- CO2  Be able to critically evaluate current research and propose possible alternate directions for further work
- CO3  Be able to develop hypothesis and methodology for research
- CO4  Be able to communicate scientific results clearly for peer review

Syllabus

1. Introduction:
   Meaning and purpose of research, objectives of research, types of research, significance of research, Research Approaches, Research Methods v/s Methodology, Research Process, Criteria of Good Research. Research and Scientific Methods

2. Research Problem:
   Steps in Research: Identification, selection and formulation of research problem- Research questions-Research design- Formulation of hypothesis- Review of literature. Definition, necessity and techniques of defining research problem; Formulation of research problem; Objectives of research problem.

3. Research Design:
   Need and features of good research design. Types of Research Designs, Basic Principles of Experimental Designs; Design of experiments.

4. Data Collection:

5. Sampling Design:
   Sampling theory-Types of sampling-Steps in sampling-Sampling and Non-sampling error-Sample size –Advantages and limitations of sampling. Census and Sample surveys, Different types of sample designs, characteristics of good sample design. Techniques of selecting a random sample.

6. Hypothesis Testing:
   Fundamentals and procedure of hypothesis testing flow diagram for hypothesis testing.
   Measurement in Research: Measurement scales – Tests of good measurement construction of
Likert and Semantic Differential scales - Source of errors in measurement - Scale validation.

Parametric and non-parametric tests of hypothesis testing, Non-parametric tests like Sign, Run Kruskal-Wallis test and Mann – Whitney test.

Testing of significance of mean, proportion, variance and correlation - Testing for significance of difference between means, proportions, variances and correlation coefficients. Limitations of tests of hypothesis, One-way and two-way ANOVA – Latin Square tests for association and goodness of fit.

7. Technical Paper and Report Writing:
   Basic concepts of paper writing and report writing, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing, Types of Research reports, Methods of presentation of report.

8. Structuring the Report:
   Types of reports, Contents, Styles of reporting, Steps in drafting reports, Chapter format, Pagination, Identification, Using quotations, Presenting footnotes – abbreviations, Presentation of tables and figures, Referencing, Documentation, Use and format of appendices- Indexing Editing and evaluating the final draft.

9. Research ethics:
   Ethical Issues, Ethical Principles that govern Research, Ethically valid Information Sources, Regulatory Compliance.

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<th><strong>Recommended books and journals etc.</strong></th>
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### Design of Water Treatment Systems

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<td>2.</td>
<td>CE5026S</td>
<td>Design of Water Treatment Systems</td>
<td>3-0-0=3</td>
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#### Course Outcome:

- **CO1** Ability to acquire skills in effective planning for water supply projects.
- **CO2** Be able to understand unit operations and unit processes in water treatment.
- **CO3** Be able to combine unit operations and unit processes together in a general flow scheme to meet specific treatment goals.
- **CO4** Be able to develop design skills and optimizing techniques in water treatment.

#### Syllabus

3. Intake structures.
10. Theories of adsorption, Adsorption Isotherms, Phenol Value, Break through time.
14. Theory of corrosion, and corrosion control.

<table>
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<tr>
<th>Recommended books, Journals etc.</th>
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<tbody>
<tr>
<td>5. Water Treatment Principles and Design-J.M. Montgomery-Wiley Interscience, Publication, N.Y.</td>
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### Design of Wastewater Treatment Systems

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<th>SN</th>
<th>Course Code</th>
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#### Course Outcome:

- **CO1**: Ability to acquire skills in effective planning for wastewater projects.
- **CO2**: Be able to understand unit operations and unit processes in wastewater treatment.
- **CO3**: Be able to combine unit operations and unit processes together in a general flow scheme to meet specific treatment goals.
- **CO4**: Be able to develop design skills and optimizing techniques in wastewater treatment.

#### Syllabus

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Solid & Hazardous waste management

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<td>4.</td>
<td>CE5028S</td>
<td>Solid &amp; Hazardous waste management</td>
<td>3-0-0=3</td>
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Course Outcome:

CO1   Be able to design and optimize techniques in Solid and Hazardous treatment.
CO2   Acquiring knowledge on the specialized Solid and Hazardous treatment.
CO3   An ability to identify and define problems, gathering data related to the problem, generating and prioritizing a set of alternative solutions, and selecting as well as implementing the best alternative for Solid and Hazardous treatment.

Syllabus

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, biodegradable, non biodegradable 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

5. Handbook of solid wastes disposal-Materials and Energy
7. Infectious & Medical Waste Management by Peter A Reinhardt Judith G Gordo
Programme Elective Course 3: Industrial Wastewater Treatment

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<tr>
<td>5.</td>
<td>CE5123S</td>
<td>Industrial Wastewater Treatment</td>
<td>3-0-0=3</td>
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**Course Outcome:**

CO1 Be able to understand processes in industries and pollutional effects of industrial waste on environment

CO2 Be able to study unit operations and unit processes for treatment of wastewater and carry out treatability studies.

CO3 Be able to identify and define problems, gathering data related to the problem, generating and prioritizing a set of alternative solutions, and selecting the best alternative to reduce, recycle and treat industrial wastewater.

CO4 Be able to plan location of industries, industrial estates and common effluent treatment plants.

CO5 Be able to carryout industrial water budgeting and performance studies for treatment plant.

**Syllabus**


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. Unit Operations and Processes: Color Removal, Oil and grease removal, Heavy Metal Removal,

5. Detailed considerations of wastes from industries such as Study of Manufacturing Process, Sources, Quality and Quantity of Wastewater, Pollution Effects, Volume and Strength reduction, Recovery of byproducts, reuse and recycle and treatment. Zero Liquid Discharge in Industries. 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*
3. Mahajan S.P. *Pollution Control in Process Industries*.
5. Proceedings of Industrial Waste Conference-Purdue University.
Programme Elective Course 3: Operation & Maintenance of Treatment facilities

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<tr>
<th>SN</th>
<th>Course Code</th>
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<th>L-T-P (Hours/Week)</th>
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<tr>
<td>5.</td>
<td>CE5124S</td>
<td>Operation &amp; Maintenance of Treatment facilities</td>
<td>3-0-0=3</td>
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Course Outcome:

CO1 Be able to plan, prepare and schedule daily operations and inspections.
CO2 Be able to identify, analyze and solve the operational problems.
CO3 Be able to understand and carryout preventive maintenance.
CO4 Be able to develop skills of handling the emergency situations related to the failures and effective resource planning required for O. & M.

Syllabus

1. Introduction
   Need of Operation & Maintenance, Basic principles, corrective and preventive maintenance, Requirement of successive operation, Limitations of O &M Operations, operation manuals, computer usage in O and M.

2. Operation & Maintenance of Water Treatment facilities
   Different Units of Water Treatment plant, Coagulation aided Sedimentation tanks, Filters, Chlorinators, Monitoring and operational problems and their trouble shooting, Check List, Record keeping, Operation & Maintenance of Appurtenances, Cleaning and rehabilitation.

3. Operation & Maintenance of Pumping Machinery
   Introduction, Operation of pumps, Preventive maintenance, Maintenance of Pumping Station, Trouble Shooting, Safety Aspects.

4. Operation & Maintenance of wastewater facilities
   Different units of Waste water plant, Inspection methods, Manual and mechanical, Sampling and analysis of waste water, Cleaning and rehabilitation, Monitoring and operational problems and their trouble shooting, Building and other civil structure, Plant Control laboratory, Flow Measuring Devices

5. Operation & Maintenance planning
   Organizational structure, work planning, preparation and scheduling of daily operations and inspection of machinery, cost estimates.
**Recommended books:**

1. Design Operation Interaction at large wastewater treatment plants, International Association of Water pollution research.
2. All India Conference on operation and maintenance, pollution control equipment, the institute of energy management, Bombay.
Programme Elective Course 3: Operational Health & Safety Management

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<td>CE5107S</td>
<td>Operational Health &amp; safety Management</td>
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Course outcome:
- C01 Be able to work as safety engineer in industry.
- C02 Be able to determine safety practices necessary for a project site and to develop safety plan.
- C03 Be able to make aware about the hazards, causes of accidents to the site employees.

Syllabus
1. Hazards and causes of accidents, safety measures
2. Safety legislation and standards for construction industry
3. Safety precautions and practices in various construction activities like excavation, concreting, scaffold erection and dismantle, concreting, steel erection and demolition of structures
4. Occupational hazards and personal protective equipment
5. Management of accidents
6. Organization for safety, site management, safety manual and check lists
7. Safety officer, safety committee, safety training, safety audit

Recommended books and journals etc.
Safety and Health in Construction, ILO, 1992
Construction hazard & Safety handbook, R Hudson and R W King, Butterworths
Programme Elective Course 3: Quality Assurance on Construction projects

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<td>5.</td>
<td>CE5113S</td>
<td>Quality Assurance on Construction projects</td>
<td>3-0-0=3</td>
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Course Outcome

CO1  Able to apply quality control concepts for improving the quality of construction
CO2  Able to maintain the records of quality assurance processes and audits.
CO3  Able to use statistical tools for better quality control in construction projects.

Syllabus:

1. Introduction: Quality basics and history, Quality advocates, Quality improvement
   Concept of Total Quality Management; contributions of Deming, Juran, Crosby
   Quality Improvement Techniques: Pareto Diagrams, Cause-Effect Diagrams, Scatter Diagrams,
   Run Charts, Cause and Effect Diagrams

2. Statistical Concepts: Definitions, Measures of Central Tendency, Measure of Dispersion,
   Concepts of Population and Samples, Normal Curves, Control Charts for Variables, Variation:
   Common vs. Special Causes Control Chart Techniques: X-bar and R chart Correlation. X-bar and
   S charts, Control Chart Interpretation and Analysis, Using Charts to Pinpoint Problems, Other
   Variable Control Charts, Individuals and Moving Range Charts, Moving Average and Moving
   Range Charts, Median and Range Charts

3. Fundamentals of Probability: Basic Concepts and Definitions, Discrete Probability Distributions,
   Continuous Probability Distributions, Control Charts for Attributes, Control Charts for Non-
   conforming Units, Control Charts for Counts of Non-conforming Units

   Quality of construction materials and workmanship: Specifications, How to define, standard
   documents and specifications therein, Evolving Standards, Benchmarking

5. Quality Function Deployment: Design of Experiments, Quality Systems: ISO 9000, Six sigma,
   Certification Requirements, and Auditing

Reference books:

1. Quality management in construction projects, A R Rumane, CRC Press
2. Management of quality in construction, Ashford, Routledge
Programme Elective Course 4: Environmental Legislation

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<td>CE5125S</td>
<td>Environmental Legislation</td>
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Course Outcome:

CO1 Be able to understand the need of environmental legislation.
CO2 Be able to develop skill of executing and operating projects with sound relevant legal background and understanding.
CO3 Be able to identify and define problems using the knowledge of environmental legislation.
CO4 Be able to understand National Environmental Protection Acts

Syllabus

1. Environmental acts-their need, historical background, national and international acts; 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.
2. 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.
3. Environmental impact assessment, environmental audit, general procedures followed in preparing reports incorporating EIA, ES and EA.
4. Case laws- Principles of case laws, statutory interpretations, site selection, land use planning, town planning act.
5. ISO: 14000 – its need, procedure to be followed to obtain ISO: 14000 certification, implications of ISO.
6. Environmental management plan, environment management cells, rehabilitation and remediation, NGOs and their role.
7. Environmental and occupational health, industrial hygiene, risk assessment, disaster management plan, epidemiology.
8. Assessment of existing effluent treatment plants, trouble shooting, remedial measures.

Recommended books:

1. Pollution législation – A.K. Mhaskar, M/s. Media Enviro, Pune
Programme Elective Course 4: Rural water supply & sanitation.

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<tr>
<td>6.</td>
<td>CE5126S</td>
<td>Rural water supply &amp; sanitation.</td>
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Course Outcome:

CO1 Be able to identify and understand rural issues of water supply and sanitation.

CO2 Acquiring skills and understanding about the development of these projects with cost effective implementation and operation & maintenance.

CO3 An ability in effective resource planning for rural environmental projects.

Syllabus


2. Planning of water supply system: Design population and demand loads. Various approaches of planning of water supply schemes in rural areas.


4. Specific Problem in rural water supply and Treatment: Source Sustainability, Slippage, Water Quality, Operation and Maintenance. Low cost treatment, appropriate technology for water supply and sanitation.

5. Improved methods and compact systems of treatment: Brief Details of multi-bottom settlers (MBS), diatomaceous earth filter, cloth filter, slow sand filter, chlorine diffusion cartridges. Water supply during fair, festival and emergencies.

6. Treatment and Disposal of Waste-water/sullage:

7. Community latrines: Different types and location of latrines, various methods of collection and disposal of night soil.

8. Simple waste water treatment units and systems in rural areas such as stabilization ponds, septic tanks, Imhoff tank, soak pit etc. Disposal of waste water soak pits and trenches.

9. Disposal of Solid Wastes. Composting, land filling, incineration, rural health. Other specific issues and problems encountered in rural sanitation

10. Biogas plants: Definition, Objective, Methodology and Construction, operation and Maintenance, Economic analysis, Benefits, Shortcoming
**Recommended books:**

1. Rural Water Supply in developing countries, International development research centre.
Programme Elective Course 4 : Integrated GIS & GPS in infrastructure

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<td>6.</td>
<td>CE5109S</td>
<td>Integrated GIS &amp; GPS in infrastructure</td>
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Course Outcomes:
- CO1. Able to analyze spatially referenced data using scientific method to address an inquiry based study
- CO2. Able to acquire and create spatial data from satellite imagery, printed maps, online sources, & GPS
- CO3. Able to develop spatial and temporal models for presentation, analysis and decision-making
- CO4. To achieve competency in the use of the GIS software packages
- CO5. Able to design and execute a workflow GIS techniques appropriate to an applied field.

Syllabus

1. Geographical Information System (GIS):
   - Information systems, spatial and non- spatial information, geographical concept and terminology, advantages of GIS, Basic component of GIS
   - Commercially available GIS hardware and Software
   - Field data, statistical data, maps, aerial Photographs, satellite data, points , lines, and areas features, vector and raster data, data entry through keyboard, digitizer and scanners, preprocessing of data rectification and registration, interpolation techniques

2. Global Positioning System (G.P.S)
   - G.P.S. Segments: Spaces Segment, Control Segment, User Segment
   - Features of G.P.S. Satellites, Principle of Operation
   - G.P.S. Receivers: Navigational Receivers, Surveying Receivers, Geodetic Receivers, Computation of Co-ordinates:- Transformation from Global to Local Datum, Geodetic Coordinates to map co-ordinates, G.P.S. Heights and mean sea level Heights
   - Applications of G.P.S.

3. Civil Infrastructure Management:
   - Introduction, Infrastructure Life Cycle, Challenges of Infrastructure Management, meeting the challenges, Infrastructure Management services tier, GIS based civil Infrastructure management.

4. Case Studies:
   - a. GIS based management approach for Transportation Infrastructure Construction
   - b. Application of GIS in Transportation
   - c. GIS based applications in Airfield Infrastructure system management and maintenance
   - d. Developing Enterprise GIS based data repositories for Municipal Infrastructure asset management
   - e. GIS based decision support system for optimal renewal planning of sewers
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<tr>
<td>f.</td>
<td>GIS based integrated infrastructure Management</td>
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<td>g.</td>
<td>GIS based technologies for watershed management</td>
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<td>h.</td>
<td>Single frequency GPS for Bridge deflection monitoring : progress and results</td>
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<tr>
<td>i.</td>
<td>Monitoring of rigid structures using GPS and RTS – Experiment</td>
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<td>j.</td>
<td>Real- time bridge health monitoring for management</td>
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<td>k.</td>
<td>Deformation studies of Koyna Dam, Western India using GPS.</td>
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**Recommended books and journals etc.**

4. International and National Journals on GIS and GPS
Programme Elective Course 4: Water Resource Management

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<td>CE5110S</td>
<td>Water Resource Management</td>
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Course Outcome:

CO1. Skill of choosing the correct management techniques for water resources.

CO2. An ability to identify and define problems, gather data, generate and prioritize a set of alternative solutions, and select and implement the best alternative.

CO3. An ability to apply the principles of remote sensing and GIS to the water resources for management.

Syllabus

1. Water resources System and planning: System Components, Planning and management, Concept of a system, Advantages and limitations of systems approach.


   Water resources planning, Modeling of Water Resources Systems, Simulation and optimization, Economics in water resources, Challenges in water sector.

2. Watershed Management techniques: Rain water harvesting, On-site and off-site management structures for soil and water conservation. Community Watershed Management


5. Linear Programming and Dynamic Programming Applications Economics in water resources, Modeling of water resources systems, Constrained and unconstrained optimization, Linear programming with applications to reservoir sizing, reservoir operation, Dynamic programming with applications to water allocation, capacity expansion, reservoir operation.


7. Measurement and Processing of Data : Measurement and Processing of Rainfall Data, Stream
flow Data, Meteorological Data, Water Quality Data, Ground Water and Other Data
Acquisition and management of spatial data Hydrological databases and Dissemination of Data
Statistical Analysis of Data: Regression, Correlation and Data Generation

**Recommended books:**


Water and Wastewater Laboratory II

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<td>7.</td>
<td>CE5029L</td>
<td>Water and Wastewater Laboratory II</td>
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Course Outcome:

CO1 An ability to take samples, analyze and interpret the results of water and wastewater samples.
CO2 An ability to use acquired knowledge in design and O & M of water and wastewater treatment plants and in research.
CO3 An ability to understand the accuracy and precision of the analytical results.
CO4 An ability to use acquired knowledge in research.

Practicals

Wastewater

1. Determination of SVI
2. Determination of Detergents
3. Determination of Oil & Grease
4. Determination of Volatile Acids
5. Determination of Optimum Dose of Alum Using Jar Test Apparatus
6. Determination of Metals- Iron
7. Determination of Metals- Chromium
8. Determination of Metals- Manganese
9. Determination of Metals- Zinc
10. Filter Sand:
    A) Determination of Specific Gravity
    B) Determination of Acid Solubility
    C) Determination of Ignition Loss
    D) Determination of Friability Loss
    E) Determination of Sieve Analysis

Sampling and Analysis of water and Wastewater

1. Study of standard procedure for collection of samples of water, Sewage & industrial wastes.
3. Methods of testing hypothesis and drawing inferences.
4. Determining physical, chemical and biological properties of the samples

Recommended Books:

1. Standard Methods for examination of water & waste water, Joint Publication of APHA, AWWA & WEF.
2. Chemistry for environmental Engineering: Sawyer & McCarty
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<td>8</td>
<td>CE5030L</td>
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**Course Outcomes:**

- **CO1** An ability to develop spreadsheets and database management systems.
- **CO2** An ability to acquire proficiency in using environmental softwares.
- **CO3** An ability to use software to arrive at optimized solutions in design.

**Syllabus**

Study of Software for analysis & Design for water supply, Sewerage & GIS systems Such as loop, Branch, SewerGEM, EPANET, Aero Mod and Noise Mapping.
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<td>CE5031L</td>
<td>Project Implementation Laboratory</td>
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Course Outcome:

- CO1 Be able to prepare project feasibility study.
- CO2 Be able to prepare tender documents.
- CO3 Be able to analyze project performance.

The laboratory shall include discussion and assignments to cover

- Preparation of project feasibility study
- Estimation of life cycle costs for projects
- Economic appraisal of projects
- Funding of the projects
- Selection of tender type and tendering procedure
- Prepare general conditions of contract
- Prepare material, workmanship & performance specifications
- Evaluation of bids and award of work
- Evaluation of project plans
- Monitoring project performance
- Processing change orders, extras and variations
- Resolution of disputes

Recommended books and journals etc.

- Patil B S, Legal Aspects of Building & Engineering Contracts
- Gajaria, Indian contract Act
- Fisk E R, Construction Project Administration, Wiley
- All referred bare Acts
- Model Concession Agreement, FIDIC Volumes, Model tender documents of Planning Commission
## Technical Seminar

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**Course Outcome:**

- **CO1** Be able to understand the reading, understanding the research paper and able to develop skill to summarize it with optimum words.
- **CO2** Be able to give presentation on allotted research topic.
- **CO3** Be able to recognize the need for lifelong learning.

**Technical Seminar**

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.

**Recommended books and journals etc.**

Any National and International Journal of Impact Factor 1.5 and above

1. Journal of Institute of Engineers
2. Journal of Indian Water Works Association
3. Journal of Environmental Health and Management
4. Journal of Environmental Engineering and Science