

Department of Civil Engineering
Ph.D. Course Work
(Applicable for the scholars admitted from the AY: 2024-25)

The credit requirement for the Ph.D. course work is a minimum of 12 credits including the courses on ‘Research Methodology’ and ‘Research and Publication Ethics’ for 2 credits each. The candidate must complete two domain-specific courses of 3 credits each, recommended by the respective Department Research Committee (DRC). These courses can be completed through MOOCs.

The candidate must present two research seminars before the completion of course work, typically within the first year. The first research seminar shall be before the end of first semester on introduction to the proposed research work, and the second seminar shall be before the end of the second semester or after the completion of course work on the research proposal, as per the format provided. Each research seminar will have one credit weightage. The course structure is presented in Table 1 and list of domain-specific courses is presented in Table 2.

Table 1: Course Structure

S.No.	Course Code	Name of the Course	Credit (s)
1	246UC001	Research Seminar -I	1
2	246UC002	Research Seminar -II	1
3	246UC003	Research Methodology	2
4	246UC004	Research and Publication Ethics	2
5	-	Domain Specific Course -I	3
6	-	Domain Specific Course -II	3
Total			12

Table 2: List of Domain-Specific Courses

S. No.	Course Code	Name of the Course
1	246CE001	Advanced Concrete Technology
2	246CE002	Finite Element Methods
3	246CE003	Experimental Techniques and Instrumentations
4	246CE004	Structural Health Monitoring
5	246CE005	Techniques of Material Characterization
6	246CE006	Pavement Analysis and Design
7	246CE007	Advanced Highway Materials
8	246CE008	Computational techniques in WRE
9	246CE009	Ship Hydrodynamics
10	246CE010	Advanced water and wastewater treatment
11	246CE011	Solid and hazardous waste management
12	246CE012	Advanced Reinforced Concrete Design
13	246CE013	Earthquake Resistant Design of Buildings
14	246CE014	Soil Exploration and Field Testing
15	246CE015	Soil Properties and Behavior
16	246CE016	Highway Traffic Analysis and Design
17	246CE017	Geometric Design of Transportation Facilities
18	246CE018	Free Surface Flow
19	246CE019	Hydraulics of Alluvial Rivers
20	246CE020	Environmental Legislation
21	246CE021	Air and Noise Pollution Control Engineering
22	246CE022	Emerging Contaminants in Water and Wastewater
23	246CE023	Theory of Engineered Cementitious Composites
24	246CE024	Geosynthetics and Reinforced Soil Structures

Research Methodology

Course Code: 246UC003

Unit -I: Research Design

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys. Case Studies.

Unit-II: Data Collection and Sources

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

Unit-III: Data Analysis and Reporting

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

Unit-IV: Intellectual Property Rights

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

Unit-V: Patents

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents.

Text Books:

1. Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, Sage Publications, 4th Edition, 2015.
2. Intellectual Property: A Very Short Introduction, Siva Vaidhyanathan, Oxford University Press, 2017.
3. Intellectual Property: 3 The Law of Trademarks, Copyrights, Patents, and Trade Secrets"Deborah E. Bouchoux, Cengage India, 4th Edition, 2013.

Reference Books:

1. Research methodology: an introduction for science & engineering students, Stuart Melville and Wayne Goddard, Juta Academic, 2nd Edition, 2014.
2. Research design: Qualitative, quantitative, and mixed methods approaches, Creswell, J.W. and Creswell, J.D., Sage publications, 2017.
3. Intellectual Property in New Technological Age, Robert P. Merges, Peter S. Menell, Mark A. Lemley, Clause 8 Publishing; Volume I: Perspectives, Trade Secrets & Patents; 2023.

Web Links:

1. <https://archive.nptel.ac.in/courses/121/106/121106007/>
2. https://onlinecourses.swayam2.ac.in/ntr24_ed08/preview

Research and Publication Ethics

Course Code: 246UC004

Unit-I: Philosophy & Ethics

Introduction to Philosophy: Definition, Nature & Scope, Concept, Branches

Ethics: Definition, Moral Philosophy, Nature of Moral Judgements & Reactions

Unit-II: Scientific Conducts

Ethics with respect to Science and Research, Intellectual Honesty & Research Integrity

Scientific Misconducts: Falsification, Fabrication & Plagiarism

Redundant Publications: Duplicate & Overlapping Publication, Salami Slicing, Selective Reporting & Misrepresentation of Data

Unit-III: Publication Ethics

Publication Ethics: Definition, Introduction and Importance

Best Practices/ Standard Setting Initiatives and Guidelines: COPE, WAVE, etc., Conflicts of Interest

Publication Misconduct: Definition, Concept, Problems that lead to unethical behaviour and vice-versa, types, Violation of Publication Ethics, Authorship and Contributorship, Identification of Publication Misconduct, Complaints and Appeals, Predatory Publishers and Journals

Unit-IV: Open Access Publishing

Open Access publications and Initiatives, SHERPA/ RoMEO online resource to check publisher copyright and self-achieving policies, Software tool to identify predatory publications developed by SPPU, Journal Finder/ Journal Suggestion tools viz. JANE, ELSEVIER, SPINGER, Journal suggester etc.

Unit-V: Publication Misconduct

Group Discussions:

Subject-specific Ethical issues, FFP, Authorship, Conflicts of Interest, Complaints and Appeals: Examples and fraud from India and Abroad

Software tools:

Use of Plagiarism software like Turnitin, Urkund and other open source software tools

Database and Research Metrics:

Database:

Indexing database, Citation database: web of science, Scopus etc.

Impact factor of journal as per journal citation report, SNIP, SJR, IPP, cite score

Metrics: h-index, g-index, i-10 index, AL metrics etc.

Text Books:

1. Philosophy in Science, Bird A, Routledge, 2006.
2. A Short History of Ethics, MacIntyre, London, 1967.

Reference Book:

1. Ethics in Science, Education and Governance, Indian National Science Academy, 2019.

Weblinks:

1. www.niehs.nih.gov/research/resources/bioethics/whatis
2. https://onlinecourses.swayam2.ac.in/nou22_ge73/preview

Course Code:246CE001

Unit-I: Concrete making materials

Cement, Types of cement – OPC, PPC, GGBFS – Grades of Cement, 33, 43 & 53–Bogues Compounds–Hydration Process–Types of Cement – Aggregates – Gradation Charts – Combined Aggregate – Alakali Silica Reaction – Admixtures – Chemical and Mineral Admixtures. Bureau of Indian Standards (BIS) Provisions.

Unit-II: Properties of concrete

Fresh Concrete: workability tests on Concrete–Setting Times of Fresh Concrete – Segregation and bleeding. Hardened concrete: Abrams Law, Gel space ratios, Maturity concept–Stress strain Behaviour – Creep and Shrinkage – Non Destructive Testing of Concrete. BIS Provisions. Durability of concrete: Factors affecting strength of concrete and Durability of concrete – Cracks in concrete – Chemical attacks carbonation.

Unit-III: High strength concrete

Microstructure – Manufacturing and Properties – Design of HSC Using Erintroy Shaklok method – Ultra High Strength Concrete.

High Performance Concrete – Requirements and Properties of High Performance Concrete – Design Considerations. BIS Provisions.

Unit-IV: Special concretes

Self-Compacting concrete, Polymer Concrete, Fibre Reinforced Concrete–Reactive Powder Concrete – Requirements and Guidelines – Advantages and Applications. Vacuum dewatering of concrete–Under water concreting

Concrete mix design: Quality Control–Quality Assurance–Quality Audit - Mix Design Method – BIS Method – IS.10262 – 2019 Concrete Mix proportion guidelines. DOE Method– Light Weight Concrete, Self-Compacting Concrete.

Unit-V: Form work

Materials – structural requests – form work systems – connections – specifications – design of form work – shores – removal for forms - shores – reshoring – failure of form work.

Text Books:

1. Concrete: Micro Structure, Properties and Materials by P. K. Mehta and P. J. Monteiro, Mc. Graw-Hill Publishing Company Ltd. New Delhi.
2. Concrete Technology by M.S. Shetty, S.Chand & Co.

Reference Books:

1. Concrete Technology by A. R. Santhakumar, 2nd Edition, Oxford University Press.
2. Design of Concrete Mixes by N. Krishna Raju, CBS Publications.

Weblinks:

1. <https://www.nachi.org/constituent-materials-concrete.htm>
2. <https://elearn.nptel.ac.in/shop/nptel/advanced-concrete-technology/?v=c86ee0d9d7ed>

Finite Element Methods

Course Code: 246CE002

Unit-I: Introduction

Review of stiffness method- Principle of Stationary potential energy-Potential energy of an elastic body- Rayleigh-Ritz method of functional approximation - variational approaches - weighted residual methods.

Unit-II: Finite Element Formulation of Truss Elements

Stiffness matrix- properties of stiffness matrix – Selection of approximate displacement functions-solution of a plane truss- transformation matrix and stiffness matrix for a 3-D truss- Inclined and skewed supports- Galerkin’s method for 1-D truss – Computation of stress in a truss element.

Unit-III: Finite Element Formulation of Beam Elements

Beam stiffness-assembly of beam stiffness matrix- Examples of beam analysis for concentrated and distributed loading- Galerkin’s method - 2-D Arbitrarily oriented beam element – inclined and skewed supports – rigid plane frame examples.

Unit-IV: Iso-Parametric Formulation

parametric bar element- plane bilinear isoparametric element – quadratic plane element - shape functions, evaluation of stiffness matrix, consistent nodal load vector - Gauss quadrature- appropriate order of quadrature – element and mesh instabilities – spurious zero energy modes, stress computation- patch test.

Unit-V: Finite Element Formulation

Plane stress, plane strain and axisymmetric problems- Derivation of CST and LST stiffness matrix and equations-treatment of body and surface forces-Finite Element solution for plane stress and axisymmetric problems- comparison of CST and LST elements –convergence of solution- interpretation of stresses

Text books:

1. An introduction to Finite Element Method, JN Reddy, McGraw Hill.
2. Introduction to Finite Elements in Engineering, Tirupati R.Chandrupatla, Ashok D.Belgunda, PHI publications.

Reference Books:

1. Finite Element Method with applications in Engineering, YM Desai, Eldho & Shah, Pearson publishers.
2. Rao.S.S, Finite Element Method in Engineering, Butterworth–Heinmann

Weblinks:

- 1 <http://nptel.ac.in/courses/112104116/>
- 2 file:///C:/Users/User/Downloads/Finite_Elemente-Book.pdf

Experimental Techniques and Instrumentations

Course Code:246CE003

Unit-I: Strain Gauges

Mechanical strain gauge – optical strain gauge – electrical resistance strain gauge - description and operation – inductance and capacitance strain gauges-strain rosettes – measurement of static and dynamic strain – effect of transverse strains –use of strain recorders and load cells – calibration of testing machines

Unit-II: NDT Methods

Load testing towers - brittle coating method - Moire fringe method- Ultra sonic pulse velocity technique - Rebound hammer method - X-ray method - Gamma ray method - corrosion measurements - linear polarization resistance - rapid chloride ion penetration test-open circuit potential measurements –Electrical impedance spectroscopy

Unit-III: Model Analysis

Structural similitude – use of models –structural and dimensional analysis – Buckingham pi theorem – Muller Breslau’s principle for direct and indirect analysis – use of Begg Eny’s deformer– moment indicators – design of models for direct and indirect analysis.

Unit-IV: Distress Measurements

Diagnosis of distress in structures - crack observation and measurement cracking due to corrosion of reinforcement in concrete construction and use - Damage assessment - controlled blasting for demolition.

Unit-V: Vibration Measurements

LVDT(linear variable differential transducer) –transducers for velocity and acceleration measurement vibration meter – seismographs – vibration analyser –display and recording signals –cathode ray oscillography – XY plotter - chart plotter – digital acquisition systems.

Text Books:

1. Experimental Methods for Engineers by J.P. Holman
2. Theory and Design for Mechanical Measurements by Richard S. Figliola and Donald E. Beasley
3. Introduction to Instrumentation and Measurements by Robert B. Northrop

Reference Books:

1. Dally J. W. & Riley W.F , “Experimental Stress Analysis”, McGraw Hill Book Company, New York , USA.
2. Dove.R.C. & Aedams .P.H, “Experimental Stress Analysis and Motion measurements”, Prentice Hall of india Ltd ,NewDelhi.

Weblinks:

1. <https://theconstructor.org/structural-engg/basic-concepts-stability-structure/ 1887>
2. <https://www.engbookspdf.com/uploads/pdfbooks/PrinciplesofStructuralStabilityTheoryCivilEngineeringandEngineeringMechanicsSeriescompressed-1.pdf>

Structural Health Monitoring

Course Code:246CE004

Unit-I: Structural Health:

Factors affecting Health of Structures, Causes of distress, Regular Maintenance. Structural Audit: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures.

Unit-II: Structural Health Monitoring:

Concept, Various Measures, Structural Safety in Alteration Structural Audit: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures

Unit –III: Dynamic Field Testing-I:

Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods,

Unit-IV: Dynamic Field Testing-II:

Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.

Unit-V: Introduction to Repairs and Rehabilitations of Structures:

Case Studies (Site Visits), Piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique.

Text Books:

1. Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes, John Wiley and Sons, 2006.
2. Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, John Wiley and Sons, 2007.

Reference Books:

1. Structural Health Monitoring and Intelligent Infrastructure, Vol1, J. P. Ou, H. Li and Z. D.Duan, Taylor and Francis Group, London, UK.
2. Structural Health Monitoring with Wafer Active Sensors, Victor Giurgutiu, Academic Press Inc.

Weblinks:

1. [https://www.iitk.ac.in/ce/test/MoHUPA%20Presentation Dr.K%20Roy%20 %20 Dr.S.Mukhopadhy.pdf](https://www.iitk.ac.in/ce/test/MoHUPA%20Presentation%20Dr.K%20Roy%20%20Dr.S.Mukhopadhy.pdf)
<https://lecturenotes.in/subject/1397/structural-health-monitoring-and-rehabilitation>
2. <https://nptel.ac.in/courses/112/104/112104160/>

Techniques of Material Characterization

Course Code:246CE005

Unit – I: Introduction to Materials and Techniques

Structure analysis tools, X-ray diffraction: phase identification, indexing and lattice parameter determination, Analytical line profile fitting using various models, Neutron diffraction, Reflection High Energy Electron Diffraction, and Low Energy Electron Diffraction

Unit – II: Microscopy Techniques

Optical microscopy, transmission electron microscopy (TEM), energy dispersive X-ray microanalysis (EDS), scanning electron microscopy (SEM), Rutherford backscattering spectrometry (RBS), atomic force microscopy (AFM) and scanning probe microscopy (SPM)

Unit – III: Thermal Analysis Technique

Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC), Thermogravimetric analysis (TGA); Electrical characterization techniques: Electrical resistivity, Hall effect, Magnetoresistance

Unit – IV: Magnetic Characterization Techniques

Introduction to Magnetism, Measurement Methods, Measuring Magnetization by Force, Measuring Magnetization by Induction method, Types of measurements using magnetometers: M-H loop, temperature-dependent magnetization, time-dependent magnetization, Measurements using AC susceptibility, Magneto-optical Kerr effect, Nuclear Magnetic Resonance, Electron Spin Resonance;

Unit – V: Optical and Electronic Characterization Techniques

UV-VIS Spectroscopy, Fourier Transform Infrared Spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy.

Text Books:

1. Characterization of Materials (Materials Science and Technology: A Comprehensive Treatment, Vol 2A & 2B, VCH (1992).
2. Semiconductor Material and Device Characterization, 3rd Edition, D. K. Schroder, Wiley-IEEE Press (2006).

Reference Books:

1. Materials Characterization Techniques, S Zhang, L. Li and Ashok Kumar, CRC Press (2008).
2. Physical methods for Materials Characterization, P. E. J. Flewitt and R K Wild, IOP Publishing (2003).

Weblinks:

1. <https://archive.nptel.ac.in/courses/113/106/113106034/>
2. <https://archive.nptel.ac.in/courses/113/105/113105101/>

Pavement Analysis and Design

Course Code:246CE006

Unit – I: Introduction

Types of pavements, Factors affecting design and performance of pavements. Highway and airport pavements, functions of pavement components.

Unit – II: Pavement Design Factors

Design wheel load, strength characteristics of pavement materials, climatic variations, traffic - load equivalence factors and equivalent wheel loads, aircraft loading, gear configuration and tyre pressure. Drainage – Estimation of flow, surface drainage, sub-surface drainage systems, design of sub-surface drainage structures

Unit – III: Flexible Pavement Design

Empirical, semi-empirical and theoretical approaches, design of highway and airport pavements by IRC, AASHTO Methods, applications of pavement design software

Unit – IV: Rigid Pavement Design

Types of joints and their functions, joint spacing; design of CC pavement for roads, highways and airports as per IRC, AASHTO, design of joints. Design of continuously reinforced concrete pavements. Reliability; Use of software for rigid pavement design

Unit – V: Pavement Management

Pavement failures, maintenance of highways, structural and functional condition evaluation of pavements, pavement management system.

Text Books:

1. Yoder and Witczak, Principles of Pavement Design, John Wiley and Sons
2. Yang. H. Huang, Pavement Analysis and Design, Second Edition, Prentice Hall Inc

Reference Books:

1. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering – Principles and Practice, CRC Press (Taylor and Francis Group)
2. W.Ronald Hudson, Ralph Haas and Zeniswki , Modern Pavement Management, Mc Graw Hill and Co

Weblinks:

1. <https://nptel.ac.in/courses/105104098>
2. <https://archive.nptel.ac.in/courses/105/106/105106221/>

Advanced Highway Materials

Course Code:246CE007

Unit – I: Aggregate

Nature and properties – aggregate requirements – types and processing – aggregates for pavement base – aggregate for bituminous mixture – aggregate for Portland Cement Concrete – lightweight aggregate – tests on aggregate – specification.

Unit – II: Bituminous Materials

Conventional and modified binders – production – types and grade – physical and chemical properties and uses – types of asphalt pavement construction – principles of bituminous pavement construction – tests on bituminous materials. Bituminous Mix design – modified mixtures – temperature susceptibility and performance.

Unit – III: Cement /concrete based materials

Cement – properties – PCC mix design and properties – modified PCC – Mix Design – Behavior – Performance – Tests on Cement and Concrete mixes. High Performance Concrete – low shrinkage – increased strength.

Unit – IV: Composites, Plastics and Geosynthetics

Plastics and polymerization process – properties – durability and chemical composition – Reinforced Polymer Composites – Geosynthetics – Dry Powdered Polymers – Enzymes.

Unit – V: Reclaimed / Recycled Waste Products

Reclaimed Materials – waste products in civil engineering applications – effect of waste products on materials, structure and properties – self healing and smart materials – locally available materials

Text books:

1. P. T. Sherwood, Alternative Materials in Road Construction, Thomas Telford Publication, London, 1997.
2. RRL, DSIR, Soil Mechanics for Road Engineers, HMSO, London , 1995.

Reference Books:

1. Koerner, R. M. Designing with Geosynthetics, Prentice Hall, Englewood Cliffs, New Jersey, U.S.A.
2. Shan Somayaji, Civil Engineering Materials, second edition, Prentice Hall Inc., 2001.

Weblinks:

1. <https://archive.nptel.ac.in/courses/105/102/105102012/>
2. <https://archive.nptel.ac.in/courses/105/106/105106203/>
3. <https://archive.nptel.ac.in/courses/105/102/105102012/>
4. <https://archive.nptel.ac.in/courses/105/106/105106052/>

Computational Techniques in Water Resources Engineering

Course Code:246CE008

Unit-I: Introduction

Computational Techniques, Database design, Spreadsheet.

Unit-II: Statistical Techniques

Presentation of data, Measures of location and dispersion, Probability concepts and distribution, Tests of significance, Correlation and Regression, Selection of suitable statistical technique.

Unit-III: Numerical Methods

Finite difference schemes, Method of characteristics, Finite element method, Finite volume method.

Unit-IV: Hydro-Informatics

Introduction, Genetic Algorithm, Artificial Neural Network, Fuzzy Logic, Other data driven methods, Virtual institute, Web based hydro informatics system

Unit-V: Applications

Application with case studies, Selection of suitable computational technique, Different types of hydraulic engineering software: Salient features, Capabilities and limitations.

Text Books:

1. Abbott, M. B., “Hydro informatics: Information Technology and the Aquatic Environment”, Avebury Technical, Aldershot, 1991.
2. Chaudhry, M.H., “Open Channel Flow”, Springer Science, New York, 2007(Second Edition).

References Books:

1. Grewal, B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 2015 (44th Edition).
2. Govindaraju, R. S., and Rao, A. R., (eds.) “Artificial Neural Networks in Hydrology”, Springer, 2010(2000 Edition).

Weblinks:

1. [Soft Computing in Water Resources Engineering \(witpress.com\)](http://witpress.com)
2. [High-performance computing in water resources hydrodynamics | Journal of Hydroinformatics | IWA Publishing \(iwaponline.com\)](http://www.iwaponline.com)

Ship Hydrodynamics

Course Code:246CE009

Unit – I: Flow over Circular Cylinder with and Without Circulation.

Continuity, Euler, Laplace, Navier-Stokes (N-S) and Bernoulli equations; Divergence and Stokes theorems; Potential flow and stream function; Elementary potential flows: parallel flow / source and sink (2D & 3D) sink / vortex / doublet, flow over circular cylinder with and without circulation.

Unit – II: Unsteady Flow around the Circular Cylinder.

Circulation and Stokes theorem (2D & 3D). D’Alembert’s paradox; Unsteady flow past circular cylinder and sphere: added mass; Lifting surfaces; Foil section characterizations; Flow around a foil: generation of lift.

Unit – III: Boundary Layer Separation over Streamlined Bodies.

N-S equations to Prandtl boundary layer (BL) equations by order of magnitude analysis; Dynamic similarity and boundary conditions; Laminar flow, BL thickness, displacement and momentum thicknesses; BL separation, bluff and streamlined bodies.

Unit – IV: Karman Vortex Street and Vortex Shedding Frequency.

Vortex shedding by cylinders, Karman vortex street, role of Strouhal no.; Vortex induced vibration; Skin friction, BL along a flat plate at zero incidence, its solution; Blasius formula; Plane Couette flow and Poiseuille flow; Impulsively started plate; Momentum integral equation of BL.

Unit – V: Characteristics of Turbulent Flow.

Characteristics of turbulent flow; Drag crisis in circular cylinder and sphere; Friction due to turbulent BL over flat plate, power law, roughness effect.

Text Books:

1. V.Betram, Practical Ship Hydrodynamics, B&H, 2000
2. O.M.Faltinsen, Hydrodynamics of High Speed marine Vehicles, Cambridge Press, 2005

Reference Books:

1. Thomas Lamp: Ship Design and Control Vol I & II, SNAME.
2. Principles of Naval Architecture, E. V. Lewis (Ed.), SNAME Publications, 1989

Weblinks:

1. [Numerical Ship and Offshore Hydrodynamics - Course \(nptel.ac.in\)](https://nptel.ac.in/courses/246/CE009/)
2. [NPTEL :: Ocean Engineering - Marine Hydrodynamics](https://nptel.ac.in/courses/246/CE009/)

Advanced Water and Wastewater Treatment

Course Code:246CE010

Unit I: Physical and Chemical Treatment:

Screening, Grit removal, Aeration and gas transfer, Application of Membrane Processes, Reverse Osmosis, Micro-filtration, Nano-filtration, Ultrafiltration and Electrodialysis Chemical precipitation, other solids removal operations, Control of odour, Control of volatile organic compounds.

Unit II: Theory of Sedimentation

Flocculent particle settling – theory of coagulation and flocculation- zeta potential - Filtration - theory of granular media filtration – head loss cleaning of filter media - backwash hydraulics – Theory of chlorination – equilibrium constants.

Unit III: Principles, Objectives of biological treatment significance

Aerobic and anaerobic treatment kinetics of biological growth - factors affecting growth – attached, suspended and Hybrid growth systems. Determination of kinetic coefficients for organics removal – Biodegradability assessment – selection of process – reactors – batch & continuous type

Unit IV: Aerobic Treatment of Wastewater

Design and construction aspects and the relevant parameters of significance of the units: Activated Sludge Process, Trickling Filters, Aerated Lagoons, Rotating Biological Contactors, Sequential Batch Reactors (SBR), Stabilization ponds, Hybrid reactors for the treatment of wastewater :- IFAS, MBBR, MBR, Expanded / fluidized bed bio reactors

Unit V: Anaerobic Treatment of Wastewater

Sludge handling and treatment -Sludge digestion: theory and principles - Disposal of digested sludge, Anaerobic ponds, UASB reactors and various modifications in UASB process and anaerobic filters. Two stage /phase reactors – biogas generation.

Text books:

1. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw-Hill edition, 2018.
2. Elements of Environmental Engineering, K.N. Duggal, S.Chand& Company Ltd. New Delhi, 2012.

Reference Books:

1. Environmental Engineering-II: Sewage disposal and Air pollution Engineering, Garg & S.K., Khanna Publications.
2. Environmental Engineering by D. Srinivasan, PHI Learning private Limited, New Delhi, 2011

Weblinks:

1. [Water and Wastewater Treatment Engineering | Civil and Environmental Engineering | MIT OpenCourseWare](#)
2. [UTS: 42991 Advanced Water and Wastewater Treatment - Engineering, UTS Handbook](#)

Solid and Hazardous Waste Management

Course Code:246CE011

Unit I: Introduction

Definition of solid waste – waste generation, sources and types of solid waste – sampling and characterization – Determination of composition of Municipal Solid Waste – Onsite storage and handling of solid waste. Collection and Transport of Solid Waste: Type and methods of waste

Unit II: Collection systems

Analysis of collection system Optimization of collection routes– alternative techniques for collection system. Transfer and Transport: Need for transfer operation, transport means and methods, transfer station types and design requirements. Separation and Processing and Transformation of Solid Waste- Waste as a Resource Economics, Disposable Materials, Recycling Collection, Processing, Potential for Reuse

Unit III: Processing and disposal

Unit operations used for separation and processing, Materials Recovery facilities, Source reduction and waste minimization, Metal Separation & Recovery Waste transformation through combustion and composting, anaerobic methods for materials recovery and treatment – Energy recovery – biogas generation and cleaning– Incinerators. Landfills: Site selection, design and operation, drainage and leachate collection systems –designated waste landfill remediation.

Unit IV: Hazardous Waste Management

Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waste regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport, e-waste -sources, collection, treatment and reuse.

Unit V: Hazardous waste treatment technologies

Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste – Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation – remediation of hazardous waste disposal sites.

Text books:

1. Integrated Solid Waste Management: Engineering Principles and Management Issues by George Tchobanoglous , Hilary Theisen, Samuel A Vigil. McGraw-Hill Series in WaterResources and Environmental Engineering
2. Environmental Engineering by Howard S.Peavy, Donald R.Rowe and George Tchobanognous, McGraw Hill Publishing Company.

Reference Books:

1. Hazardous Waste Management, Charles A. Wentz; McGraw Hill Publication,
2. Solid and Hazardous Waste Management by MN Rao, Razia Sultana, BSP Books

Weblinks:

1. [Water and Wastewater Treatment Engineering | Civil and Environmental Engineering | MIT OpenCourseWare](#)

Advanced Reinforced Concrete Design

Course Code:246CE012

Unit–I: Limit analysis of R C structures

Rotation of a plastic hinge, Redistribution of moments, moment rotation characteristics of RC member, I.S. code provisions, loading pattern, Bending Moment Envelop, Application for Fixed Beams and Continuous Beams. Inelastic Analysis of Slabs, Moment Redistribution.

Unit–II: Yield line analysis for slabs

Yield line criterion – Virtual work and equilibrium methods of analysis – For square circular, Rectangular, Triangular and Hexagonal with simple and continuous end conditions.

Unit–III: Ribbed slabs

Analysis of the Slabs for Moment and Shears, Ultimate Moment of Resistance, Design for shear, Deflection, Arrangement of Reinforcements.

Flat slabs:

Direct design method – Distribution of moments in column strips and middle strip-moment and shear transfer from slabs to columns – Shear in Flat slabs-Check for one way and two way shears-Introduction to Equivalent frame method. Limitations of Direct design method, Distribution of moments in column strips and middle strip sketch showing reinforcement details.

Unit–IV: Design of reinforced concrete deep beams & corbels

Steps of Designing Deep Beams, Design by IS 456. Checking for Local Failures, Detailing of Deep Beams, Analysis of Forces in a Corbels, Design of Procedure of Corbels, Design of Nibs. Detailing of reinforcement.

Unit–V: Design of slender columns

Slenderness limits, Methods of Design of Slender Columns, Additional Moment Method, Procedure for Design of Slender Columns. Detailing of reinforcement. Eccentrically loaded columns, Development of interaction Diagrams.

Text Books:

1. Advanced Reinforced Concrete Design, by P.C. Varghese Prentice Hall India Limited.
2. Design of Reinforced Concrete Structures by N.Subramanian, Oxford University Press.

Reference Books:

1. Concrete Technology by A. R. Santhakumar, 2nd Edition, Oxford University Press.
2. Design of Concrete Mixes by N. Krishna Raju, CBS Publications.

Weblinks:

1. <https://nptel.ac.in/courses/105106176/>
2. <https://lecturenotes.in/subject/179/design-of-advanced-concrete-structures-dacs>

Earthquake Resistant Design of Buildings

Course Code:246CE013

Unit-I: Engineering seismology

rebound theory – plate tectonics – seismic waves - earthquake size and various scales – local site effects – Indian seismicity – seismic zones of India – theory of vibrations – near ground and far ground rotation and their effects.

Unit-II: Seismic design concepts

EQ load on simple building – load path – floor and roof diaphragms – seismic resistant building architecture – plan configuration – vertical configuration – pounding effects – mass and stiffness irregularities – torsion in structural system- Provision of seismic code (IS 1893 & 13920) – Building system – frames – shear wall – braced frames – layout design of Moment Resisting Frames
(MRF) – ductility of MRF – Infill wall – Non- structural elements.

Unit-III: Calculation of EQ load

3D modeling of building systems and analysis (theory only) Design and ductile detailing of Beams and columns of frames Concept of strong column weak beams, Design and ductile detailing of shear walls.

Unit-IV: Cyclic loading behavior of RC

Steel and pre- stressed concrete elements - modern concepts-Base isolation – Adaptive systems – case studies.

Unit-V: Retrofitting and restoration of buildings

Subjected to damage due to earthquakes- effects of earthquakes – factors related to building damages due to earthquake- methods of seismic retrofitting- restoration of buildings.

Text Books:

1. Earthquake Resistant Design of Structures Pankaj Agarwal and Manish ShriKhande, Prentice – Hall of India, New Delhi.
2. Earthquake Resistant Design of Structures- S.K. Duggal, Oxford Publications

Reference Books:

1. Seismic design of reinforced concrete and masonry buildings by Paulay and Priestley.
2. Earthquake Resistant Design and Risk Reduction- David Dowrick.
3. IS 4326 -1998: Earthquake Resistant Design and Construction of Buildings.

Weblinks:

1. <http://nptel.ac.in/courses/105105104/pdf/m16139.pdf>.
2. <https://www.slideshare.net/mvm2594/earthquake-resistant-designs-12158375>.

Soil Exploration and Field Testing

Course Code:246CE014

Unit-I: Scope and objectives - planning an exploration program

Methods of exploration - exploration for preliminary and detailed design - spacing and depth of bores - data presentation - Geophysical exploration and interpretation - seismic and electrical methods - cross bore hole, single bore hole - up hole - down hole methods.

Unit-II: Methods of boring and drilling

Non-displacement and displacement methods - drilling in difficult subsoil conditions - limitations of various drilling techniques, stabilization of boreholes - bore logs.

Unit-III: Sampling Techniques:

Quality of samples - factors influencing sample quality - disturbed and undisturbed soil sampling advanced sampling techniques, offshore sampling, shallow penetration samplers, preservation and handling of samples.

Unit-IV: Field tests

Penetration tests - Field vane shear - Insitu shear and bore hole shear test - pressuremeter test - Dilatometer test - plate load test - monotonic and cyclic; field permeability tests - block vibration test limitations - correction and data interpretation of all methods.

Unit-V: Instrumentation in soil engineering

strain gauges, resistance and inductance type, load cells, earth pressure cells, settlement and heave gauges, pore pressure measurements - slope indicators, sensing units, case studies.

Text Books:

1. GopalRanjan and Rao, A.S.R, Basic and Applied Soil Mechanics, Wiley Eastern Limited
2. Bowles, J.E, Foundation Analysis and Design, McGraw-Hill International edition, 1997.

References Books:

1. Bowles, J.E, Physical and Geotechnical Properties of Soil, McGraw-Hill Book Company
2. Compendium of Indian Standards on Soil Engineering Parts 1 and II 1987 – 1988. All related ASTM codes and Eurocode 7 - Part 2.

Weblinks:

1. <https://archive.nptel.ac.in/courses/105/105/105105168/>
2. <https://archive.nptel.ac.in/courses/105/101/105101201/>

Soil Properties and Behaviour

Course Code:246CE015

Unit-I: Introduction

formation of soils - different soil deposits and their engineering properties - Genesis of clay minerals -identification and classification - Anion and cation exchange capacity of clays - specific surface area - bonding in clays.

Unit-II: Physical and physio-chemical behaviour of soils

Diffused double layer theory - computation of double layer distance - effect of ion concentration, ionic valency, pH, dielectric constant, temperature on double layer - stern layer- attractive and repulsive forces in clays - types of soil water mechanism of soil - water interactions - soil structure.

Unit-III:

Problems associated with swelling and shrinkage behaviour of soils -Causes, consequences and mechanisms factors influencing swell - shrink characteristics swell potential osmotic swell pressure soil fabric and measurement - sensitivity, thixotropy of soils - soil suction - soil compaction - factors affecting soil compaction.

Unit-IV:

Compressibility, shear strength and permeability behaviour of fine and coarse grained soils mechanisms and factors influencing engineering properties - liquefaction potential - causes and consequences.

Unit-V:

Conduction in soils - hydraulic, electrical, chemical and thermal flows in soils - applications - coupled flows - Electro-kinetic process - thermo osmosis - electro osmosis - prediction of engineering behaviour of soils using index properties - empirical equations and their applicability.

Text Books:

1. Das, B.M., Principles of Geotechnical Engg, PWS Publishing Comp, Boston
2. McCarthy D.F., Essentials of Soil Mechanics & Foundations, Prentice-Hall

References Books:

1. Mitchell, J.K., Fundamentals of Soil Behaviour, John Wiley, New York, 1993.
2. Yong, R.N. and Warkentin, B.P., Introduction to Soil Behaviour, Macmillan, Limited, London, 1979.

Weblinks:

1. <https://archive.nptel.ac.in/courses/105/103/105103207/1>

Highway Traffic Analysis and Design

Course Code:246CE016

Unit – I: Elements of Traffic Engineering

Road user, vehicle and road way. Vehicle characteristics - IRC standards - Design speed, volume. Highway capacity and levels of service - capacity of urban and rural roads - PCU concept and its limitations - Road user facilities - Parking facilities - Cycle tracks and cycleways - Pedestrian facilities.

Unit – II: Traffic volume studies

Origin-destination studies, speed studies, travel time and delay studies, Parking studies, Accident studies.

Unit – III: Elements of design

Alignment - Cross-sectional elements - Stopping and passing sight distance. Horizontal curves - Vertical curves. Design problems – Hill Roads.

Unit – IV: Traffic regulation and control

Signs and markings - Traffic System Management - Design of at-grade intersections – Principles of design – Channelization - Design of rotaries - Traffic signals - pre-timed and traffic actuated. Design of signal setting - phase diagrams, timing diagram – Signal co-ordination.

Unit – V: Grade-separated intersections

Geometric elements for divided and access-controlled highways and expressways – Road furniture - Street lighting. Traffic Safety – Principles and Practices – Road Safety Audit.

Text Books:

1. ITE Hand Book, Highway Engineering Hand Book, Mc Graw - Hill.
2. AASHTO A Policy on Geometric Design of Highway and Streets

Reference Books:

1. R. J. Salter and N. B. Hounsel, Highway Traffic Analysis and Design, Macmillan Press Ltd, 1996.
2. Yang H, Huang, Pavement analysis and design, Pearson, 2008

Weblinks:

1. <https://archive.nptel.ac.in/courses/105/101/105101008/>
2. <https://archive.nptel.ac.in/courses/105/105/105105215/>
3. <https://archive.nptel.ac.in/courses/105/104/105104098/>

Geometric Design of Transportation Facilities

Course Code:246CE017

Unit – I: Geometric Design of Highway Facility

Elements of geometric design, design considerations, factors affecting design, performance-based geometric design, alignment and topography, design of horizontal alignment, reverse and compound curves, design of vertical curves, tangent grade, controls and criteria for expressway, landscaping, freeway and multilane highways and expressways criteria, weaving segments configurations and ramp roadways, auxiliary lanes, and design practices.

Unit – II: Geometric Design of Intersections

Design considerations, factors affecting the design of elements, intersections geometric suitability, alignment, and profile, functional and physical area, data requirement, types of turning roadway, curb radii and turning path, pedestrian considerations in design, design of channelization, median opening and islands, rotary and modern roundabout design, auxiliary lanes at intersection, ramp roadways and weaving segment design examples.

Unit – III :Design of Street Lighting

Definitions and background, pavement luminance and measurement, illumination level, Veiling Luminance, longitudinal uniformity, utilization factor, depreciation factor, maintenance factor, traffic criteria, warranting conditions, and design practices.

Unit – IV: Pedestrian Facilities, Parking Facilities

Elements of pedestrian facility design, sign of pedestrian facility at junctions, street and corner, pedestrian signals, design examples, Parking influencing factors, types, parking angles and aisle width, on-street parking design, various parking layouts and vehicle circulation, design of off-street parking facilities.

Unit – V: Traffic Interchanges and Terminals

Classification and types, layouts of interchange, warrants, design elements, Interchange evaluation based on delay, Cross-section design of logistic terminals, elements, Location considerations terminal concourse, cross-section design elements, terminal concourse, multiple interchange and vertical separation, traffic circulation, multiple interchange and vertical separation, traffic circulation, design examples.

Text Books:

1. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, 2024, 9th Edition.
2. Partha Chakraborty, Animesh Das; Principles of Transportation Engineering, PHI Learning, 2017, 2nd Edition.

Reference Books:

1. Fred L. Mannering, Scott S. Washburn; Principles of Highway Engineering and Traffic Analysis, Jhon Wiley & Sons, 2019, 7th Edition.
2. NASEM, TRB, Highway Capacity Manual: A Guide for Multimodal Mobility Analysis, The National Academies Press, Washington, DC, 2022, 7th Edition.
3. C. Jotin Khisty, B Kent Lall; Transportation Engineering: An Introduction, Pearson Education India, 2016, 3rd Edition.

Weblinks:

1. <https://nptel.ac.in/courses/105/101/105101008>
2. <https://nptel.ac.in/courses/105/104/105104098>
3. <https://www.crridom.gov.in/sites/default/files/Indo-HCM%20Snippets.pdf>
4. <https://www.monash.edu/engineering/its/publications/tem2017>

Free Surface Flow

Course Code:246CE018

Unit-I: Uniform Flow

Specific energy curve and its limitations, critical depth and section factor for critical and uniform flow computations, open channel flow transitions, standing wave, venturi flumes, control sections and hydraulic exponent for critical and uniform flow computations.

Unit-II: Non-Uniform Flow

Assumptions in GVF analysis, dynamic equation of GVF, classification of channel slopes, GVF profiles, its identification and computation, applications, Specific force curve and its application in the analysis of hydraulic jump, hydraulic jump characteristics.

Unit-III: Spatially Varied Flow

Basic principles and assumptions, differential equations, analysis of flow profiles and flow through side weirs and bottom racks.

Unit-IV: Unsteady Flow

Waves, classification of waves, waves celerity, occurrences of unsteady flow, height and celerity of gravity waves, governing equations for one dimensional flow, St. Venant equations and numerical methods.

Unit-V: Unsteady Flow Numerical Methods

Method of characteristics, Finite difference methods, explicit and implicit finite difference schemes, consistency, stability.

Text Books:

1. Subramanya, K., "Flow in open channels", Fifth edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2019.
2. Srivastava,R., "Flow through open channels", Oxford Higher Education, Oxford University Press, 2007.

Reference Books:

1. Chaudhary, H. M., "Open Channel flow", Springer, 2007(Second Edition).
2. Chow, V. T., "Open Channel Hydraulics",The Blackburn Press, 2009 Edition

Weblinks:

1. [Hydrology and Free Surface Flows - my.UQ - The University of Queensland, Australia](#)
2. [Fundamentals of Fluid-Solid Interactions | Coursera](#)

Hydraulics of Alluvial Rivers

Course Code:246CE019

Unit-I: Properties and Incipient Motion of Sediments

Nature of sediment problems, Origin and formation of sediments, individual and bulk properties of sediments, competent velocity, lift force and critical tractive stress concept on cohesion less and cohesive soils; regimes of flow.

Flow Resistance: Resistance to flow in alluvial streams, resistance relations based on total resistance and division of resistance into grain and form resistance, preparation of stage discharge curves for alluvial streams, velocity distribution in alluvial channel, sediment Petrography (Sediment sampling)

Unit-II: Bed Load Transportation

Bed load computation by empirical equations, dimensional considerations and semi theoretical equations for uniform and non-uniform sediments, saltation.

Unit-III: Suspended Load Transportation

Mechanism of suspension, general equations of diffusion. Integration of sediment distribution equation, Differences between actual and theoretical exponents, prediction of reference concentration, Method of integrating curves of concentration and velocity. Simple relations for suspended load, Effect of temperature on suspended load, Wash load, Non-equilibrium transport of suspended load, Computation of total loads.

Unit-IV: Stable Channel Design

Design of lined and unlined channels for carrying clear and sediment-laden water.

Unit-V: Alluvial River Models

Hydraulic geometry of alluvial streams, bed level variation of alluvial streams, aggradations and degradation models and local scour

Text Books:

1. Shen,H.W.,“River Mechanics”,Water Resources Publication, Colorado, 1971.
2. Garde, R. J., and Ranga Raju, K. G., “Mechanics of Sediment transportation and Alluvial Stream Problems”, New Age International (P) Limited, New Delhi, 2000 (Third edition).

Reference Books:

1. Garde, R. J., “River Morphology”, New Age International Publisher, New Delhi, 2006.
2. Yalin, M.S., “Mechanics of Sediment Transport”, Pergamon Press, Oxford (U K),1977.

Weblinks:

1. [Introduction to Fluid Motions, Sediment Transport, and Current-Generated Sedimentary Structures | Earth, Atmospheric, and Planetary Sciences | MIT OpenCourseWare](#)

Environmental Legislation

Course Code:246CE020

Unit I: Introduction

Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – National and International multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration etc – Institutional framework (SPCB/CPCB/MOEF) – Supreme Court Judgments in Landmark cases

Unit II :Water (P & CP) Act, 1974

Power & functions of regulatory agencies - responsibilities of Occupier, Provision relating to prevention and control, Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

Unit III: Air (P & CP) Act, 1981

Power & functions of regulatory agencies - responsibilities of Occupier, Provision relating to prevention and control, Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

Unit IV: Environment (Protection) Act 1986

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

Unit V: Other Acts & Management Systems

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Fundamentals of Environmental Management and ISO 14000 series - principles and elements. The ISO 14001- Environmental management systems standards.

Text books:

1. Environmental law and enforcement by Greger I. Megregor, Lewis Publishers, London1994.
2. The ISO 14000 Handbook: Joseph Cascio. 7. ISO 14004: Environmental management systems: General guidelines on principles, systems and supporting techniques (ISO 14004:1996 (E)).

Reference Books:

1. CPCB, Pollution Control acts, Rules and Notifications issued there under Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
2. Constitution of India [Referred articles from part-III, part-IV and part-IV A

Weblinks:

1. [Environmental Politics and Law | Yale Online](#)

Air and Noise Pollution Control Engineering

Course Code:246CE021

Unit I: Introduction to Air Quality

An Overview of the Clean Air Act Amendments; Fate and Transport in the Environment; Priority Air Pollutants; Indoor Air Quality. Properties of Air Pollutants; Selected Chemical and Physical Properties of Potential Atmospheric Pollutants; Basic Properties and Terminology.

Unit II: Industrial Air Pollution Sources and Prevention

Air Pollution in the Chemical Process, Petroleum, Iron and Steel Manufacturing, Lead and Zinc Smelting Industries, Air Pollution from Nickel Ore Processing and Refining; Air Pollution from Aluminum Manufacturing; Air Pollution from Copper Smelting

Unit III: Ventilation and Indoor Air Quality Control

An Overview of Indoor Air Quality; The Basics of HVAC Systems; IAQ Issues and Impacts on Occupants; Application of Audits to Developing an IAQ Profile; Developing Management Plans; IAQ Problems; Control; Quantification and Measurement, Air Pollution Dispersion-Dispersion Theory Basics- Air Quality Impact of Stationary Sources- Models and Resources

Unit IV: Prevention versus Control

Pollution Prevention: Principles of Pollution Prevention; Methods of Particulate Collection; Methods for Cleaning Gaseous Pollutants, Environmental Cost Accounting; Total Cost Accounting Terminology.

Unit V: Noise pollution

Sound level-measuring transient noise-acoustic environment-health effects of noise –noise control. Introduction to cosmic pollution

Text books:

1. Fundamentals of air pollution engineering, Richard C Flagan and John H Seinfeld, Prentice hall Inc, 2012
2. Air Pollution, M.N.Rao and H.V.N.Rao, Tata McGraw Hill Company, 2011

Reference Books:

1. Anjaneyulu. Y, 'Air Pollution and Control Technologies', Allied Publishers (P) Ltd., India, 2002.
2. Arthur C.Stern, ' Air Pollution (Vol.I – Vol.VIII)', Academic Press, 2006.
3. David H.F. Liu, Bela G. Liptak 'Air Pollution', Lweis Publishers, 2000.
4. Heck, R.M and Farrauto, R.J, Catalytic Air Pollution Control: Commercial Technology, 2nd Edition John Wiley Sons, 2012.

Weblinks:

1. [Introduction to Environmental Law and Policy | Coursera](#)
2. [Environmental Politics and Law | Yale Online](#)

Emerging Contaminants in Water and Wastewater

Course code: 246CE022

UNIT 1: Introduction

Emerging contaminants – Sources – Classifications – Pharmaceuticals – Personal Care Products – surfactants – Flame retardants – Pesticides – Wastewater Effluents – Occurrence – Fate - Behaviour in water & Wastewater.

UNIT 2: Analytical Strategies for Emerging Contaminants

Sample handling - Storage – Preparation – Sample Extraction Methods – Solid Phase Extraction (SPE) – Liquid-Liquid Extraction (LLE) – Solid Phase Micro Extraction (SPME) – Sample analysis – Gas Chromatography-Mass Spectrometry and Tandem Mass Spectrometry (GC-MS/MS) – Liquid Chromatography-Mass Spectrometry and Tandem Mass Spectrometry (LC-MS/MS) - High Performance Liquid Chromatography (HPLC) - Inductively Coupled Plasma (ICP)-MS.

UNIT 3: Treatment Technologies of Emerging Contaminants

Physical treatment methods – Adsorption process (activated carbon, biochar & Graphene) – Membrane Technology – Ultrafiltration, Nanofiltration, Microfiltration, Reverse Osmosis – chemical treatment methods – Advanced oxidation process (AOP) – Ozonation, UV treatment, Ozone/H₂O₂, Fenton oxidation, Photo Fenton oxidation – Solar Driven Photo Catalysis – Membrane Bioreactor - Biological Treatment Process- Activated Sludge Process (ASP) – Pure culture, Mixed culture.

UNIT 4: Transformation Products of Emerging Contaminants

Transformation Products & Metabolites of ECs – Illicit drugs – Pharmaceuticals – Personal Care Products – surfactants – Flame retardants – Pesticides – Artificial Sweeteners - Wastewater Effluents - Ground Water- Drinking Water – Surface Water – AOP.

UNIT 5: Effects and Risk Assessment of Emerging Contaminants

Effects of Acute – Chronic toxicity – Environment – Human Health – Biodiversity – Bioaccumulation in Aquatic Biota - Environmental Risk Assessment – Impact on the Environment and Human Health.

Text Books:

1. John. R. Dean (1998). Extraction Methods for Environmental Analysis. Methods, 1998 John Wiley & Sons Ltd.
2. Barceló, D., Petrovic, M. (2008), “Emerging Contaminants from Industrial and Municipal Waste: Removal Technologies”, The handbook of environmental chemistry, Vol. 5, Part S/2, © Springer-Verlag Berlin Heidelberg.

Reference Books:

1. Lambropoulou, D. A., & Nollet, L. M. L. (2014), Transformation products of emerging contaminants in the environment: analysis, processes, occurrence, effects and risks, Wiley.

Web Links:

1. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/emerging-contaminant>
2. <https://www.usgs.gov/mission-areas/water-resources/science/emerging-contaminants>

Theory of Engineered Cementitious Composites

Course Code: 246CE023

Unit -I: Introduction to Engineered Cementitious Composites

Introduction - Concrete technology development – Engineered cementitious composites – Difference between ECC and FRC.

Unit-II: Processing of Engineered Cementitious Composites

Introduction – Self consolidating casting – Fibre dispersion control and characterization – Sprayable ECC – Extrusion of ECC.

Unit-III: Mechanical Properties of Engineered Cementitious Composites

Introduction – Direct tension, Flexure, Shear compression, Fatigue, Creep – Specimen geometries – Test setup – Stress strain behaviour – Crack width.

Unit-IV: Durability properties of engineered cementitious composites

Overview on durability of Reinforced Engineered cementitious composites – Chloride diffusivity, Steel corrosion and cover spalling – Permeability of ECC – Sorptivity of ECC – Long term strain capacity – Durability under various exposure environments.

Unit-V: Multifunctional ECC

Introduction – Thermal adaptive ECC – Self healing ECC – Photo catalytic ECC - Self sensing ECC. Applications of ECC – Building infrastructure, Transportation infrastructure, Water infrastructure – other applications.

Text Books:

1. Li, V. C. (2019). Engineered cementitious composites (ECC): bendable concrete for sustainable and resilient infrastructure. Springer.
2. Praveenkumar, S., & Davim, J. P. (Eds.). (2024). Production, Properties, and Applications of Engineered Cementitious Composites. IGI Global.

Reference Books:

1. Pacheco-Torgal, F., Melchers, R. E., Shi, X., De Belie, N., Van Tittelboom, K., & Perez, A. S. (Eds.). (2017). Eco-efficient repair and rehabilitation of concrete infrastructures. Woodhead Publishing.
2. Mechtcherine, V., Slowik, V., & Kabele, P. (Eds.). (2017). Strain-hardening cement-based composites: SHCC4 (Vol. 15). Springer.

Web Links:

1. https://www.made-in-china.com/video-channel/tsquark_rJYpaHqKVIWU_High-Performance-Fiber-Reinforced-Cementitious-Composites-Hpfrcc-Engineered-Cementitious-Composit-Ecc-High-Ductility-Concrete.html
2. [https://www.sciencedirect.com/topics/engineering/engineered-cementitious-composite#:~:text=Engineered%20Cementitious%20Composites%20\(ECC\)%20are%20a%20special%20class%20of%20High,fibre%20reinforced%20concrete%20\(FRC\).](https://www.sciencedirect.com/topics/engineering/engineered-cementitious-composite#:~:text=Engineered%20Cementitious%20Composites%20(ECC)%20are%20a%20special%20class%20of%20High,fibre%20reinforced%20concrete%20(FRC).)

Geosynthetics and Reinforced Soil Structures

Course Code: 246CE024

UNIT 1: Introduction to Geosynthetics

Types of geosynthetics and their applications-manufacture of geosynthetics-strength of reinforced soils-testing of geosynthetics.

UNIT 2 : Reinforced Soil Retaining Walls

Different types of soil retaining structures -construction aspects of geosynthetic reinforced soil retaining walls-design codes for reinforced soil retaining walls-external stability analysis of reinforced soil retaining walls -seismic loads and internal stability analysis of reinforced soil walls-testing requirements for reinforced soil retaining walls.

UNIT 3: Design of Reinforced Soil Retaining Walls

Design of reinforced soil retaining walls – simple geometry-design of reinforced soil retaining walls – sloped backfill soil -design of reinforced soil retaining walls supporting a bridge abutment.

UNIT 4: Stability analysis of reinforced soil slopes

Stability analysis of reinforced soil slopes – infinite and finite slopes-stability analysis of reinforced soil slopes resting on soft foundation soils-stability analysis of reinforced soil slopes resting on strong foundation soil-stability analysis of reinforced soil slopes – bilinear wedge analysis.

UNIT 5: Load transfer mechanism in Geosynthetics

Design of embankments supported on load transfer platforms-reinforced soil for supporting shallow foundations -accelerated consolidation of soft clays using geosynthetics-geosynthetic encased stone columns for load support.

UNIT 6: Applications in Geosynthetics

Drainage application of geosynthetics-filtration applications of geosynthetics- erosion control using geosynthetics- natural geosynthetics and their applications- geosynthetics for construction of municipal and hazardous waste landfills.

Text books:

1. Almeida, M. and Marques, M.E.S. (2013) Design and Performance of Embankments on Very Soft Soils, CEC Press, London, U.K.
2. Jewell, R.A. (1996) Soil reinforcement with geotextiles, CIRIA & Thomas Telford, London, U.K.
3. Koerner, R.M. (2012) Designing with Geosynthetics. Vols. 1&2, 6th Edition, Xlibris Corporation, USA.

Reference Books:

1. Saran, Swami (2006) Reinforced Soil and its Engineering Applications, I.K. International, New Delhi.
2. Jones, C.J.F.P. (2010) Earth Reinforcement and Soil Structures, Thomas Telford, London, U.K.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc25_ce28/course
2. <https://archive.nptel.ac.in/courses/105/106/105106052/>