Department of Civil and Environmental Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

To educate students at Undergraduate, Postgraduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.

- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

To develop quality intellectuals through education, research and motivation so that they can bring a positive contribution to the society in area of Civil and Environmental Engineering

Department Mission

- To develop professional skills through quality education & research.
- To outreach various sectors of society through interdisciplinary programmes and practical oriented approach.
- To create dynamic, logical and effective leaders with inspiring mindsets.

Proposed PEOs and POs for M.Tech. (Civil Engineering)

Programme Educational Objectives (PEOs)

PEO1: To impart students with strong knowledge base through theory courses and sessional that makes them suitable for industries, academics, research, and consultancies.

PEO2: To develop students analytical, computational and research skills through assignments, weekly presentations, and modelling software.

PEO3: To train the students on developing practical, efficient, and cost-effective solutions on problems and challenges on civil engineering.

PEO4: To inculcate among student's sensitivity towards social and corporate responsibilities.

Programme Outcomes (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery for designing and solving civil engineering problems.

PO4: An ability to use appropriate modern tools in civil engineering. In doing so he should demonstrate sufficient knowledge of competing tools and their relative merits and demerits.

PO5: An ability to demonstrate the traits of learning and unlearning throughout his professional career, and be willing to learn new techniques, methods, and processes.

PO6: Tune his knowledge to be a responsible engineer adhering to all established practices of his profession.

Proposed Course Curriculum for M.Tech. (Civil Engineering)

First Semester

Theory Courses

Course Code	Course	L-T-P	Credits
CE501	Advanced Solid Mechanics	3-0-0	3
CE579	Construction Technology and Project Management	3-0-0	3
CE580	Urban Environmental Management	3-0-0	3
CE581	Numerical Methods and Computational Techniques	3-0-0	3
CE582	Optimization Techniques	3-0-0	3

Laboratory Courses

Course Code	Course	L-T-P	Credits
CE583	Construction Materials and Quality Control	0-0-4	2
CE584	Modern Tools in Civil Engineering	0-0-4	2
MT132	Communication Skills – I	0-0-3	1.5

Total Credits in First Semester = 20.5

COURSE INFORMATION SHEET

Course code	**:**	**CE501**
Course title	**:**	**ADVANCED SOLID MECHANICS**
Pre-requisite(s)	**:**	**B.E. /B. Tech in Civil with basic courses on Solid Mechanics.**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**I/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES:

The objective of this course is to provide a comprehensive understanding of the fundamental principles of elasticity and plastic deformation, and their application in solving real-world problems.

COURSE OUTCOMES:

CO1	Analyse displacement, strain, and stress fields, including principal strains and compatibility conditions.
CO2	Formulate and solve elasticity equations, understand stress-strain relationships, and address boundary value problems.
CO3	Solve plane stress and plane strain problems using Airy's stress function in Cartesian and polar coordinates.
CO4	Analyse torsional behaviour in prismatic bars using methods like Saint Venant's approach and Prandtl's membrane analogy.
CO5	Understand and apply concepts of plastic deformation, including yield criteria and plastic stress-strain relations.

SYLLABUS

Module I

Analysis of Stress & Strain: Displacement, Strain and Stress Fields, Constitutive Relations, Cartesian Tensors and Equations of Elasticity. Elementary Concept of Strain, Stain at a Point, Principal Strains and Principal Axes, Compatibility Conditions, Stress at a Point, Stress Components on an Arbitrary Plane, Differential Equations of Equilibrium, Hydrostatic and Deviatoric Components.

(8L)

Module II

Equations of Elasticity: Equations of Equilibrium, Stress- Strain relations, Strain Displacement and Compatibility Relations, Boundary Value Problems, Co-axiality of the Principal Directions.

(8L)

Module III

Two-Dimensional Problems of Elasticity: Plane Stress and Plane Strain Problems, Airy's stress Function, Two-Dimensional Problems in Polar Coordinates.

(8L)

Module IV

Torsion of Prismatic Bars: Saint Venant's Method, Prandtl's Membrane Analogy, Torsion of Rectangular Bar, Torsion of Thin Tubes.

(8L)

Module V

Plastic Deformation: Strain Hardening, Idealized Stress- Strain curve, Yield Criteria, von Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-Strain Relations, Principle of Normality and Plastic Potential, Isotropic Hardening.

(8L)

RECOMMENDED BOOKS

TEXT BOOKS:

1. Advanced Mechanics of Solids, Srinath L.S., Tata McGraw Hill,2000.
2. Theory of Elasticity, Timoshenko S. and Goodier J. N., McGraw Hill, 1961.
3. Solid Mechanics, Kazimi S. M. A., Tata McGraw Hill,1994.
4. Theory of Elasticity, Sadhu Singh, Khanna Publishers, 2003.
5. Theory of Elasticity, Timoshenko S. and Goodier J. N., McGraw Hill, 1961.

REFERENCE BOOKS:

1. Elasticity, Sadd M.H., Elsevier, 2005.
2. Engineering Solid Mechanics, Ragab A.R., Bayoumi S.E., CRC Press,1999.
3. Computational Elasticity, Ameen M., Narosa,2005

Gaps in the syllabus (to meet Industry/Profession requirements)

PO1

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1		1	3		2	2
CO2		2	3	2	2	2
CO3		2	3	2	2	2
CO4		1	3	2	2	2
CO5		1	3		2	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	**:**	**CE579**
Course title	**:**	**CONSTRUCTION TECHNOLOGY AND PROJECT MANAGEMENT**
Pre-requisite(s)	**:**	**-**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**I/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES:

Equip students with the essential knowledge and skills to effectively manage construction projects, including core concepts, economic considerations, scheduling techniques (PERT & CPM), material and cost management, and risk, insurance, and safety practices.

COURSE OUTCOMES:

CO1	Able to build the basic concepts of project management.
CO2	Able to solve complex problems involving construction economics.
CO3	Able to apply PERT and CPM techniques in construction project management.
CO4	Able to manage efficiently materials and cost related to construction project.
CO5	Able to analyze risk and insurance aspects along with safety management in construction.

SYLLABUS

Module I

Introduction: Phases of a construction project, Relevance of project management, Stakeholders of a construction project, Forms of business organization, Important traits of a project coordinator. Ethical conduct for engineers, Factors behind the success of a construction organization.

(8L)

Module II

Construction Economics: Economic decision making, Cash-flow diagram, Present worth, Future worth, Annual Worth, Rate of return method. Effect of inflation on cash flow.

(8L)

Module III

Network analysis: Event, Activity, Dummy activity, Development of Network, PERT – Time computations, Slack, Critical path. CPM network, Activity time estimate, Earliest event time, Latest allowable occurrence time, Start and Finish times of activity, Critical path.

(8L)

Module IV

Construction Material and Cost Management: Material procurement process, Custody, Material accounting, Transportation, Vendor development, Disposal. Inventory management. Cost budgeting and control, Collection of cost related information, Value management in construction.

(8L)

Module V

Risk, Insurance and Safety management in Construction: Risk identification process, Analysis and evaluation of risk, Response management process, Insurance in construction industry, Fundamental principles, Insurance policies for a typical construction organization. Evolution of safety, Unsafe conditions, Roles of safety personnel, Causes of accidents, Principles of safety.

(8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Construction Project Management by Kumar Neeraj Jha, Pearson.
2. Project Planning and Control with PERT And CPM – B.C. Punmia, K.K. Khandelwal. Laxmi Publications.

REFERENCE BOOKS:

1. Construction Project Management, Planning, Scheduling and Controlling – K.K. Chitkara. McGraw Hill Education.

Gaps in the syllabus (to meet Industry/Profession requirements)

Design of real-time industrial projects.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	1	2	2
CO2	2	2	3	1	2	2
CO3	2		3	2	2	1
CO4	1		3	2	2	2
CO5	2	2	2	1	2	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD3, CD5, CD6, CD7, CD8

CO2: CD1, CD2, CD3, CD4, CD6, CD8

CO3: CD1, CD2, CD3, CD4, CD6, CD7, CD8

CO4: CD1, CD2, CD3, CD4, CD5, CD6, CD7, CD8

CO5: CD1, CD2, CD3, CD4, CD5, CD6, CD7, CD8

COURSE INFORMATION SHEET

Course code	:	**CE580**
Course title	:	**URBAN ENVIRONMENTAL MANAGEMENT**
Pre-requisite(s)	:	**B.E. /B. Tech in Civil Engineering**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**I/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

Equip students to address urban environmental challenges by integrating sustainability principles, understanding urban ecology, and evaluating efficient urban infrastructure

COURSE OUTCOMES:

CO1	Apply the fundamentals of sustainability to solve the urban environmental challenges
CO2	Explain the critical role played by urban ecology in managing the environmental services
CO3	Critically assess and apply the various approaches for water, wastewater and solid waste management in urban regions

SYLLABUS

Module I

Urbanisation & Environmental Sustainability: Basics of urban environment, sustainable development & UN sustainable development goals, green cities, major laws on the environment - Environmental Protection Act, legislation related to air, water, and waste management, major urban development schemes in India.

(8L)

Module II

Urban Ecology & Environment: Fundamentals of urban ecology, urban biodiversity, urban aquatic systems, urban terrestrial systems (land & forests), atmosphere - urban heat island, aerosols & carbon emissions, sea level rise, ecosystem services, carrying capacity.

(8L)

Module III

Urban Water Infrastructure: Water sources, collection and conveyance, water supply – water treatment, water distribution network, water storage for distribution, rainwater harvesting structures, water supply & revenue.

(8L)

Module IV

Solid Waste Management: Solid waste management approaches across the globe, functional elements of solid waste management, waste processing techniques, waste to resource, landfill, solid waste management in industries.

(8L)

Module V

Liquid Waste Management: Stormwater management, sewage treatment, centralised and decentralized systems, sewer network, industrial effluent treatment, nature-based wastewater treatment systems.

(8L)

Reading Resources:

1. Introduction to Environmental Engineering and Science, G.M. Masters & Wendell Ela, PHI Publishers
2. Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy, McGraw-Hill Publishers
3. Water and Wastewater Engineering – designs, principle and practice, Mackenzie L. Davis. McGraw-Hill Education
4. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning
5. Environmental Planning and Management, Christian N Madu, Imperial College Press.
6. Adler, Frederick and Tanner, Colby. Urban ecosystems: ecological principles for the built environment. Cambridge University Press
7. Ecology and environment – P. D. Sharma
8. Tchobanoglous G., Theisen H., Vigil S.: Integrated Solid Waste Management Engineering Principles and Management Issues (McGraw Hill Education)

Gaps in the syllabus (to meet Industry/Profession requirements)

Application of real-life industrial problems

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	1	2
CO2	2	1	1	1	1	1
CO3	3	2	2	1	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2

CO2: CD1, CD2

CO3: CD1, CD2, CD3, CD5

COURSE INFORMATION SHEET

Course code	**:**	**CE581**
Course title	**:**	**Numerical Methods and Computational Techniques**
Pre-requisite(s)	**:**	**B.E. /B. Tech in Civil Engineering**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**I/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES:

The course aims to equip students with the necessary skills to effectively approximate and solve various computational problems.

COURSE OUTCOMES:

CO1	Apply numerical methods to solve nonlinear and linear equations
CO2	Employ curve fitting and interpolation techniques to accurately model and represent real-world data using polynomial function
CO3	Understand finite difference schemes by explaining how they are used to approximate derivatives and solve ordinary differential equation.
CO4	Implement finite difference methods to solve partial differential equations.
CO5	Select and apply numerical integration techniques to compute integrals.

SYLLABUS

Module I

Approximations and Errors in Computation

Solving Linear Equations: Gauss iteration Methods, Gauss-Jacobi iteration, Gauss-Seidal iteration, Relaxation Method, Eigen values by QR factorization method.

Solving Nonlinear Equations: Bisection method, Regula falsi method, Newton's method, Secant method, Fixed-point iteration method.

(8L)

Module II

Curve fitting and Interpolation: Curve fitting with a linear equation, Curve fitting with quadratic and higher order polynomials, Interpolation using a single polynomial, Lagrange polynomials, Newton's polynomials, Piecewise (spline) interpolation.

(8L)

Module III

Finite Difference Scheme: Finite difference approximation of the Derivative: Forward, backward and central difference formula, Finite Difference Method for Ordinary Differential Equations

(8L)

Module IV

Numerical Solution of Partial Differential Equation: Finite Difference Approximations to Partial Derivatives, Solution of Laplace's Equation, Solution of Poisson's Equation.

(8L)

Module V

Numerical Integration: Trapezoidal and Simpson's rule, Newton-Cotes Quadrature Formula, Gaussian Integration.

(8L)

RECOMMENDED BOOKS

TEXT BOOKS:

1. Numerical Methods in Engineering and Science: C, C++, and MATLAB, B. S. Grewal, Mercury Learning and Information, 2019
2. Numerical methods, V. Rajaraman, Prentice - Hall India Pvt. Ltd., (2003)
3. Numerical methods, S.S. Sastry, Prentice Hall of India Pvt. Ltd., New Delhi (2003).

REFERENCE BOOKS:

1. Numerical Methods for Engineers, Steven Chapra and Raymond Canale, McGraw Hill, 2007.
2. Applied Numerical Analysis, C. F. Gerald and P. O. Wheatley , 7th edition, Addison Wesley, 2009.
3. A Friendly Introduction to Numerical Analysis, Bradie, Brian, Pearson Education India. Dorling Kindersley (India) Pvt. Ltd, 2006.

Gaps in the syllabus (to meet Industry/Profession requirements)

PO1 & PO6

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2	3	2	
CO2		1	2	3	2	
CO3			3	3	2	
CO4			3	3	2	
CO5			2	2	3	

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	:	**CE582**
Course title	:	**OPTIMIZATION TECHNIQUES**
Pre-requisite(s)	:	**B.E. /B. Tech in Civil Engineering**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**I/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

Students will be able to apply various optimization techniques (linear, integer, non-linear) to solve and critically evaluate solutions for civil engineering problems.

COURSE OUTCOMES:

CO1	Apply the fundamentals of optimization to solve the civil engineering related problems.
CO2	Apply linear programming concept to frame engineering minima and maxima problems in the framework of optimization problems.
CO3	Critically assess and apply the various approaches for structural, geotechnical and environmental management in both rural and urban regions.
CO4	Apply nonlinear programming concept to solve optimization problems.
CO5	Critically assess and apply the various approaches of modern methods of optimization for application in civil engineering related problems

SYLLABUS

Module I

Introduction to optimization : Introduction to Optimization: Engineering application of Optimization – Statement of an Optimization problem – Optimal Problem formulation – Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria, Linear programming methods for optimum design, Application of LPP models in Civil engineering.

(8L)

Module II

Linear Programming : Introduction to Linear Programming, Solving Linear Programming Problems, The Simplex Method, Duality Theory and Sensitivity Analysis. Simplex Method – Artificial variable techniques - Big M-Method, Two Phase Method, Degeneracy problem, Method to resolve Degeneracy. Revised Simplex Method.

(8L)

Module III

Integer programming: Some Formulation Examples, The Branch-and-Bound Technique for BIP and Mixed Integer Programming, The Branch-and-Cut Approach, The Incorporation of Constraint Programming.

(8L)

Module IV

Non-linear Programming: Graphical Illustrations of Nonlinear Programming, One Variable and Multi-variable Unconstrained Optimization, The Karush-Kuhn-Tucker (KKT) Conditions, Quadratic Programming, Separable Programming, Convex and non-convex.

(8L)

Module V

Modern methods of Optimization: Genetic Algorithms – Simulated Annealing – Ant colony optimization, Neural-Network based Optimization, Fuzzy optimization techniques

(8L)

TEXT BOOKS:

1. S. Hiller & G.J. Lieberman – Operations Research, 8 th Edn, TMH, New Delhi – 2006
2. H.A.Taha – Operations Research, 8/e , Pearson Education , New Delhi-2007.

REFERENCE BOOKS:

1. J.K. Sharma – Operations Research, 3/e, Mcmillan , India Ltd, 2007
2. Pradeep Prabhakar Pai, “Operations Research Principles and Practice”, Oxford Higher Education,2012.

Gaps in the syllabus (to meet Industry/Profession requirements)

Application of optimization in construction/environmental/ industrial problems

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	2	2	2
CO2	3	2	1	2	2	3
CO3	3	1	1	2	2	3
CO4	3	2	1	2	2	3
CO5	3	2	3	3	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

Proposed Course Curriculum for M.Tech. (Civil Engineering) -With Specialization in Structural Engineering

Second Semester

Theory Courses (Any Five Courses)

Course Code	Course	L-T-P	Credits
CE506	Finite Element Method	3-0-0	3
CE503	Structural Dynamics and Earthquake Engineering	3-0-0	3
CE511	Advanced Concrete Technology	3-0-0	3
CE507	Theory of Plates and Shells	3-0-0	3
CE547	Prestressed Concrete	3-0-0	3
CE542	Bridge Engineering	3-0-0	3
CE585	Retrofitting and rehabilitation of concrete structures	3-0-0	3
CE543	Design of High Rise Structures	3-0-0	3
CE549	Structural Design of Foundation	3-0-0	3
CE546	Fracture Mechanics	3-0-0	3

Laboratory Courses

Course Code	Course	L-T-P	Credits
CE585	Concrete and Building Materials Laboratory	0-0-4	2
CE586	Structural Analysis and Design	0-0-4	2
MT133	Communication Skills – II	0-0-3	1.5

Total Credits in Second Semester = 20.5

Third Semester

Course Code	Course	L-T-P	Credits
CE513	Thesis (Part – I)		8
	OE – I/ MOOC – I		3
	OE – II/ MOOC – II		3

Total Credits in Third Semester = 14

Fourth Semester

Course Code	Course	L-T-P	Credits
CE514	Thesis (Part – II)		16

Total Credits in Fourth Semester = 16

COURSE INFORMATION SHEET

Course code	:	**CE506**
Course title	:	**FINITE ELEMENT METHOD**
Pre-requisite(s)	:	**Advanced Solid Mechanics**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**II/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

The course aim to provide comprehensive understanding of theoretical background of finite element method and to use finite element method for solving complex engineering problems.

COURSE OUTCOMES:

CO1	Understand the principles and applications of finite element methods, including energy principles and truss analysis.
CO2	Apply the Galerkin Finite Element Method for structural element applications.
CO3	Apply interpolation functions and numerical integration to various element types and formulations.
CO4	Implement finite element methods in solid mechanics for stress analysis and iso-parametric formulations.
CO5	Gain proficiency in FEM software for pre-processing, solution phases, and post-processing in engineering analysis.

SYLLABUS

Module I

Introduction: History and Applications, **Spring and Bar Elements:** Minimum Potential Energy Principle, **Truss Structures:** Direct Stiffness Method, Nodal Equilibrium equations, Assembly of Global Stiffness Matrix, Element Strain and Stress.

(8L)

Module II

Beam Elements: Flexure Element, Element Stiffness Matrix, Element Load Vector.

Method of Weighted Residuals: Galerkin Finite Element Method, Application to Structural Elements

(8L)

Module III

Interpolation Functions: Compatibility and Completeness Requirements, Polynomial Forms, Applications to Element Types: Triangular Elements, Rectangular Elements, Three- Dimensional Elements, Iso-parametric Formulation, Axi-Symmetric Elements, **Numerical Integration:** Gaussian Quadrature.

(8L)

Module IV

Application to Solid Mechanics: Plane Stress: CST Element, Plane Strain: Rectangular Element, Iso-parametric Formulation of the Plane Quadrilateral Element, Axi- Symmetric Stress Analysis, Strain and Stress Computations

(8L)

Module V

Computer Implementation of FEM procedures: Pre-Processing, Solution, Post-Processing, Use of Commercial FEA Software.

(8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Fundamentals of Finite Element Analysis, Hutton David, Mc-Graw Hill, 2004.
2. Concepts and Applications of Finite Element Analysis, Cook R. D., Wiley J., New York, 1995.
3. Finite Element Analysis, Seshu P., Prentice-Hall of India,2005.

REFERENCE BOOKS:

1. Finite Element Method, Zienkiewicz O.C. & Taylor R.L. Vol. I, II & III, Elsevier, 2000.
2. Finite Element Procedures, Bathe K. J., Prentice Hall, 1996
3. Finite Element Methods in Engineering, Belegundu A.D., Chandrupatla, T.R., Prentice Hall India, 1991.
4. Finite Element Analysis, Buchanan G.R., McGraw Hill Publications, New York, 1995.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	2	2	
CO2	3	2	3	2	2	2
CO3	2		3	3		
CO4	3		3	3	2	
CO5	2	2	3	2	3	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	:	**CE503**
Course title	:	**STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING**
Pre-requisite(s)	:	**-**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**II/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

Apply earthquake engineering principles to analyze and design structures for seismic resilience.

COURSE OUTCOMES:

CO1	Understand Earth's structure and earthquake mechanisms.
CO2	Analyze the behaviour of single-degree-of-freedom systems under dynamic loads.
CO3	Determine the modal properties of multi-degree-of-freedom systems.
CO4	Implement the response spectrum method for seismic analysis of structures.
CO5	Evaluate the influence of soil-structure interaction and base isolation on seismic performance.

SYLLABUS

Module I

Seismology: Earth's Interior and Plate Tectonics, Causes of Earthquakes and Seismic Waves, Measurement of Earthquakes, Seismic Hazard Analysis.

(8L)

Module II

Single Degree of Freedom Systems: Overview of Structural Dynamics, Single Degree of Freedom Systems – Analysis of Free Vibrations – undamped and damped systems, estimation of damping by logarithmic decrement method. Response of SDOFS systems to Harmonic, Periodic, Impulse, Earthquake Load. Response Spectrum.

(8L)

Module III

Multi Degree of Freedom Systems: Formulation of equation of motion for two/three DOF systems, finding mode shapes and frequencies. Response of MDOFS systems to Harmonic, Earthquake Load. Modal superposition and Response Spectrum Methods, Concept of modal mass and mode participation factors

(8L)

Module IV

Formulation Response Spectrum Method of Analysis: Concept of Equivalent Lateral Force for Earthquake. Response Spectrum Method of Analysis of Structures and IS code provisions.

(8L)

Module V

Seismic Soil - Structure Interaction: Fundamentals of Seismic Soil-Structure Interaction, Direct Method of Analysis of Soil-Structure Interaction using FEM, Sub-structuring Method of Analysis of Soil-Structure Interaction.

Base Isolation for Earthquake Resistant Design of Structures: Base isolation concept, isolation systems, stability of elastomeric bearings.

(8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Anil Chopra, "Dynamics of Structures ", Mc Graw Hill,2001.
2. Patrick Paultre, "Dynamics of Structures", John Willey & Sons,2008.
3. Pankaj Agarwal and Manish Shrikhande, 'Earthquake Resistant Design of Structures', PHI, 2008
4. S. K. Duggal; Earthquake resistance design of structures; Oxford University Press, New Delhi.

REFERENCE BOOKS:

1. Ray W. Clough & Penzien, "Dynamics of Structures", Mc Graw Hill,1993.
2. Ellis L. Krinitzsky, J.M. Gould and Peter H. Edinger, 'Fundamentals of Earthquake Resistant Construction', John Wiley, 1993
3. Newmark N.M. and Rosenblueth E., 'Fundamentals of Earthquake Engg.,' Prentice Hall, 1971.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	2	2	
CO2	3	2	3	2	2	2
CO3	3		3	3	2	
CO4	3	2	3	3	2	2
CO5	3	2	3	3	3	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	:	**CE511**
Course title	:	**ADVANCED CONCRETE TECHNOLOGY**
Pre-requisite(s)	:	**-**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**II/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

Develop expertise in designing and selecting concrete materials for optimal performance and durability.

COURSE OUTCOMES:

CO1	Understand the influence of microstructure on concrete properties.
CO2	Select and optimize chemical and mineral admixtures for desired concrete performance.
CO3	Design concrete mixes using standardized methods.
CO4	Assess the durability of concrete against various environmental factors.
CO5	Identify and utilize advanced concrete materials and techniques.

SYLLABUS

Module I

Bogue's compounds, Hydrated Cement Paste structure and volume, porosity of paste and concrete, transition Zone, factors affecting strength and elasticity of concrete, Rheology of concrete.

(8L)

Module II

Chemical and Mineral admixtures, Effect of admixtures on concrete property in fresh and hardened state, Optimum dosage of admixtures

(8L)

Module III

Design of concrete mix as per IS10262 and current American (ACI)/ British (BS) methods. NDT Tests on concrete

(8L)

Module IV

Permeability of concrete, chemical attack, acid attack, efflorescence, Corrosion in concrete. Thermal conductivity, thermal diffusivity, specific heat. Alkali Aggregate Reaction, IS456-2000 requirement for durability.

(8L)

Module V

Fiber reinforced concrete, High volume fly ash concrete, Self-compacting concrete, Light weight concrete. Utilization of industrial wastes in concrete.

(8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Concrete Technology, A.R. Santhakumar,-Oxford University Press.
2. Concrete- P.K. Mehta, P J M Monteiro,- Prentice Hall, New Jersey
3. 3Non-Destructive Test and Evaluation of Materials, J.Prasad, C G K Nair-Mc Graw Hill.
4. Concrete Technology Theory & Practice, M.S. Shetty, S.Chand and Co, 2004

REFERENCE BOOKS:

1. IS 10262-2019, ACI Code for Mix Design.
2. Advanced Concrete Technology Constituent materials- John Newman, Ban Seng Choo- London
3. Properties of Concrete- Neville, A.M., Longman Publishers, 2004.
4. Properties of Fresh Concrete, Power T.C.- E and FN, London

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
O1	3		3	2	2	1
CO2	2	2	3	2	2	2
CO3	3		3	3	2	2
CO4	2	1	3	2	2	3
CO5	2	2	3	3	3	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	:	**CE507**
Course title	:	**THEORY OF PLATES AND SHELLS**
Pre-requisite(s)	:	**Advanced Solid Mechanics**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**II/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

Master the analysis of plates and shells using classical and numerical methods for various structural applications

COURSE OUTCOMES:

CO1	Apply classical plate theory to analyze isotropic plates under various conditions.
CO2	Implement numerical methods for advanced plate analysis.
CO3	Analyze the behavior of orthotropic plates and plates resting on elastic foundations.
CO4	Understand principles for various shell structures.
CO5	Analyze folded plate structures.

SYLLABUS

Module I

Plate Analysis Fundamentals: Plate equation derivation in Cartesian and polar coordinates for isotropic rectangular and circular plates. Solving for deflection and stresses in rectangular and circular plates with different boundary conditions (simply supported, fixed) and loadings (uniform load, concentrated load). Analysing the behaviour of circular plates with holes considering stress concentrations.

(8L)

Module II

Advanced Plate Analysis Methods: Numerical Techniques, Cylindrical Bending.

(8L)

Module III

Orthotropic Plates and Plates on Elastic Foundation: Orthotropic Plates, Plates on Elastic Foundation.

(8L)

Module IV

Shell Structures: Shell Classification, Shell Theories, Cylindrical Shells.

(8L)

Module V

Folded Plates: Types of Folded Plates, Analysis.

(8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Timoshenko, S.P. Theory of Plates and Shells, Mc Graw Hill Book Company, New York, USA (1959).
2. Ramaswamy, G.S. Design and Construction of Concrete Shell Roofs, CBS Publishers, India (1986).

REFERENCE BOOKS:

1. Rudolph Szilard. Theories and Application of Plate Analysis, John Wiley & Sons, USA (2004).
2. Shames, I.H., and Dym, C.L., Energy and Finite Element Methods in Structural Mechanics, New Age International Publishers, 2003.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	2		
CO2	3	2	3	3	2	2
CO3	3		3	3	2	
CO4	3		3	3	2	2
CO5	3	2	3	3	3	2

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	:	**CE547**
Course title	:	**PRESTRESSED CONCRETE**
Pre-requisite(s)	:	**-**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**II/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

Develop proficiency in the analysis and design of prestressed concrete structures for various applications, considering both flexural and serviceability limit states.

COURSE OUTCOMES:

CO1	Understand the principles and components of prestressed concrete design.
CO2	Design prestressed concrete beams for various limit states.
CO3	Analyze and design prestressed concrete structures for indeterminate behaviour.
CO4	Utilize composite construction principles in prestressed concrete design.
CO5	Design prestressed concrete structures for specific geometries.

SYLLABUS

Module I

Introduction – Theory, Behaviour and Materials: Basic concept of pre-stressing (including advantages and disadvantages), Basic Definitions; Pre-stressing methods - Thermo elastic, chemical , Electrical; Material Properties - Concrete and Pre-stressing steel; Pre-stressing Systems - Pre-tensioning and Post-tension systems. (8L)

Module II

Losses in Pre-stress: Purpose of calculating losses – Elastic loss, creep, shrinkage, relaxation and anchorage losses; Friction loss in pre-stress, Force variation diagram in friction loss. (8L)

Module III

Analysis and Design for Flexure: Analysis of stresses by stress method, force method and load balancing method; Pre-Basic assumptions for calculating flexural stresses, permissible stresses in steel and concrete as per IS 1343 Code; Design of sections of Type II and Type III Post-tensioned (PT) Beams/slabs; Check for strength limit based on IS 1343; Layout of cables in PT -beams/slabs. (8L)

Module IV

Deflection and Design of Anchorage Zone: Factors influencing deflections – Short term deflections of un-cracked members; Prediction of long term deflections due to creep and shrinkage; Check for serviceability limit state of deflection, estimation of crack width. Determination of anchorage zone stresses in post-tensioned beams by Magnel's method, Guyon's method and IS 1343 method; design of anchorage zone reinforcement, Check for transfer bond length in pre-tensioned beams. (8L)

Module V

Special Topics: Continuous beams - concepts; Composite Construction of Pre-stressed and in situ Concrete; Pre-stressed Concrete Poles Piles Sleepers –concepts; Construction of Pre-stressed Concrete Structures. (8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Prestressed Concrete, Krishnaraju N., Tata McGraw Hill, New Delhi, 1981.(T1)
2. Design of Prestressed Concrete Structures, Lin T.Y., Asia Publishing House, 1955.(T2)

REFERENCE BOOKS:

1. Limited State Design of Prestressed Concrete, GuyanY., Applied Science Publishers. (R1)
2. IS: 1343- Code of Practice for Prestressed Concrete. (R2)

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	2		
CO2	3		3	3	2	
CO3	3		3	3	2	
CO4	3		3	3	2	
CO5	3		3	3	3	

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	:	**CE542**
Course title	:	**BRIDGE ENGINEERING**
Pre-requisite(s)	:	**-**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**II/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

Develop a comprehensive understanding of bridge engineering principles to analyze, design, and evaluate various bridge components for safe and sustainable functionality.

COURSE OUTCOMES:

CO1	Understand fundamental bridge concepts and design loads.
CO2	Analyze and design concrete bridge decks for different configurations.
CO3	Apply design principles for steel and composite bridge decks.
CO4	Analyze and design bridge substructures and expansion systems.
CO5	Evaluate special bridge design considerations and future trends.

SYLLABUS

Module I

Introduction & Bridge Components: Introduction to Bridges, Planning of Bridges, Loading and Design Specifications. (8L)

Module II

Analysis and Design of Concrete Bridge Decks: Concrete Slab Decks, Concrete Beam-and-Slab Decks, Box Girder Decks. (8L)

Module III

Steel & Composite Bridges and Advanced Bridge Type: Steel Truss Bridges and Composite Decks, Introduction to Advanced Bridge Types. (8L)

Module IV

Bridge Support Structures and Expansion Systems: Bridge Piers, Abutments, and Well Foundations, Bridge Bearings and Expansion Joints. (8L)

Module V

Special Topics in Bridge Engineering: Construction Methods and Seismic Design, Foot Bridges & Future Considerations (Optional) (8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Victor, D.J., Essentials of Bridge Engineering, 6th Ed., Oxford & IBH Publishing Co. Pvt. Ltd., 2007.
2. Rajagopalan, N., Bridge Superstructure, Narosa Publishing House Pvt. Ltd., 2006.
3. Krishna Raju, N., Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., 1998.

REFERENCE BOOKS:

1. IRC 5, IRC 6, IRC 112, Indian Roads Congress
2. IRS Bridge Rules, IRS Concrete Bridge Code, Research Designs and Standards Organization, Indian Railways
3. Ponnuswamy, S., Bridge Engineering, Tata McGraw-Hill Publishing Company Limited, 1986.
4. Raina, V.K., Concrete Bridge Practice "Analysis, Design and Economics, 2nd Ed., Tata McGraw-Hill Pub., 1994.
5. Surana, C.S. and Agarwal, R., Grillage Analogy in Bridge Deck Analysis, NarosaPublishing House Pvt. Ltd., 1998.
6. Hambly, E.C., Bridge Deck Behaviour, 2nd Ed., E & FN Spon (Chapman & Hall), 1991.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1		1	1
CO2	2		3	2	1	1
CO3	2		3	2	1	1
CO4	2		3	2	1	1
CO5	1		1	1	3	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	**:**	**CE585**
Course title	**:**	**RETROFITTING AND REHABILITATION OF CONCRETE STRUCTURES**
Pre-requisite(s)	**:**	**-**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**II/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES:

The course enables the student to recognize and understand the causes of deterioration in concrete structures, providing practical techniques for repair, retrofitting, and strengthening, while enhancing their proficiency in effectively applying fiber reinforced polymer composites (FRPC) for structural reinforcement, including design considerations, installation methods, and quality control

COURSE OUTCOMES:

CO1	Understand the causes of deterioration in concrete structures, including material-related distresses and environmental factors.
CO2	Acquire proficiency in repair and retrofitting techniques, including surface preparation, selection of materials, and various repair methods.
CO3	Comprehend the fundamentals of fiber reinforced polymer composites (FRPC), including types, properties, and manufacturing methods.
CO4	Apply FRPC effectively in strengthening structural components, considering design considerations, installation techniques, and quality control measures.
CO5	Analyze real-world case studies of retrofitting projects to identify challenges and best practices in the application of repair and strengthening techniques to existing concrete structures.

SYLLABUS

Module I

Understanding Deterioration in Concrete Structures : Introduction, Need for retrofitting and rehabilitation of existing infrastructure, Deterioration in Concrete Structures: Different Causes of Deterioration, Material related distresses: Corrosion in Reinforcement, Acid Attack in Concrete, Sulphate attack in concrete, Alkali aggregate reaction in concrete, Other distresses in Concrete: Freezing and Thawing, Thermal Effect, Shrinkage, Creep, Types of Evaluation, Identification of Distresses in Concrete Structures, Semi-destructive Testing, Non-destructive Tests, Other Tests.

(8L)

Module II

Considerations and Techniques for Repair and Retrofitting : Considerations for Repair and Retrofitting, Steps for Repair and Retrofitting, Shoring and Scaffolding, Surface Preparation, Repair Materials, Repair Techniques, Surface Preparation near corroded reinforcements, Repair of cracks by sealing and grouting methods, Repair of cracks by various grouting methods (Shotcrete, Ferro-cement), Corrosion Treatments of Steel reinforcements, Conventional Strengthening Techniques, Attachment of Steel to Concrete and Crack Stabilization, Strengthening of Structural Components, Advantages and Limitations of Strengthening with Steel, Strengthening of Structural Components (Strengthening of Foundation, Slab-jacking).

(8L)

Module III

Fundamentals of Fiber Reinforced Polymer Composites: Introduction to Composite Types and Phases of Composite, Fiber Reinforced Polymer Composite (FRPC) Types, Types of Fibers and their Characteristics, Types of Resins and their Characteristics, Properties of Fibers and Resins, Stress-Strain Relationships in FRPC, Advantages and Limitations of FRPC, Applications of FRPC, Micromechanics of Composites, Determination of Elastic Moduli of Composites, Different Methods of FRP Manufacturing.

(8L)

Module IV

Application of FRPC in Strengthening Structural Components: FRPC in strengthening of structural components, Flexural strengthening of structural members, FRPC in Shear Strengthening of Structural Members, FRPC in Axial Strengthening of Structural Members, Design Considerations for FRP Strengthening System, Near Surface Mounted FRP Reinforcement in Strengthening of Structural Members, Strengthening of Beam-Column Joints using FRP Composites, Anchorage Systems for FRP Strengthening,

Installation of FRP on Existing Structural Components, Surface Preparation Steps for Application of FRP on prepared surface, Quality Control, Repair after FRP Application.

(10L)

Module V

Case Study of Retrofitting

(6L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Sidney, M. Johnson, "Deterioration, Maintenance and Repair of Structures"
2. Denison Campbell, Allen & Harold Roper, "Concrete Structures – Materials, Maintenance and Repair"- Longman Scientific and Technical.
3. Dobmann, Gerd, Christiane Maierhofer, and Hans-Wolf Reinhardt, eds. Non-destructive Evaluation of Reinforced Concrete Structures: Deterioration Processes and Standard Test Methods. CRC press, 2010.
4. Central Public Works Department (CPWD). Handbook on repair and rehabilitation of RCC buildings, 2002.

REFERENCE BOOKS:

1. R.T.Allen and S.C. Edwards, "Repair of Concrete Structures"-Blakie and Sons
2. Raiker R.N., "Learning for failure from Deficiencies in Design, Construction and Service"- R&D Center (SDCPL).
3. Ransom, W.H. Building Failures: Diagnosis and Avoidance. United States, CRC Press, 2002.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1		1	1
CO2	2		3	2	1	1
CO3	1		1	1	1	
CO4	2		3	2	1	1
CO5	1		1		3	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	:	**CE543**
Course title	:	**DESIGN OF HIGH-RISE STRUCTURE**
Pre-requisite(s)	:	**B.E. /B. Tech in Civil with basic courses on RCC and Steel Design,**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**II/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

Develop expertise in the analysis and design of tall structures and transmission systems, considering various loads, dynamic behavior, and software applications.

COURSE OUTCOMES:

CO1	Design transmission lines, towers, masts, and trestles for various loads.
CO2	Design RC and steel chimneys for different soil conditions.
CO3	Understand structural concepts for tall buildings under wind and seismic loads.
CO4	Apply dynamic analysis and design principles for tall buildings.
CO5	Implement software for analysis and design of tall structure.

SYLLABUS

Module I

Design of Transmission/ TV Tower, Mast and Trestles: Configuration, bracing system, analysis and design for vertical, transverse and longitudinal loads.

(8L)

Module II

Analysis and Design of RC and Steel Chimney: Foundation design for varied soil strata.

(8L)

Module III

Tall Buildings: Structural concepts, configurations, various systems, wind and siesmic loads.

(8L)

Module IV

Tall Buildings: Dynamic approach, structural design considerations and IS code provisions, firefighting design provisions.

(8L)

Module V

Application of software: Analysis and design.

(8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Structural Design of Multi-storeyed Buildings, Varyani U.H., 2nd Ed., South Asian Publishers, New Delhi, 2002.
2. Structural Analysis and Design of Tall Buildings, Taranath B.S., Mc GrawHill, 1988.
3. Illustrated Design of Reinforced Concrete Buildings (GF+3Storeyed), Shah V.L. &Karve
4. S.R., Structures Publications, Pune, 2013.

REFERENCE BOOKS:

1. Design of Multi-storeyed Buildings, Vol.1 & 2, CPWD Publications, 1976.
2. Tall Building Structures, Smith Byran S. And Coull Alex, Wiley India, 1991.
3. High Rise Building Structures, Wolfgang Schueller, Wiley., 1971.
4. Tall Chimneys, Manohar S.N., Tata Mc GrawHill Publishing Company, New Delhi.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	2	1	1
CO2	3		2	2	1	1
CO3	1		3	1	1	1
CO4	3		3	3	1	1
CO5	1		2	3	2	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	:	**CE549**
Course title	:	**STRUCTURAL DESIGN OF FOUNDATION**
Pre-requisite(s)	:	**B.E. /B. Tech in Civil with basic courses on RCC design**
Co- requisite(s)	:	**-**
Credits	:	**3 (L: 3 T: 0 P: 0)**
Class per week	:	**3**
Class	:	**MTech.**
Semester / Level	:	**II/5**
Branch	:	**Civil Engineering**
Name of Teacher	:	

COURSE OBJECTIVES:

Design safe and stable foundations for various structures.

COURSE OUTCOMES:

CO1	Understand subsurface exploration and interpret data for foundation design.
CO2	Design shallow foundations and optimize load distribution with combined footings and rafts.
CO3	Analyze and design retaining walls and sheet pile walls for lateral earth pressures.
CO4	Analyze and design pile foundations.
CO5	Design machine foundations to accommodate dynamic loads.

SYLLABUS

Module I

Subsurface exploration: Boring, Sampling, SPT, CPT, Geophysical methods, Bore log and soil report.

(8L)

Module II

Design of Shallow Foundations: Shallow Foundations, Design of Combined and Raft foundations.

(8L)

Module III

Retaining Walls & Sheet Pile Wall: Design of Retaining walls, Sheet Pile Walls.

(8L)

Module IV

Design of Pile Foundations: Introduction to Pile Foundations, Pile Analysis & Design

(8L)

Module V

Machine Foundation: Machine Foundation Design

(8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Varghese, P.C., Design of Reinforced Concrete Foundations, Prentice-Hall of India Pvt. Limited, 2009.
2. Kurian, N. P., Design of Foundation Systems " Principles and Practices, Narosa Publishing House Pvt. Ltd., 2005.

REFERENCE BOOKS:

1. IS 456, IS 1080, IS 1904, IS 2911, IS 2950, IS 2974, IS 6403, Bureau of Indian Standards.
2. Wayne C. Teng, Foundation Design, Prentice-Hall, Inc., 1962
3. Bowles, J. E., Foundation Analysis and Design, Mc-Graw Hill International Editions, 2001
4. Pillai, S.U. and Menon D., Reinforced Concrete Design, McGraw-Hill Publishing Co. Ltd., 2011.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		1	1	1	1
CO2	2		3	1	1	1
CO3	2		3	1	1	1
CO4	2		3	2	1	1
CO5	2		3	2	1	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code	**:**	**CE546**
Course title	**:**	**FRACTURE MECHANICS**
Pre-requisite(s)	**:**	**CE501- Advanced Solid Mechanics** **CE506- Finite Element Method**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**II/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES:

The course enables the student to develop a comprehensive understanding of fracture phenomena, stress intensity factors, anelastic deformation, crack tip displacement, fracture characterization test methods, fatigue failure mechanisms, and finite element analysis of cracks. Additionally, it equips students with the knowledge of mixed-mode crack propagation criteria and various non-destructive testing techniques for crack detection, empowering them to effectively address structural integrity challenges in engineering applications.

COURSE OUTCOMES:

CO1	Identify, and describe fracture phenomena, modes of failure, damage tolerance, and energy release rates in materials and structures.
CO2	Analyse, evaluate, and apply anelastic deformation, crack tip opening displacement, and J-Integral concepts to solve engineering problems related to fracture mechanics.
CO3	Assess, and determine critical fracture parameters using test methods, while also analysing and evaluating fatigue failure and environment-assisted fracture mechanisms.
CO4	Analyse, evaluate, and apply finite element analysis techniques to determine fracture parameters in solids.
CO5	Apply, and integrate knowledge of mixed-mode crack initiation, crack propagation criteria, and non-destructive testing methods to effectively detect and mitigate structural flaws

SYLLABUS

Module I

Introduction: Fracture Phenomena in Nature and Engineering, Brittle and Ductile Fracture, Modes of Fracture Failure, Damage Tolerance, Energy Release rate.

Stress Intensity Factor: Introduction, Stress and Displacement Fields in Isotropic Elastic Mater, Stress Intensity Factor, Westergaard's Approach and its application, Edge Cracks, Embedded Cracks, The Relation between G1 and K1, Critical Stress Intensity Factor, Bending and Twisting of Cracked Plates

(8L)

Module II

Anelastic Deformation at the Crack Tip: Investigation at the Crack Tip, Approximate Shape and Size of the Plastic Zone, Effective Crack Length, Effect of Plate Thickness J-Integral: Relevance and Scope, Applications to Engineering Problems

Crack Tip Opening Displacement: Relationship between CTOD, Kr and Gr for Small Scale Yielding, Equivalence between CTOD and J- Integral

(8L)

Module III

Test Methods: KIc-Test Technique, Test Methods to Determine J1c, Test Methods to Determine G1c and GIIc, Determination of Critical CTOD.

Fatigue Failure and Environment-assisted Fracture: Fatigue Failure, Environment-assisted Fracture, Environment-assisted Fatigue Failure

(8L)

Module IV

Finite Element Analysis of Cracks in Solids: Direct Methods to Determine Fracture Parameters, Indirect Methods to Determine Fracture Parameters

(8L)

Module V

Mixed Mode Crack Initiation and Growth: Fracture Surface, Mixed Mode Crack Propagation Criteria. Crack Detection through Non-Destructive Testing: Examination through Human Senses, Liquid Penetration Inspection, Ultrasonic Testing, Radiographic Imaging, Magnetic Particle Inspection

(8L)

RECOMMENDED BOOKS

TEXTBOOKS:

1. Elements of Fracture Mechanics, Prashant Kumar, Tata McGraw Hill, New Delhi, India, 2009.
2. Fracture Mechanics for Modern Engineering Design, K. R.Y.Simha, Universities Press (India) Limited, 2001
3. e-Book on Engineering Fracture Mechanics, K. Ramesh, IIT Madras, 2007.

REFERENCE BOOKS:

1. Elementary Engineering Fracture Mechanics, D.Broek, Kluwer Academic Publishers, Dordrecht, 1986.
2. Fracture Mechanics - Fundamentals and Applications, T.L.Anderson, 3rd Edition, Taylor and Francis Group, 2005.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		1		1	1
CO2	3		3		1	1
CO3	3		3	1	1	1
CO4	3		3	3	1	1
CO5	3		3	1	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD6

CO2: CD1, CD2, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD6

CO5: CD1, CD2, CD6

Proposed Course Curriculum for M.Tech. (Civil Engineering) – with Specializxation in Geotechnical Engineering

Second Semester

Theory Courses (Any Five Courses)

Course Code	Course	L-T-P	Credits
CE515	Advanced Soil Mechanics	3-0-0	3
CE516	Foundation Engineering	3-0-0	3
CE518	Soil Dynamics	3-0-0	3
CE519	Soil Exploration	3-0-0	3
CE520	Earth and Earth Retaining Structures	3-0-0	3
CE523	Rock Mechanics and Tunnelling	3-0-0	3
CE554	Environmental Geotechnics	3-0-0	3
CE556	Ground Water Flow	3-0-0	3
CE558	Ground Improvement	3-0-0	3
CE562	Stability of Slopes	3-0-0	3

Laboratory Courses

Course Code	Course	L-T-P	Credits
CE588	Soil Testing Laboratory	0-0-4	2
CE589	Design of Foundations	0-0-4	2
MT133	Communication Skills – II	0-0-3	1.5

Total Credits in Second Semester = 20.5

Third Semester

Course Code	Course	L-T-P	Credits
CE513	Thesis (Part – I)		8
	OE – I/ MOOC – I		3
	OE – II/ MOOC – II		3

Total Credits in Third Semester = 14

Fourth Semester

Course Code	Course	L-T-P	Credits
CE514	Thesis (Part – II)		16

Total Credits in Fourth Semester = 16

COURSE INFORMATION SHEET

Course code	**:**	**CE515**
Course title	**:**	**ADVANCED SOIL MECHANICS**
Pre-requisite(s)	**:**	**Soil Mechanics & Foundation Engineering at Bachelor's level**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**II/5**
Branch	**:**	**Civil Engineering**

COURSE OBJECTIVES

This course aims to provide comprehensive understanding of the theoretical background of the advanced concepts of soil mechanics and apply advanced soil mechanics theories for solving complex geotechnical engineering problems.

COURSE OUTCOMES

CO1	Comprehend the importance of advanced concepts and theories in soil mechanics
CO2	Assess clayey soil for various Geotechnical Engineering applications by suitably predicting the behaviour
CO3	Be familiar with advanced equipments
CO4	Evaluate and interpret the state of stress in soil and the various failure criteria for soils
CO5	Analyse the critical state model for the deformation and strength of soils

SYLLABUS

Module I

Clay Mineralogy: Types of bonds; Clay-Water system; Diffused Double Layer; Gouy-Chapman theory, Kaolinite, Illite, Montmorillonite; SEM and DTA; Expansive Soils;

(8L)

Module II

Capillary Water: Capillary phenomenon and potential; Gas pressure in bubbles and voids; Suction of held water; Soil suction; Sorption curves;

(8L)

Module III

Limit State Equilibrium and State of stress in Soils: Fundamental concepts; Yield criteria and failure theories, Yield surfaces, Choice of shear parameters for design; Mathematical consideration, Effective and total stress concept; Stress-Path concept; Stress path in triaxial tests

(8L)

Module IV

Critical State Soil Mechanics Critical state line; Roscoe and Hvorslev surfaces; Complete state boundary;

(8L)

Module V

Behaviour of Soils before Failure Elastic and Plastic deformation; Plasticity of soils; Cam clay Model; Behaviour of sands;

(8L)

RECOMMENDED BOOKS

Text Books:

1. Clay Mineralogy by R. E. Grim
2. Critical State Soil Mechanics by Atkinson and Bransby
3. Soil Mechanics by T.W.Lambe and R.V.Whitman

Reference Books:

1. Clay colloid Chemistry by H. Van Olphen
2. Advanced Soil Mechanics by Braja M .Das
3. Soil behavior and Critical State Soil Mechanics by D.M Wood

Gaps in the syllabus (to meet Industry/Profession requirements)

Study of field problems

POs met through Gaps in the Syllabus: PO4

Topics beyond syllabus/Advanced topics/Design:

Design of field problems

POs met through Topics beyond syllabus/Advanced topics/Design: PO5

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	3
CO2	3	3	3	2	2	3
CO3	3	3	3	2	2	3
CO4	3	3	3	2	2	3
CO5	3	3	3	2	2	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD4, CD6

CO2: CD1, CD2, CD3, CD4, CD6

CO3: CD1, CD2, CD3, CD4, CD5, CD6

CO4: CD1, CD2, CD3, CD4, CD5, CD6, CD7

CO5: CD1, CD2, CD3, CD4, CD6, CD7

COURSE INFORMATION SHEET

Course code: CE516
Course title: FOUNDATION ENGINEERING
Pre-requisite(s): Basics of Soil Mechanics
Co- requisite(s): None
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: M.Tech.
Semester / Level: II/ Level 5
Branch: Civil Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students:

A.	To learn about different theories of bearing capacity, and settlement calculations.
B.	To impart knowledge about different types of combined footings, and design of raft footing.
C.	To learn design of pile foundations including pile groups.
D.	To learn design of well foundations, cofferdams and pier foundations.
E.	To learn design of foundations in collapsible soils.

COURSE OUTCOMES

After the completion of this course, students will be:

1.	Student shall be able to choose type of foundations; perform calculations of bearing capacity using different theories; perform calculation of settlement below foundations.
2.	Student would be able to perform design of rectangular and trapezoidal combined footings, strap footing, and raft foundation.
3.	Student will be capable of analyzing the mechanics of load transfer in piles; calculation of pile load carrying capacity; able to design pile groups.
4.	Student shall be able to calculate load carrying capacity of well foundations; analysis of well foundations based on bulkhead concept; analysis of stability and design of coffer dams; understanding the concept and uses of pier foundations.
5.	Student would be able to design foundations in collapsible soils.

SYLLABUS

Module I

Foundation types and Bearing capacity: Types of foundations, Choice of foundation type. Bearing capacity of shallow foundations – analyses of Prandtl, Terzaghi, Skempton, Meyerhof, Hansen, Vesic. Safe and allowable bearing pressure. General and local shear failure. Effect of water table on bearing capacity. Bearing capacity from field tests, Primary consolidation and Secondary settlement of soil.

8 Lectures

Module II

Combined footings and Raft footings: Types of combined footings – Rectangular combined footing, Trapezoidal combined footing, Strap or cantilever footing. Advantages of combined footings. Design of Combined footing, Bearing capacity of rafts on clay and sands. Design of Raft foundations – conventional method and elastic method (soil line method). Floating raft.

8 Lectures

Module III

Pile foundations: Types of pile foundation. Mechanics of load transfer in piles. Critical depth. Determination of pile capacity. Pile load test. Underreamed piles. Design of Pile groups including settlement calculations., Efficiency of pile groups, Bearing capacity of pile groups embedded in sands and gravels, Pile groups in cohesive soils, Negative skin friction. Piles under horizontal forces, Batter piles in Cohesionless soils,

8 Lectures

Module IV

Well foundations, Coffer dams and Pier foundations: Types of well foundations, Components of well foundations, Sinking of well foundations, Allowable bearing pressure, Analysis based on bulkhead concept. Cofferdams – types and uses, Stability and design of cofferdams. Pier foundation and its types and uses, Design considerations, Load transfer mechanisms, Bearing capacity of drilled piers.

8 Lectures

Module V

Foundation on collapsible soils: General observations, Collapse potential and settlement, Computation of collapse settlement, Foundation design, Treatment methods for collapsible soils

8 Lectures

TEXT BOOKS

Venkatramaiah, C. "Geotechnical Engineering", New Age International Limited, New Delhi.
Murthy, V.N.S. "Advanced Foundation Engineering." CBS Publishers

REFERENCE BOOKS

Bowles, J.E. "Foundation Analysis And Design", McGraw Hill Education (India) Private Limited, New Delhi.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	3
CO2	3	3	3	2	1	3
CO3	3	3	3	2	1	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	1	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4, CD6
CO2	CD1, CD2, CD4, CD6
CO3	CD1, CD2, CD4, CD6
CO4	CD1, CD2, CD4, CD6
CO5	CD1, CD2, CD4, CD6

COURSE INFORMATION SHEET

Course code	**:**	**CE518**
Course title	**:**	**Soil Dynamics**
Pre-requisite(s)	**:**	**Soil Mechanics and Foundation Engineering**
Co- requisite(s)	**:**	**Knowledge of Engineering Mathematics and Theory of Elasticity**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**II/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES

1.	Understand the fundamental concepts of theory of vibration and the various terminology encompassed, to study the behavior of soils because of dynamic loads & the phenomenon of Vibration Isolation
2.	Assess the nature of wave propagation through soil & recognize the dynamic soil properties & study the determination of them by field and laboratory tests with special reference to foundations subjected to vibrations
3.	Create an understanding about the general principles of analysis and design of machine foundations & the method of dynamic compaction for purposes of site remediation
4.	Familiarize with the methods of analysis of dynamic earth pressure & dynamic bearing capacity of shallow foundations
5.	Study the phenomenon of liquefaction and comprehend the anti-liquefaction measures

COURSE OUTCOMES

CO1	Develop skill in applying theory of vibrations to basic facets of soil behaviour under dynamic loading together with the exposure of the fundamental principles of wave propagation in soil.
CO2	Evaluate the dynamic properties of soil and be able to perform relevant tests in laboratory and in the field for the proportioning of foundations which can tolerate dynamic loads.
CO3	Apply the general principles for the design of machine foundation & familiarize with site improvement techniques like dynamic compaction, foundation isolation.
CO4	Recognize & differentiate between the conventional behavior and the behavior under the influence of dynamic loads for the analysis of dynamic earth

	pressure & bearing capacity.
CO5	Predict the liquefaction potential of sites and select appropriate mitigation measures for achieving safety of them.

SYLLABUS

Module I

Theory of Vibrations – General, Basic Terminologies, Harmonic Motion, Vibrations of a SDOF system, Vibration isolation, Theory of Vibration Measuring Instruments, Vibration of Multi Degree of Freedom Systems

8 Lectures

Module II

Wave Propagation in an Elastic, Homogeneous & Isotropic Medium – Stress, Strain & Elastic Constants, Longitudinal Elastic Waves in a rod of infinite length, Longitudinal vibrations of rods of infinite length, Torsional Vibrations of rods of infinite & finite length, End Conditions, Wave propagation in an infinite, homogeneous, isotropic, elastic medium, Wave propagation inelastic half space, Geophysical prospecting

8 Lectures

Module III

Dynamic Properties of Soils, Dynamic Compaction of Soils &General principles of Machine foundation design - Dynamic soil testing technique, Laboratory and field tests, Factors affecting Shear modulus, Elastic modulus & Elastic constants, Types of Machines and Machine Foundations, General requirements of Machine Foundations, Permissible amplitude, Allowable soil pressure, Permissible stresses of Concrete, Steel & Timber

8 Lectures

Module IV

Dynamic Earth Pressures & Bearing capacity of shallow footings subjected to dynamic loading–Active & Passive pressures, Retaining walls subjected to dynamic load; graphical construction, I.S. code of practice, Pseudo – static methods & Displacement analysis, Bearing capacity of footings; Pseudo – static analysis; Settlement, tilt & Horizontal Displacement, Dynamic Analysis

8 Lectures

Module V

Liquefaction of Foundation soils –definitions, mechanism of liquefaction, field conditions for soil liquefaction, Standard curves & correlations for liquefaction, Evaluation of zone of liquefaction in field, Evaluation of liquefaction potential using SPT, factors affecting liquefaction& anti liquefaction measures

8 Lectures

TEXTBOOKS:

1. Soil Dynamics & Machine Foundations by Shamsher Prakash

2. Soil Dynamics & Machine Foundations by Swami Saran

REFERENCE BOOKS:

1. Foundation for Bases & Machines by D. Barkan
2. Machine Foundations by A. Major

Gaps in the syllabus to meet Industry/Profession requirements
Exposure to field problems

POs met through Gaps in the Syllabus PO4

Topics beyond syllabus/Advanced topics/Design
Exposure to software

POs met through Topics beyond syllabus/Advanced topics/Design PO5

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	3
CO2	3	3	3	2	1	3
CO3	3	3	3	2	1	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	1	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4, CD6
CO2	CD1, CD2, CD4, CD6
CO3	CD1, CD2, CD4, CD6
CO4	CD1, CD2, CD4, CD6
CO5	CD1, CD2, CD3,CD4, CD6

COURSE INFORMATION SHEET

Course code: CE519
Course title: Soil Exploration
Pre-requisite(s): Basics of Soil Mechanics
Co- requisite(s): Performance of laboratory experiments to determine properties of soil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: M.Tech.
Semester / Level: II /5
Branch: Civil Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students:

A.	To learn about objects and stages of site investigation; types of samples and samplers.
B.	To know about the different boring methods.
C.	To impart knowledge about standard penetration test, static and dynamic cone penetration tests, in-situ vane shear test, geophysical exploration methods.
D.	To know about plate load test, pressuremeter test, piezometer, slope inclinometer, location of ground water table.
E.	To learn about offshore exploration; preparation of site investigation report.

COURSE OUTCOMES

After the completion of this course, students will be:

1.	Students would be able to identify the objects of site investigation; and describe the use of different types of samples and samplers.
2.	Students would understand the process of soil exploration by different boring methods.
3.	Students shall be able to perform standard penetration test, static and dynamic cone penetration tests, in-situ vane shear test, geophysical exploration methods.
4.	Students will be capable of carrying out plate load test, pressuremeter test; using piezometer, slope inclinometer; able to locate ground water table.
5.	Students would be able to perform offshore exploration, prepare site investigation report.

SYLLABUS

Module I

Introduction and Types of samples and sample disturbance: Objects of site investigation, Information obtained from site investigation, Disturbed and Undisturbed samples; Representative and Non-Representative samples, Area ratio, Inside clearance, Outside clearance, Recovery ratio; Methods of preventing loss of sample; Preservation of samples, Types of samplers.

8 Lectures

Module II

Direct method and Semi-direct methods of soil exploration: Direct methods – Test pits, Trial pit/ Trenches. Semi-direct methods- Boring – Auger boring, Auger and Shell boring, Wash boring, Percussion drilling, Rotary drilling; Layout and number of boreholes, Depth of borehole; Stabilization of borehole.

8 Lectures

Module III

Indirect methods of soil exploration: Standard penetration test, Static cone penetration test, Dynamic cone penetration test, In- Situ vane shear test; Geophysical Exploration – Seismic refraction, Electrical resistivity.

8 Lectures

Module IV

Other field tests and Location of ground water table: Plate load test, Pressuremeter test, Piezometer, Slope inclinometer, Permeability test. Location of ground water table- Hvorslev method.

8 Lectures

Module V

Offshore exploration and Preparation of site investigation report: Offshore exploration, Methodology of report writing of site investigation –Introduction, Borehole log, Field and, Laboratory test results, Analysis of data, Conclusions and Recommendation.

8 Lectures

TEXT BOOKS:

Venkatramaiah C. "Geotechnical Engineering", New Age International Limited, New Delhi.
Punmia, B.C. "Soil Mechanics And Foundations" Laxmi Publications, New Delhi.

REFERENCE BOOKS:

Ranjan, G., Rao, A.S.R. "Basics And Applied Soil Mechanics", New Age International Limited, New Delhi.
Moitra, Debashis. " Geotechnical Engineering", Universities Press, Hyderabad.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	3
CO2	3	3	3	2	1	3
CO3	3	3	3	2	1	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	1	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4, CD6
CO2	CD1, CD2, CD3, CD4, CD6
CO3	CD1, CD2, CD3, CD4, CD6
CO4	CD1, CD2, CD3, CD4, CD6
CO5	CD1, CD2, CD4, CD6

COURSE INFORMATION SHEET

Course code: CE520
Course title: Earth and Earth Retaining Structures
Pre-requisite(s): Basics of Soil Mechanics
Co- requisite(s):
Credits:3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: M.Tech.
Semester / Level: II /5
Branch: Civil Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students:

A.	To learn about lateral earth pressures.
B.	To know about the mechanically stabilized earth walls.
C.	To impart knowledge about sheet pile walls.
D.	To know about walls for excavations.
E.	To learn about design of cofferdams.

COURSE OUTCOMES

After the completion of this course, students will be:

1.	Students would be able to identify and solve problems relating to earth pressures.
2.	Students would understand the process of constructing mechanically stabilized earth walls.
3.	Students shall be able to perform designs involving sheet pile walls.
4.	Students will be capable of constructing walls for excavations.
5.	Students would be able to solve problems involving cofferdams.

SYLLABUS

Module I

Lateral earth pressure: Active earth pressure, Passive earth pressure, Earth pressure at rest, Coulomb earth pressure theory, Rankine earth pressure theory, Earth pressure on walls, Retaining walls problems.

8 Lectures

Module II

Mechanically stabilized earth walls:
Mechanically reinforced earth walls, Design of reinforced earth walls, Wall stability, Wall joints, Soil properties for retaining walls, Allowable bearing capacity, Wall settlements, Retaining walls of varying heights.

8 Lectures

Module III

Sheet pile walls: Types and materials used for sheetpiling, Soil properties for sheet pile wall, Stability number for sheet pile wall, Sloping dredge line, Anchor rods, Wales, Wall stability and safety.

8 Lectures

Module IV

Walls for excavations: Construction excavations, Soil pressures on braced excavation walls, Ground loss around excavations, heave, Construction dewatering.

8 Lectures

Module V

Cellular cofferdams: Types and uses, Cell fill, Stability and design of cellular cofferdams, Bearing capacity, Cell settlement, Diaphragm cofferdam cell.

8 Lectures

TEXT BOOKS

Bowles, J.E. "Foundation Analysis And Design", McGraw Hill Education

REFERENCE BOOKS

Venkatramaiah C. "Geotechnical Engineering", New Age International Limited, New Delhi.
Moitra, Debashis. " Geotechnical Engineering", Universities Press, Hyderabad.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (CO) Attainment Assessment Tools And Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	3
CO2	3	3	3	2	1	3
CO3	3	3	3	2	1	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	1	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4, CD6
CO2	CD1, CD2, CD4, CD6
CO3	CD1, CD2, CD4, CD6
CO4	CD1, CD2, CD4, CD6
CO5	CD1, CD2, CD4, CD6

COURSE INFORMATION SHEET

Course code: CE523
Course title: Rock Mechanics and Tunnelling
Pre-requisite(s): Basics of Soil Mechanics
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: M.Tech.
Semester / Level: II /5
Branch: Civil Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students:

A.	To know about scope and problems of Rock Mechanics
B.	To understand rock classification, rock coring, laboratory testing of rocks.
C.	To understand deformation characteristics of rocks, permeability characteristics
D.	To know about mechanical, thermal and electrical properties of rock mass.
E.	To know about bearing capacity of homogeneous as well as discontinuous rocks.

COURSE OUTCOMES

After the completion of this course, students will be:

1.	Students should be conversant with scope and problems of Rock Mechanics
2.	Students should be exposed with Rock exploration, laboratory testing etc.
3.	Student should be conversant with Deformation characteristics of rocks.
4.	Student should be conversant with mechanical, thermal and electrical properties of rock mass
5.	Student should be conversant with Rock mechanics application, bearing capacity of homogeneous as well as discontinuous rocks, Rock bolting plastic mechanics

SYLLABUS

Module I

Introduction objective, scope and problems of Rock Mechanics, Classification by origin, Lithological, Engineering.

8 Lectures

Module II

Rock exploration rock coring, geophysical methods. Laboratory testing of rocks, all types of compressive strength, tensile and flexural strength tests, Strength and failure of rocks.

8 Lectures

Module III

In-situ tests on rock mass Deformation characteristics of rocks, instrumentation and measurement of deformation of rocks. Permeability characteristics, interstitial water on rocks, unsteady flow of water through jointed rock mass.

8 Lectures

Module IV

Correlation between laboratory and field properties. Analysis of stress. Rock support needed to avoid plastic deformation. Linked and unlinked tunnels. Structural discontinuities of rock i.e. faulting, folding, shear planes and joints. Rock mechanics applications.

8 Lectures

Module V

Bearing capacity of homogeneous as well as discontinuous rocks. Delineation of types of rock failure. Rock slope failures i.e. Plane failure, Wedge failure and circular failure. Rock bolting.. Tunnels, shapes, usages, Methods of Construction, Problems associated with tunnels; Tunnelling in various subsoil conditions and rocks

8 Lectures

TEXT BOOKS

1. Fundamentals of Rock Mechanics by Jaeger and Cook
2. Rock Mechanics in Engineering Practice by K. G. Stagg and O. C Zienkiewicz
3. Rock Slope Stability by E. Hoek and Bray.

REFERENCE BOOKS

1. Design Methods in Rock Mechanics by C. Fairhurst
2. Applications of Rock Mechanics by Jr. E. R. Hoskins
3. New Horizons in Rock Mechanics by Jr. H. R. Hardy
4. Rock Mechanics and Design of Structures by O'Bert and Leonard

Gaps in the syllabus (to meet Industry/Profession requirements)

Design of real-time industrial projects.

Topics beyond syllabus/Advanced topics/Design

Application of Rock mechanics in the field of slope stability and tunnel construction and foundation of dams & bridges.

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (Co) Attainment Assessment Tools And Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	1	3
CO2	3	2	3	2	1	3
CO3	3	2	3	2	1	3
CO4	3	2	3	2	1	3
CO5	3	2	3	2	1	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4, CD5, CD6
CO2	CD1, CD2, CD4, CD5, CD6
CO3	CD1, CD2, CD4, CD5, CD6
CO4	CD1, CD2, CD4, CD5, CD6
CO5	CD1, CD2, CD4, CD5, CD6

COURSE INFORMATION SHEET

Course code : CE554
Course title : Environmental Geotechnics
Pre-requisite(s) : 1. Geotechnical Engineering.
2. Environmental Engineering

Co- requisite(s) :
Credits : 3 (L: 3 T: 0 P: 0)
Class per week : 3
Class : MTech.
Semester / Level : II/5
Branch : Civil Engineering
Name of Teacher :

COURSE OBJECTIVES:

This course enables the students:

1.	To know about the fundamentals of Geo-environmental Engineering
2.	To have a thorough knowledge on soil water interaction and contamination
3.	To study about waste containment system
4.	To know about the various remediation methods of a contaminant site
5.	To study about soil characterization using advanced methods

COURSE OUTCOMES:

After the completion of this course, students will be:

CO1	Able to know the role of soil in geo-environmental applications and impact of ground contamination on geo-environment
CO2	Able to understand the concept of soil water interaction, unsaturated soil and its importance in geo-environmental problems and factors effecting retention and transport of contaminants
CO3	Able to have an idea on role of soil in waste containment, different components of waste containment system and its stability and able to design waste containment facilities
CO4	Able to plan site remediation methods
CO5	Able to characterize soil using advanced methods

SYLLABUS

Module I

Fundamentals of Geo-environmental Engineering- Scope of geo-environmental engineering -multiphase behaviour of soil – role of soil in geo-environmental applications –importance of soil physics, soil chemistry, hydrogeology, biological process –sources and type of ground contamination– impact of ground contamination on geo-environment - case histories on geo-environmental problems.

8 Lectures

Module II

Soil-Water-Contaminant Interaction- Soil mineralogy characterization and its significance in determining soil behavior – soil-water interaction and concepts of double layer – forces of interaction between soil particles. Concepts of unsaturated soil – importance of unsaturated soil in geo-environmental problems - measurement of soil suction -water retention curves - water flow in saturated and unsaturated zone. Soil-water-contaminant interactions and its implications – Factors effecting retention and transport of contaminants

8 Lectures

Module III

Waste Containment System-Evolution of waste containment facilities and disposal practices – Site selection based on environmental impact assessment –different role of soil in waste containment – different components of waste containment system and its stability issues – property evaluation for checking soil suitability for waste containment – design of waste containment facilities

8 Lectures

Module IV

Contaminant Site Remediation -Site characterization – risk assessment of contaminated site – remediation methods for soil and groundwater – selection and planning of remediation methods – some examples of in-situ remediation

8Lectures

Module V

Advanced Soil Characterization -Contaminant analysis-water content and permeability measurements – electrical and thermal property evaluation – use of GPR for site evaluation - introduction to geotechnical centrifuge modeling

8 Lectures

TEXTBOOKS

1. Geotechnical and Geo-environmental Engineering Handbook by Rowe R.K., Kluwer Academic Publications, London, 2000.

2. Geo-environmental Engineering, Principles and Applications" by L. N. Reddi and H. I. Inyang, by Marcel Dekker Inc. New York, 2000.

3. Geo-environmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation by R. N. Yong, CRC Press, New York, 2001.

4. Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies by H.D. Sharma and K.R. Reddy, John Wiley & Sons, Inc., USA, 2004.

5. Soil Mechanics for Unsaturated Soils by D.G. Fredlund and H. Rahardjo, Wiley-Interscience, USA, 1993.

6. Fundamentals of Soil Behaviour by J. K Mitchell, Wiley, 2005.

REFERENCE BOOKS:

1. Introduction to Environmental Soil Physics by D Hillel, Academic Press, New York, 2003.

2. Environmental Soil Chemistry by D.L. Sparks, "Academic Press, New York, 2002.
3. Design of landfills and integrated solid waste management by A. Bagchi, John Wiley & Sons, Inc., USA, 2004.

4. Soil-Water-Solute Process Characterization: An Integrated Approach by J. Alvarez-Benedi and R. Munoz-Carpena, R., "CRC Press, New York, 2005.

5. Berkowitz, B. Dror, I. and Yaron, B., "Contaminant Geochemistry" Springer, Germany, 2008.

6. Mohamed, A. M. O., "Principles and Applications of Time Domain Electrometry in Geo-environmental Engineering" Taylor and Francis, New York, 2006

Gaps in the syllabus (to meet Industry/Profession requirements)
Analysis of field problems

POs met through Gaps in the Syllabus
PO3

Topics beyond syllabus/Advanced topics/Design
Modelling using software

POs met through Topics beyond syllabus/Advanced topics/Design
PO3, PO4

Course Outcome (Co) Attainment Assessment Tools And Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	2	3	3	3	3
CO3	3	2	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	2	3	3	3	3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD4, CD6
CO3	CD1, CD2, CD4, CD6
CO4	CD1, CD2, CD4, CD5.CD6
CO5	CD1, CD2, CD3,CD6

COURSE INFORMATION SHEET

Course code: CE556
Course title: Groundwater Flow
Pre-requisite(s):
Co- requisite(s):
Credits:3 L: 3 T:0 P:0
Class schedule per week: 3
Class: M.Tech.
Semester / Level: LEVEL 5
Branch: CIVIL ENGINEERING
Name of Teacher:

COURSE OBJECTIVES

This course enables the students:

A.	To understand concepts of hydrogeology and groundwater flow. (K1, K2)
B.	To measure and improve the quality of groundwater. (K2, K3, K4)
C.	To investigate the available of groundwater resources. (K3, K4, K5)
D.	To design groundwater flow models. (K3, K4, K5)

COURSE OUTCOMES

After the completion of this course, students will be able to:

1.	Understand the aquifer parameters for estimation of groundwater resources at different geological conditions. (K1, K2)
2.	Understand well hydraulics and analyse the flow. (K2, K3, K4)
3.	Model the groundwater flow and design the artificial groundwater recharge. (K3, K4, K5)
4.	Investigate the ground water resources using different techniques. (K2, K3, K4, K5)
5.	Measure and analyse the groundwater quality. (K3, K4, K5)

SYLLABUS

Module I

Hydrogeology: *Introduction:* Groundwater development in India, Conjunctive use of groundwater, Groundwater in the hydrologic cycle, Vertical distribution of Groundwater, Geologic formations of aquifers, Types of aquifers, Storage Coefficient.
Groundwater Movement: Darcy's law, Permeability, Hydraulic Conductivity, Anisotropic Aquifers, Groundwater Flow rates and flow directions, General flow equations.

8 Lectures

Module II

Well Hydraulics: Steady unidirectional flow, Steady radial flow in a well, Well in a uniform flow, Unsteady radial flow in confined and unconfined aquifers, Well flow near aquifer

boundaries, Characteristic well losses, Specific capacity, Recharge methods, Artificial recharge, Water spreading, Wastewater Recharge, Recharge mounds.

8 Lectures

Module III

Groundwater Modeling Techniques: Groundwater models, Porous media models, Analog models, Electrical analog models, Digital computer models.

8 Lectures

Module IV

Groundwater Geophysical Investigations: Surface geophysical techniques, Electrical resistivity, Seismic refraction and reflection, Remote Sensing application.

8 Lectures

Module V

Groundwater Quality: Water sampling, Groundwater quality standards, Potable water standards of WHO, Geotechnical survey of groundwater for various requirements.

8 Lectures

TEXT/REFERENCE BOOKS

1. Ground Water Engineering, D. K. Todd, John Wiley.
2. Ground Water, H. M. Raghunath, New Age International.
3. Ground Water Hydrology, H. Bowner, McGraw Hill.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	✓
Tutorials/Assignments	✓
Seminars	✓
Mini projects/Projects	✓
Laboratory experiments/teaching aids	✓
Industrial/guest lectures	✓
Industrial visits/in-plant training	✓

Self- learning such as use of NPTEL materials and internets	✓
Simulation	✓

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
End Sem Examination Marks	50
Quizes	10+10+10
Assignment	10
Seminar	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
End Sem Examination	✓	✓	✓	✓	✓
Quiz 1	✓	✓			
Quiz 2			✓		
Quiz 3				✓	✓
Assessment	✓	✓	✓	✓	✓
Seminar	✓	✓	✓	✓	✓

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	3	3	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	2	3	3

Mapping Between COs and Course Delivery (CD) methods				
CD	Course Delivery methods		Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD5, CD8
CD2	Tutorials/Assignments		CO2	CD1, CD5, CD8

CD3	Seminars		CO3	CD1, CD2, CD5, CD8, CD9
CD4	Mini projects/Projects		CO4	CD1, CD5, CD8
CD5	Laboratory experiments/teaching aids		CO5	CD1, CD5, CD8
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self- learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code	**:**	**CE558**
Course title	**:**	**GROUND IMPROVEMENT TECHNIQUES**
Pre-requisite(s)	**:**	**Soil Mechanics & Foundation Engineering at Bachelor's level**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**II/5**
Branch	**:**	**Civil Engineering**

COURSE OBJECTIVES:

Develop expertise in selecting, customising and applying site – specific solutions for the improvement of poor in-situ soil conditions to suit the contextual and desired level of Civil Engineering performance.

COURSE OUTCOMES:

CO1	Familiarize with difficult ground conditions which require improvement.
CO2	Comprehend the principles of mechanical, hydraulic, chemical & thermal improvements of poor soil conditions.
CO3	Study the mechanism of soil reinforcements.
CO4	Suggest appropriate methods of modification for weak site conditions.
CO5	Assess the degree of improvement attained by application of different site suitable ground improvement techniques.

SYLLABUS

Module I

Introduction & soil reinforcement: Situations where ground improvements become necessary; mechanism of reinforced earth; different types of reinforcements;

8 Lectures

Module II

Mechanical Modification: Methods of compaction; blasting; vibro-floatation; stone columns;

8 Lectures

Module III

Hydraulic Modification: dewatering systems; preloading & pre-compression; vertical drains; electro-kinetic dewatering;

8 Lectures

Module IV

Chemical Modification: Improving by admixtures; grouting; wastes;

8 Lectures

ModuleV

Thermal Modification: Ground freezing & thawing;

8 Lectures

RECOMMENDED BOOKS

TEXT BOOKS:

1. Earth Reinforcement and Soil Structures by C. J. F. P. Jones
2. Soil Improvement Edited by J. P. Welsh

REFERENCE BOOKS:

1. Construction and Geotechnical Methods in Foundation Engineering by R.M., Koerner, McGraw-Hill
2. Geotechnical Engineering Principles and Practices by D.P. Coduto, Prentice Hall of India Pvt. Ltd., New Delhi
3. Principles of Foundation Engineering by B. M. Das, Thomson Books/Cole.

Gaps in the syllabus (to meet Industry/Profession requirements)

Exposure to field problems

POs met through Gaps in the Syllabus: PO4

Topics beyond syllabus/Advanced topics/Design:

Design of field problems

Pos met through Topics beyond syllabus/Advanced topics/Design: PO5

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	3
CO2	3	3	3	2	2	3
CO3	3	3	3	2	2	3
CO4	3	3	3	2	2	3
CO5	3	3	3	2	2	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD3, CD4, CD5, CD6, CD7

CO2: CD1, CD2, CD3, CD4, CD6

CO3: CD1, CD2, CD3, CD4, CD5, CD6

CO4: CD1, CD2, CD3, CD4, CD5, CD6, CD7

CO5: CD1, CD2, CD3, CD4, CD5, CD6, CD7

COURSE INFORMATION SHEET

Course code: CE562
Course title: Stability of Slopes
Pre-requisite(s): Basics of Soil Mechanics
Co- requisite(s): None
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: M.Tech.
Semester / Level: II/ Level 5
Branch: Civil Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students:

A.	To know about aims of stability analysis, natural slopes and its stability, man-made slopes, Types of Slope movement and its consequences.
B.	To analyse stability of slope by Fellenius method, Bishop's method and Morgenstern-Price methods, Effect of ground water table i.e. Seepage force, hydrostatic force, Excess Pore water pressures, Seismic and Blast vibration effect on slope. Embankment and earth rock dams. Behaviour of rock slope in presence of structural discontinuities, weak and fragmented rock, rock mass rating
C.	To know about different geo-engineering parameters influencing stability of internal dump and external dump
D.	To be exposed for solving stability problems of internal dump, external dump and rock high wall of opencast mines
E.	To be conversant with Slope Protection measures like Drum- debris walls, Geo-textiles and Geo-membranes, Geo-grids and Gabions, Re-vegetation mats, Braced coffer dams – walls and supports, bottom heave and piping, Cellular coffer dams, Cantilever sheet pile walls, Anchored Bulkheads with Free and Fixed Earth supports, Rowe's moment reduction method and Modified equivalent Beam method, Bulkhead anchorages, Failures in Anchored Bulkheads

COURSE OUTCOMES

After the completion of this course, students will be:

1.	Student shall be exposed to aims of stability analysis, natural slopes and its stability man Made slopes, Geomorphology and Slopes, Types of Slope movement and Land slides

2.	Student shall be analyse stability of slope by Fellinius method, Bishop's method, Effect of ground water table i.e. Seepage force, hydrostatic force, , Seismic and Blast vibration effect on slope. Embankment and earth rock dams. behaviour of rock slope in presence of structural discontinuities, weak and fragmented rock, rock mass rating
3.	Students should understand different geo-engineering parameters influencing stability of internal dump, external dump and rock slope
4.	Student shall be able to determine Factor of Safety of internal dump, external dump and rock high-wall of opencast mines
5.	Student shall be conversant with Slope Protection measures like Geo-textiles and Geomembranes, Geo-grids and Gabions, Braced coffer dams – walls and supports, bottom heave and piping, Cellular coffer dams, Cantilever sheet pile walls, Anchored Bulkheads with Free and Fixed Earth supports, Rowe's moment reduction method and Modified equivalent Beam method, Bulkhead anchorages, Failures in Anchored Bulkheads.

SYLLABUS

Module I

Introduction Stability of Slopes, Aims of Slope Analysis, Natural Slopes and their stability, Slopes, Geomorphology and Slopes, Types of Slope movement and Landslides.

8 Lectures

Module II

Methods of Analysis :- Fellinius method, Bishop's method and Morgestern- Price methods, approach, Statistical and Probabilistic analysis Seepage force, hydrostatic force, , Seismic and Blast vibration effect on slope. Embankment and Earth -rock dams Behaviour of rock slope in presence of structural discontinuities, We fragmented rock, Rock Mass rating. Case studies of Slope failure.

8 Lectures

Module III

Geo-engineering Parameters influencing Stability of Internal dump, External dump and rock highwall.

8 Lectures

Module IV

Stability Analysis of Internal Dump, External Dump and Rock Highwall.

8 Lectures

Module V

Slope Protection Geo-textiles and Geo-membranes, Geo-grids, Coffer dams Braced coffer dams – walls and supports, bottom heave and piping, Cellular Sheet Piles :- Cantilever sheet pile walls, Bulkhead anchor Failures in Anchored Bulkheads

8 Lectures

TEXT BOOKS

1. Rock Slope Engineering by E. Hoek and Bray
2. Slope Stability by R.N Chowdhury
3. Soil Mechanics by T. William Lambe and Robert V. Whitman

REFERENCE BOOKS

1. A handbook on Dragline Dump profiles in Surface Coal mines of India by I Roy & S. Sengupta

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements)

Design of real-time industrial projects.

Topics beyond syllabus/Advanced topics/Design

Slope stability analysis of existing and future slope

POs met through Topics beyond syllabus/Advanced topics/Design

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD 1	Lecture by use of boards/LCD projectors/OHP projectors
CD 2	Tutorials/Assignments
CD 3	Seminars
CD 4	Mini projects/Projects
CD 5	Laboratory experiments/teaching aids
CD 6	Industrial/guest lectures
CD 7	Industrial visits/in-plant training
CD 8	Self- learning such as use of NPTEL materials and internets

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

Course Outcome	**Program Outcomes**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	1	3
CO2	3	2	3	2	1	3
CO3	3	2	3	2	1	3
CO4	3	2	3	2	1	3
CO5	3	2	3	2	1	3

< 34 % = 1, 34-66 % = 2, > 66 % = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHODS

Course Outcome	Course Delivery Method
CO1	CD1, CD2, CD3,CD5,CD8
CO2	CD1, CD2, CD3, CD8
CO3	CD1, CD2, CD3,CD5,,CD6, CD8
CO4	CD1, CD2, CD3, CD7, CD8
CO5	CD1, CD2, CD3,CD5,CD8

COURSE INFORMATION SHEET

Course code: CE588
Course title: Soil Testing Laboratory
Pre-requisite(s): Basics of Soil Mechanics
Co- requisite(s): None
Credits:2 L: 0 T: 0 P: 4
Class schedule per week: 4
Class: M.Tech.
Semester / Level: II**/** Level 5
Branch: Civil Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

A.	Learn Moisture content, Specific gravity, Atterberg limits tests.
B.	Learn Grain size distribution, Proctor tests.
C.	Learn Unconfined compression, Triaxial tests.
D.	Learn Direct shear test, Vane Shear tests.
E.	Learn Sand replacement, Core cutter, Permeability tests.

COURSE OUTCOMES

After the completion of this course, students will be:

1.	Perform Moisture content, Specific gravity, Atterberg limits tests.
2.	Perform Grain size distribution, Proctor tests.
3.	Perform Unconfined compression, Triaxial tests.
4.	Perform Vane Shear tests.
5.	Perform Sand replacement, Core cutter, Permeability tests.

List of Experiments

Experiment 1: Determination of moisture content and specific gravity
Experiment 2: Determination of Atterberg limits
Experiment 3: Determination of Grain size distribution
Experiment 4: Proctor compaction test
Experiment 5: Unconfined compression test
Experiment 6: Triaxial test
Experiment 7: Direct shear test
Experiment 8: Vane shear test

Experiment 9: Sand replacement and Core cutter test
Experiment 10: Permeability test (constant and variable head)

TEXT BOOKS

Punmia, B.C. "Soil Mechanics and Foundations", Laxmi Publications
Venkatramaiah, C. "Geotechnical Engineering", New Age International Limited, New Delhi.

REFERENCE BOOKS

Murthy, V.N.S. "Soil Mechanics and Foundation Engineering." CBS Publishers

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (Co) Attainment Assessment Tools And Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	2	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD2, CD3, CD4, CD5, CD6
CO2	CD2, CD3, CD4, CD5, CD6
CO3	CD2, CD3, CD4, CD5, CD6
CO4	CD2, CD3, CD4, CD5, CD6
CO5	CD2, CD3, CD4, CD5, CD6

COURSE INFORMATION SHEET

Course code: CE589
Course title: Design of Foundations
Pre-requisite(s): Basics of Soil Mechanics
Co- requisite(s): None
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 4
Class: M.Tech.
Semester / Level: II/ Level 5
Branch: Civil Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

A.	Learn Consolidation test, California bearing ratio
B.	Learn Electro osmosis test, Relative density test
C.	Learn Dynamic cone penetration test, Standard penetration test
D.	Learn North Dakota test, Plate load test
E.	Learn Plotting of phreatic lines, Point load test

COURSE OUTCOMES

After the completion of this course, students will be:

1.	Perform Consolidation test, California bearing ratio
2.	Perform Electro osmosis test, Relative density test
3.	Perform Dynamic cone penetration test, Standard penetration test
4.	Perform North Dakota test, Plate load test
5.	Perform Plotting of phreatic lines, Point load test

List of Experiments

Experiment 1: Consolidation test
Experiment 2: California bearing test
Experiment 3: Electro-Osmosis test
Experiment 4: Relative density test
Experiment 5: Dynamic cone penetration test
Experiment 6: Standard penetration test
Experiment 7: North Dakota test
Experiment 8: Plate load test

Experiment 9: Plotting of Phreatic lines
Experiment 10: Point load test

TEXT BOOKS

Punmia, B.C. "Soil Mechanics and Foundations", Laxmi Publications
Venkatramaiah, C. "Geotechnical Engineering", New Age International Limited, New Delhi.

REFERENCE BOOKS

Murthy, V.N.S. "Soil Mechanics and Foundation Engineering." CBS Publishers

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Outcome (Co) Attainment Assessment Tools And Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as use of NPTEL materials and internets

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	2	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD2, CD3, CD4, CD5, CD6
CO2	CD2, CD3, CD4, CD5, CD6
CO3	CD2, CD3, CD4, CD5, CD6
CO4	CD2, CD3, CD4, CD5, CD6
CO5	CD2, CD3, CD4, CD5, CD6

Proposed Course Curriculum for M.Tech. (Civil Engineering) -With Specialization in Environmental Engineering

Second Semester

Theory Courses (Any Five Courses)

Course Code	Course	L-T-P	Credits
CE529	Water Supply Engineering	3-0-0	3
CE532	Wastewater Engineering	3-0-0	3
CE533	Air Pollution and Control	3-0-0	3
CE534	Solid Waste Management	3-0-0	3
CE537	Environmental Impact Assessment	3-0-0	3
CE572	Industrial Safety and Occupational Health	3-0-0	3
CE563	Climate Change and Sustainable Development	3-0-0	3
CE574	Renewable Energy Technology	3-0-0	3
CE590	Environmental Quality and Monitoring	3-0-0	3
CE527	Ecological Engineering	3-0-0	3

Laboratory Courses

Course Code	Course	L-T-P	Credits
CE591	Water and Wastewater Analysis Laboratory	0-0-4	2
CE592	Air and Soil Analysis Laboratory	0-0-4	2
MT133	Communication Skills - II	0-0-3	1.5

Total credits in Second Semester = 20.5

Third Semester

Course Code	Course	L-T-P	Credits
CE513	Thesis (Part – I)		8
	OE – I/ MOOC – I		3
	OE – II/ MOOC – II		3

Total Credits in Third Semester = 14

Fourth Semester

Course Code	Course	L-T-P	Credits
CE514	Thesis (Part – II)		16

Total Credits in Fourth Semester = 16

Total Credits in M.Tech. Programme = 20.5 + 20.5 + 14 + 16 = 71

Open Electives

To be offered to M.Tech. Students of other Departments

Course Code	Course	L-T-P	Credits
CE593	Environmental Management	3-0-0	3
CE594	Natural Resources Management	3-0-0	3
CE577	Industrial Pollution and Control	3-0-0	3
CE578	Waste Management	3-0-0	3

COURSE INFORMATION SHEET

Course code	**:**	**CE529**
Course title	**:**	**WATER SUPPLY ENGINEERING**
Pre-requisite(s)	**:**	**Environmental Science**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**II/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES:

The course aims to provide a concept of water supply engineering and to use appropriate water treatment techniques To analyse the problem and find a problem-solving **approach**.

COURSE OUTCOMES:

CO1	Understand the water quality for different water supply schemes.
CO2	Apply the to calculate water demand for upcoming or existing establishments over time.
CO3	Apply to identify the sources for specific requirements.
CO4	Implement to understand the existing treatment units and recommend the modern technologies required to meet new standards.
CO5	to analyse the existing distribution network and modernise it.

SYLLABUS

Module I

Water quality: Physical, chemical, Bacteriological characteristics, Epidemiological and toxic aspects, water quality standards, and water quality index.

8 Lectures

Module II

Basics of water supply engineering: Design Period, Population Forecast, Factors affecting population growth, Water Demand, variations in water demand

8 Lectures

Module III

Sources of water and its transportation: Hydrological cycle, Rainfall and runoff, groundwater and its development (equilibrium and non-equilibrium formula), Surface sources, intake structures and conduits, Pumps.

8 Lectures

Module IV

Water treatment units: Conventional water treatment, modern water treatment technologies. Aeration, sedimentation, filtration, membrane filtration (micro-filtration, ultra-filtration, nano-filtration, reverse osmosis), disinfection (and sterilisation), softening, adsorption, ion exchange

8 Lectures

Module V

Distribution Network Water distribution network and its optimisation, service reservoirs, water supply appurtenances, smart water systems.

8 Lectures

RECOMMENDED BOOKS

TEXTBOOKS:

1. Garg, S. K. (2007) Water supply engineering, 18th ed, Vol. I. New Delhi: Khanna Publisher.

2. Chatterjee, A. K.2010.Water supply, Waste disposal and environmental Engineering, 8th ed. New Delhi: Khanna Publisher.

3. CPHEEO 1999. Manual on water Supply and treatment. 3rd Edition

4. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning.

5. Chatterjee, A. K.2010.Water supply, Waste disposal and environmental

Engineering, 8th ed. New Delhi: Khanna Publisher..

REFERENCE BOOKS:

1. Mark J Hammer, Mark J Hammer Jr. (2004). Water and Waste water Technology,

4th edition, Prentice Hall pub.

2. American Water Works Association, Manual, AWWA.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus: Syllabus is framed according to industrial and professional requirement

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Advanced Smart water systems already included in syllabus covers the recent advances in the water supply systems

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10

Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as the use of NPTEL materials and the internet

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	2	2	3
CO2	2	3	1	2	1	1
CO3	3	3	1	1	1	2
CO4	3	3	1	1	3	1
CO5	3	3	3	2	3	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD3, CD6

CO2: CD1, CD2, CD3, CD5, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD3, CD4, CD5, CD6

CO5: CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course code	**:**	**CE532**
Course title	**:**	**WASTEWATER ENGINEERING**
Pre-requisite(s)	**:**	**B.E. /B. Tech in Civil Engineering**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**M.Tech.**
Semester / Level	**:**	**I/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES

This course enables the students to:

1	Explain the basics of wastewater treatment
2	Describe the design and operation of wastewater treatment units
3	Identify specific processes for treatment of different wastewater
4	Evaluate the existing problems and finding alternative sustainable methods for wastewater treatment

COURSE OUTCOMES

After the completion of this course, students will be able to:

CO1.	Categorise terminology and parameters frequently used in wastewater management
CO2.	Appraise different parameters involved in the design of wastewater treatment plants
CO3.	Interpret and illustrate the basics of wastewater treatment methods
CO4.	Design aerobic and anaerobic wastewater treatment plants
CO5	Solve the routine problems in operations, control and management of wastewater treatment plants

SYLLABUS

Module I:

Basics of wastewater:
Quality of sewage, sewage estimation, stormwater estimation, hydraulics of sewer, design of sewer system

8 Lectures

Module II:

Unit operations for sewage treatment:
Preliminary and Primary treatment – screening, comminuting, grit removal, flow measurement, primary sedimentation.

8 Lectures

Module III:

Unit processes for sewage treatment:
Secondary & Tertiary treatment – Microbial growth, suspended growth systems – ASP, SBR, ponds and lagoons, attached growth systems – MBBR.

8 Lectures

Module IV:

Advanced unit processes for sewage treatment & solids management:
Tertiary treatment – nitrogen removal, phosphorus removal; sludge management sludge characteristics, sludge thickening, sludge digestion, sludge disposal.

8 Lectures

Module V:

Anaerobic treatment processes:
Suspended and attached growth systems, traditional and modern reactors.

8 Lectures

Books recommended:

TEXTBOOKS:

1. Metcalf & Eddy (2003) Wastewater engineering: treatment and reuse, 4th ed. New Delhi: Tata McGrawHill.
2. Water and Wastewater Engineering – designs, principle and practice, Mackenzie L. Davis. McGraw-Hill Education

REFERENCE BOOKS:

1. Qasim, Syed R., Motley, Edward M., and Zhu, Guang (2000) Water works engineering: planning, design and operation. New Jersey: Prentice Hall.
2. Nathanson, Jerry A. (2009) Basic environmental technology: water supply, waste management and pollution control, 4th ed. New Delhi: PHI Learning.
3. Garg, S.K. (2007) Sewage disposal and air pollution engineering, 20th ed, Vol. II. New Delhi: Khanna Publisher.
4. Chatterjee, A. K.2010.Water supply, Waste disposal and environmental Engineering, 8th ed. New Delhi: Khanna Publisher.
5. CPHEEO Manual on Sewerage and Sewage treatment, latest edition

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time industrial projects.
POs met through Gaps in the Syllabus: **PO4, PO5 & PO6**

Topics beyond syllabus/Advanced topics/Design:
Modern methods for nutrients removal, biosolids and energy recovery
POs met through Topics beyond syllabus/Advanced topics/Design: **PO4, PO5 & PO6**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	1	1
CO2	3	1	3	2	2	1
CO3	3	1	2	2	1	1
CO4	3	1	2	2	1	1

CO5	3	1	2	2	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: CE 533
Course title: AIR POLLUTION & CONTROL TECHNOLOGY
Pre-requisite(s): NA

Credits:	L:	T:	P:
	3	0	0

Class schedule per week: 3
Class: M.Tech.
Semester / Level: II/5
Branch: Civil
Name of Teacher:

COURSE OBJECTIVES:

This course enables the students to:

A.	Understanding the basic concepts of ambient and indoor air pollution.
B.	Plan and execute ambient and stack air pollution sampling and monitoring.
C.	Explain the role of meteorology in air pollutant dispersal.
D.	Apply the knowledge of air pollution modelling.
E.	Identify appropriate air pollution control devices.

COURSE OUTCOMES

After the completion of this course, students will be able to:

1.	Identify air pollution problems and interpret air quality data.
2.	Design an air pollution sampling and monitoring plan.
3.	Air pollutants prediction modelling.
4.	Suggest suitable air pollution control devices and prepare action plan for control of air pollution.

SYLLABUS

Module I:

Air Pollution: Sources of ambient and indoor air pollution; types of air pollutants, emission inventory, concept of airshed, effects of air pollution in regional and global scale.

8 Lectures

Module II:

Air Quality Monitoring: Objectives, ambient and indoor air sampling methods and devices, stack monitoring, CPCB guidelines for air quality monitoring, analysis of air pollutants and interpretation of air pollution data, source apportionment, air pollution standards and indices.

8 Lectures

Module III:

Atmospheric meteorology and dispersion of air pollutants: Temperature lapse rates and atmospheric stability, inversions, wind profiles, wind velocity and turbulence, plume behaviour, estimation of plume rise, dispersion equations, box model, Gaussian plume model, software (AERMOD, CALPUFF etc.).

8 Lectures

Module IV:

Particulate matter and gaseous pollutants control technologies: Control methods for air pollution, factors affecting selection of control equipment, working principle, design, operational considerations, process control and monitoring, particulate matter and gaseous air pollution control equipment.

8 Lectures

Module V:

Vehicular pollution and noise pollution: Internal combustion engines, technological improvements of engines for reduction of vehicular emissions, after exhaust treatments, alternative transportation fuels, emission measurement and testing, regulation and programs to control vehicular emission. Sources and effects of noise Pollution, measurement, standards, control and preventive measures.

8 Lectures

TEXT BOOKS:

1. Environmental Engineering- Peavy & Rowe. Prentice Hall Pub.
2. Air Pollution Control – Rao and Rao
3. Environmental Pollution and Control – C.S. Rao

REFERENCE BOOKS:

1. Noel de Nevers, Air Pollution Control Engineering, Mc Graw Hill, New York.
2. Arthur C. Stern, Air Pollution (Vol. I – Vol. VIII), Academic Press
3. Introduction to Environmental Engineering and Science, Gilbert M Masters
4. CPCB manual for Guidelines for ambient air quality monitoring. Published By: Dr. B. Sengupta, Member Secretary, Central Pollution Control Board

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

DIRECT ASSESSMENT

Assessment Tool	% Contribution during CO Assessment
Quizzes (3)	3x10 = 30
Seminar	10
Teacher's Assessment	10
Semester End Examination	50

INDIRECT ASSESSMENT –

1. Students' Feedback on Course Outcome

MAPPING OF COURSE OUTCOMES ONTO PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	0	1	1
CO2	3	2	1	2	1	1
CO3	3	1	0	0	1	1
CO4	3	2	0	2	1	1

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Gaps in the syllabus (to meet Industry/Profession requirements):

Design of real-time industrial projects.

POs met through Gaps in the Syllabus: None

Topics beyond syllabus/Advanced topics/Design: Air pollution modelling software POs met through Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design: None

Course Delivery Methods

CD	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Industrial visits/in-plant training
CD5	Self- learning such as use of NPTEL materials and internets
CD6	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Mapping Between COs and Course Delivery (CD) methods	
Course Outcome	Course Delivery Method
CO1	CD1, CD2, CD3, CD5
CO2	CD1, CD2, CD3, CD5
CO3	CD1, CD2, CD3, CD5
CO4	CD1, CD2, CD3, CD5

COURSE INFORMATION SHEET

Course code	**:**	**CE534**
Course title	**:**	**SOLID WASTE MANAGEMENT**
Pre-requisite(s)	**:**	**B.Tech**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**MTech.**
Semester / Level	**:**	**II/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES:

The course aims to develop a concept of solid waste collection, transfer, and transport and to use treatment options and study operations of various material, resource, and energy recovery facilities in an environment-friendly manner.

COURSE OUTCOMES:

CO1	Understand the components and characteristics of a solid waste management system.
CO2	Apply the **to** identify municipal solid waste management's various collection, transfer and transport mechanisms.
CO3	Apply **to** design and operate various processing, material and energy recovery facilities.
CO4	Implement **a plan for** radioactive and biomedical waste management.
CO5	**to analyse and** identify the different hazardous waste management methods.

SYLLABUS

Module I

Fundamentals of Solid Waste Management and ISWM system: Municipal Solid Waste: Sources, types, waste generation rates, factors affecting generation, composition, characteristics, effects of improper disposal, functional elements of solid waste management, the concept of ISWM system. Municipal Solid Waste Rules

8 Lectures

Module II

Waste collection, transportation and processing: Methods of collecting municipal solid wastes, collection vehicles, manpower, collection routes, vehicle routing, transfer station – location and operation.

Waste processing, component separation and volume reduction, various processing technologies, biological and chemical conversion methods, resource and energy recovery, and thermal processing methods.

8 Lectures

Module III

Treatment and disposal Composting, bio methanation, incinerator, pyrolysis, landfill, leachate management and gas control; Environmental monitoring systems for landfill sites, resource recovery.

8 Lectures

Module IV

Radioactive and biomedical waste management sources, classification, health and safety aspects, management of radioactive wastes; Biomedical wastes: sources and categories of biomedical wastes, segregation and color coding, treatment and disposal of biomedical wastes, biomedical wastes management and handling rules

8 Lectures

Module V

Hazardous waste management Sources and characteristics, Classification, health and environmental impacts. Safe storage, transport and treatment of hazardous waste, Hazardous waste management, handling and transboundary movement rules.

8 Lectures

RECOMMENDED BOOKS

TEXTBOOKS:

1. Tchobanoglous G., Theisen H., Vigil S.: Integrated Solid Waste Management Engineering Principles and Management Issues (McGraw Hill Education)
2. Bhatia S.C.: Handbook of Industrial Pollution & Control Vol. 1 (CBS Publishers)
3. G M Masters and Wendell P Ela, introduction to environmental engineering and science, Pearson

REFERENCE BOOKS:

i. CPHEEO, Ministry of Urban Development: Manual on Municipal Solid Waste Management 2000
ii. CPHEEO, Ministry of Urban Development: Manual on Municipal Solid Waste Management 2016

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus: Syllabus is framed according to industrial and professional requirement

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Advanced Smart water systems already included in syllabus covers the recent advances in the water supply systems

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

3. Student Feedback on Faculty
4. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as the use of NPTEL materials and the internet

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	2	2	3
CO2	2	3	1	2	1	1
CO3	3	3	1	1	1	2
CO4	3	3	1	1	3	1
CO5	3	3	1	3	3	1

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD3, CD6

CO2: CD1, CD2, CD3, CD5, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD3, CD4, CD5, CD6

CO5: CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course code : CE 537

Course title :ENVIRONMENTAL IMPACT ASSESSMENT

Pre-requisite(s) : -
Co-requisite : -
Credits :3 (L:3 T:0 P:0)
Class schedule per week :3
Class :M-Tech
Semester / Level :II/5
Branch :Civil Engineering
Name of Teacher :

COURSE OBJECTIVES

This course enables the students:

1	To provide an overview on international conventions, and laws for sustainable environment
2	To develop a basic understanding on the process of environmental impact assessment
3	To understand the components of environmental reports and management plans

COURSE OUTCOMES

After the completion of this course, students will be able to:

CO1.	Identify and analyse the international sustainable development initiatives and reports
CO2.	Understand the features of laws related to environment protection and pollution control
CO3.	Understand the process of Environmental Impact Assessment
CO4.	Analyse and document environmental projects and prepare management plan
CO5	Understand and apply the concepts of environmental audits

SYLLABUS

Module I:

International Conventions: Rio Declaration, COP 21, sustainable development initiatives, Basel Convention, Montreal Protocol, Millennium Development goals, IPCC reports.

8 Lectures

Module II:

Laws and Protocol: Salient features of Acts pertaining to protection of Air, Water, Wildlife, Forest, and Environment in India.

8 Lectures

Module III:

Concepts of EIA: Framework for environmental impact assessment. Environmental clearance, EIA process: Screening, Scoping and baseline studies, Impact Assessment Methods, Public hearing, Mitigation. EIA notification.

8 Lectures

Module IV:

Aspects, Impacts and Management: Review of DPRs and Industrial Case studies, EMP preparation

8 Lectures

Module V:

Environmental audit: Concepts of Environmental auditing, ecolabels and life cycle assessment. Environmental-Social-Governance concepts.

8 Lectures

Books recommended:

TEXT BOOKS:

1. Environmental Impact Assessment: Larry Canter. McGraw Hill Publication.
2. Disaster Management- Edited by R. B. Singh. Rawat Publications. India.

3. Environmental Impact Assessment- A. K. Shrivastava. APH Pub. India.
4. Environmental Impact Assessment. Theory and Practice. Anji Reddy Mareddy, 1st Edition, eBook ISBN: 9780128112380, Paperback ISBN: 9780128111390, Butterworth-Heinemann.
5. Environmental Audit: A.K.Shrivastava. APH pub Corp. New Delhi.
6. ISO 14000: Environmental Management 1st Edition, David L. Goetsch , Stanley Davis. ISBN-13: 978-0130812360. Jenson Books Inc

REFERENCE BOOKS:

1. Methods of Environmental Impact Assessment, Graham Wood,Riki Therivel. ISBN-13: 978-1138647671. Routledge; 4 editions.
2. Climate Change 2014 – Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects. Working Group II Contribution to the IPCC Fifth Assessment Report. Volume 1. Global and Sectoral Aspects. Intergovernmental Panel on Climate Change. December 2014, ISBN: 9781107641655
3. Climate Change 2014 – Impacts, Adaptation and Vulnerability: Part B: Regional Aspects Working Group II Contribution to the IPCC Fifth Assessment Report. Volume 2. ,Intergovernmental Panel on Climate Change, December 2014, ISBN: 9781107683860.
4. Global Green standards: ISO 14000 and Sustainable Development. IISD pub. Minitoba.
5. ISO 14000 Answer Book: Environmental Management for the World Market (Wiley Quality Management) 1st Edition. by Dennis R. Sasseville W. Gary Wilson, Robert W. Lawson . ISBN-13: 978-0471179337. John Wiley and sons. Canada.

Gaps in the syllabus (to meet Industry/Profession requirements) :

Syllabus is framed according to industrial and professional requirement.

Topics beyond syllabus/Advanced topics/Design:

Module 4 covers review of DPRs that will be allow the students to learn and write project reports that require EIA.

POs met through Topics beyond syllabus/Advanced topics/Design: **PO2**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment:

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO 2	PO3	PO4	PO5	PO6
CO 1	3	3	3	2	3	3
CO 2	2	1	3	1	2	2
CO 3	3	3	3	3	3	2
CO 4	3	3	3	2	3	3
CO 5	1	2	2	2	2	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcome	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2, CD8, CD6
CO4	CD1, CD2, CD3
CO5	CD1 ,CD2,CD8,CD6

COURSE INFORMATION SHEET

Course code :**CE572**

Course title :**INDUSTRIAL SAFETY AND OCCUPATIONAL HEALTH**

Pre-requisite(s) : **BTech**
Co-requisite : **-**
Credits :**3 (L:3 T:0 P:0)**
Class schedule per week :**3**
Class :**MTech**
Semester / Level :**II/5**
Branch :**Civil Engineering**
Name of Teacher :

COURSE OBJECTIVES

This course enables the students to:

1	Develop a Strong Foundation in Occupational Health & Industrial Safety
2	Enhance Skills in Hazard Identification, Risk Assessment & Industrial Safety Measures
3	Understand and Apply Industrial Safety Legislation & Modern Safety Technologies

COURSE OUTCOMES

After the completion of this course, students will be able to:

CO1	Demonstrate a comprehensive understanding of OHS principles, legal frameworks and industrial disaster
CO2	Perform Hazard Identification & Risk Assessments
CO3	Design and recommend fire prevention strategies, electrical safety protocols, and hazard mitigation plans
CO4	Interpret and Apply Industrial Safety Legislation
CO5	Leverage Technology for Safety & Environmental Management

SYLLABUS

Module I

Introduction to Occupational Health & Industrial Safety

Concepts & Importance of occupational health and safety (OHS), Occupational Safety and Health Administration (OSHA), Factories Act, 1948 (India), Roles and responsibilities of employers, employees, and safety officers, Case Studies: Major industrial disasters (Bhopal Gas Tragedy, Chernobyl, etc.)

8 Lectures

Module II
Hazard Identification and Risk Assessment (HIRA)

Types of Hazards (Physical, Chemical, Biological, Ergonomic, and psychosocial), ISO 45001, Hazard and Operability Study (HAZOP), Job Safety Analysis (JSA), Preliminary Hazard Analysis (PHA), Fault Tree Analysis (FTA), Risk Identification & Risk Matrix (Severity vs. Likelihood), Hierarchy of Hazard Control, Personal Protective Equipment (PPE) Selection and Use

8 Lectures

Module III
Industrial Hazards and Their Management

Fire: properties of fire, Factors contributing to fire, Common cause of industrial fires. Fire prevention and protection system, Electricity: Hazards, safety measures for electric work, Chemical & Process Safety Hazards

8 Lectures

Module IV
Occupational Safety, Health and Environment Management

Evolution of OSHE in India, The Occupational Safety, Health and Working Conditions (OSHWC) Code, 2020, BIS & OSHA guidelines, Exposure limits (NIOSH, ACGIH, Indian standards), Role of IoT and AI in safety & environment management, CSR and ESG in industrial safety & environment

8 Lectures

Module V
Legislation related to Industrial safety:

Key organizations responsible for enforcement (DGFASLI, BIS, MoLE, CPCB, SPCBs), The Factories Act, 1948, The Mines Act, 1952 & Petroleum Act, 1934, The Environment Protection

Act, 1986 & Related Environmental Laws, The Explosives Act, 1884 & The Dangerous Machines (Regulation) Act, 1983, The Electricity Act, 2003.

8 Lectures

Books recommended:

TEXTBOOKS:

1. R.K.Jain and Sunil S.Rao , Industrial Safety, Health and Environment Management Systems, Khanna publishers , New Delhi (2006) (**T1**)
2. Herman Koren and Michel Bisesi, Handbook of Environmental Health and Safety: Jaico Publishing House, Delhi (1999). (**T2**)
3. Rao.S /Saluja H.L., Electrical Safety, Fire Safety Engineering and Safety Management, Publishers: Khanna Publishers, 1998 (**T3**)
4. L.M. Deshmukh, Industrial safety management, Tata Mcgraw Hill, New Delhi, 2006. (**T4**)

REFERENCE BOOKS:

1. **"Industrial Safety, Health, and Environment Management Systems"** – R. K. Jain & Sunil S. Rao
   Covers Indian laws like the OSHWC Code, 2020, The Environment Protection Act, and BIS safety standards.
2. **"Occupational Health and Safety Management: A Practical Guide"** – Charles D. Reese
   Reference for ISO 45001, OSHA standards, and global safety practices.

Gaps in the syllabus (to meet Industry/Profession requirements):

Exposure to real situations in Industry.

POs met through Gaps in the Syllabus: **PO2, PO3 & PO4**

Topics beyond syllabus/Advanced topics/Design:

Guest lectures by industry professionals can help to develop further in this field.

POs met through Topics beyond syllabus/Advanced topics/Design: **PO2, PO3 & PO4**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	2	1	1	2	3	3
CO2	2	2	1	2	3	3
CO3	2	1	1	2	3	3
CO4	2	1	1	2	3	3
CO5	2	1	2	2	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4, CD5, CD6
CO2	CD1, CD2, CD4, CD5, CD6
CO3	CD1, CD2, CD4, CD5, CD6
CO4	CD1, CD2, CD4, CD5, CD6
CO5	CD1, CD2, CD4, CD5, CD6

COURSE INFORMATION SHEET

Course code: CE563
Course title: CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L:3 T:0 P:0
Class schedule per week:
3 Class: M.Tech.
Semester / Level: /5
Branch: Civil
Name of Teacher:

COURSE OBJECTIVES:

This course enables the students to:

1.	To relate to the natural climate system and causes of climate change.
2.	To predict the vulnerability of natural system due to climate change.
3.	To create risk management plan for climate change.
4.	To develop adaptation strategies based on international and national policies.

COURSE OUTCOMES:

At the end of the course, a student should be able to:

CO1	Able to identify the control factors for climate system.
CO2	Able to analyse the causes of climate change and its effect.
CO3	Able to conduct and formulate a risk and vulnerability assessment plan of climatic impacts on major systems.
CO4	Able to develop sustainable mitigation strategies for climate change and action plan towards a carbon net zero society.

SYLLABUS

Module I:

Elements of climate: Earth's radiation balance, radiation laws, latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, Air masses and fronts, climatic controls, climatic classification.

8 Lectures

Module II:

Climate change causes and effects: Natural and anthropogenic factors of climate change, climatic feedback mechanism and sensitivity. Impacts of climate change, assessing climate impacts on key sectors and systems (heat stress, water resources, coastal zones, agricultural systems, biodiversity), climatic modelling, climate projections and their uncertainties.

8 Lectures

Module III:

Adaptation and risk management: Concepts of coping, adaptation and risk management, adaptive capacity, indicators and metrics, adaptation planning at different levels, strategies and approaches, implementation.

8 Lectures

Module IV:

Mitigation of climate change: Mitigation measures, recent researches to combat climate change, International negotiations and initiatives, UNFCCC, IPCC, policies and measures, carbon credit and carbon footprint and emission trading, calculation of carbon footprints, National Action Plan on Climate Change (NAPCC).

8 Lectures

Module V:

Sustainable development: Concept of sustainable development, SDGs, Historical evolution, Brundtland Report, Sustainable Development Goals (SDGs), principles of sustainable development, challenges, and opportunities. Relation of SDG and climate change, net zero society and related case studies.

8 Lectures

Books recommended:

TEXT BOOK

1. Peixoto, J. P., and Oort, A. H., Physics of Climate, Springer, 1992 (T1)
2. L. D. Danny Harvey, Global warming The Hard Science, Pearson, 1992. (T2)

REFERENCE BOOK

1. Climate Change 2007 - Mitigation of Climate Change: Working Group III contribution to the Fourth Assessment Report of the IPCC (Climate Change 2007), Cambridge University Press, 2007 g) Houghton, J., Global Warming: The Complete Briefing, Cambridge University Press; 2004. (R1)

2. IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4
Progressive Evaluation Marks	✓	✓	✓	✓
End Examination Marks	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	0	0	1	1
CO2	3	3	0	0	1	1
CO3	3	2	0	0	1	1
CO4	3	3	0	0	1	1

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2,CD7
CO4	CD1, CD2

COURSE INFORMATION SHEET

Course code: CE574

Course title: RENEWABLE ENERGY TECHNOLOGY

Pre-requisite(s): Basic Science

Co- requisite(s): Environmental Science

Credits: 3, **L:3, T:0, P:0**
Class schedule per week:3
Class: M.Tech.

Semester / Level: /5 Branch: Environmental Science and Engineering

Name of Teacher:

COURSE OBJECTIVES

This course enables the students to:

1	Gain knowledge about the energy scenario of the world and understand the importance of renewable energy sources
2	Know the facts and information about the various renewable and non-conventional energy sources
3	Realize the potential of renewable energy resources globally and in India for a sustainable future

COURSE OUTCOMES

After the completion of this course, students will be able to:

CO1.	Know about the energy demand and crisis globally and learn about prospects of renewable energy sources and ways of energy conservation
CO2.	To critically know the design parameters and potential of solar energy
CO3	Assess the extent to apply wind energy systems
CO4	Understand the mechanism and processes of geothermal and ocean energy options
CO5	Understand the principles, processes and application of energy from biomass.

SYLLABUS

Module 1

Conventional and non-conventional energy: World energy sources and their classification, Fossil fuels - past, present & future, small hydropower, Alternative energy: Fuel cell: design, operation, classification, conversion efficiency, applications. Hydrogen energy: production methods, storage, transportation and utilization; Thermo nuclear energy; Energy audit – Energy Conservatio

8 Lectures

Module II

Solar energy: Introduction, storage of solar thermal energy, solar window, flat plate collectors and concentrating collectors, Installation of flat plate collectors, performance analysis, effect of various parameters on collector performance, applications of solar energy.

8 Lectures

Module III

Wind energy: Introduction, wind characteristics, air density, power in wind, wind turbines, Lift and drag, Types of rotors, wind energy extraction, extraction of wind turbine power, power density duration curve, Weibull probability density function. Wind rose data, Energy pattern factor in wind power, Beaufort wind scale.

8 Lectures

Module IV

Geothermal and ocean energy: Structure of earth's interior, plate tectonic theory, Geothermal gradients and resources, geothermal power generation, Indian scenario of geothermal energy; Principle of ocean thermal energy conversion system, Principles of Wave and Tidal energy conversion.

8 Lectures

Module V

Energy from Biomass: Introduction, Biomass resources, biofuels, biogas technology, producer gas, liquid fuel, biochemical conversion, biomass gasification, energy recovery from urban waste, power generation from landfill, biodiesel, biomass energy scenario of India.

8 Lectures

Books recommended:

TEXT BOOKS:

1. Renewable energy sources and emerging technologies by D.P. Kothari, K.C. Singal and Rakesh Ranjan, PHI learning private ltd.
2. Non-conventional energy sources by G.D. Rai, Khanna publishers
3. Energy conservation and management by S. s. Thipse, Narosa publication
4. Alternate Energy Sources, Applications and Technologies by N.K. Giri , Khanna Publishers; First edition (2012)
5. Renewable Energy Resources for Sustainable Development, by A.M. Omer, Discovery publishing house (2017)

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus: **PO4, PO5 & PO6**

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: **PO4, PO5 & PO6**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	1	1	2
CO2	3	2	1	2	2	2
CO3	3	1	1	2	2	2
CO4	3	2	1	2	2	2
CO5	3	2	2	2	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code :**CE590**

Course title : **ENVIRONMENTAL QUALITY AND MONITORING**

Pre-requisite(s) : **BTech**
Co-requisite : **-**
Credits :**3 (L:3 T:0 P:0)**
Class schedule per week :**3**
Class :**MTech**
Semester / Level :**II/5**
Branch :**Civil Engineering**
Name of Teacher :

COURSE OBJECTIVES

This course enables the students to:

1	To equip students with an in-depth understanding of environmental quality indicators
2	Enhance Technical Skills in Environmental Monitoring Techniques
3	To enable students to analyze and interpret environmental quality data and familiarize themselves with national and international environmental standards

COURSE OUTCOMES

After the completion of this course, students will be able to:

CO1.	Demonstrate a strong understanding of environmental quality indicators
CO2.	Apply Advanced Monitoring Techniques for Environmental Assessment
CO3	Evaluate and Interpret Pollution Data Using Scientific Indices
CO4	Design and recommend suitable remediation techniques for mitigating soil and water contamination.
CO5	Interpret and apply national and global environmental regulations to ensure compliance in industrial and urban pollution management.

SYLLABUS

Module I

Fundamentals of Environmental Quality & Monitoring Concept of Environmental Quality, Environmental Degradation & Pollution, Monitoring Strategies & Protocols: In-situ vs. ex-situ monitoring, periodic vs. real-time monitoring. National & Global Environmental Standards: CPCB, BIS, WHO, USEPA, ISO 14001.

8 Lectures

Module II

Air Quality Monitoring & Assessment Sources & Types of Air Pollutants: Primary & secondary pollutants, GHGs, aerosols, Ambient Air Quality Monitoring: High-volume samplers, PM2.5 & PM10 monitoring, gaseous pollutant analysers (SO_2, NOx, CO, O_3), Emission Monitoring: Stack sampling, Continuous Emission Monitoring Systems (CEMS), Air Quality Indices (AQI), Advanced Air Monitoring Technologies

8 Lectures

Module III

Water Quality Monitoring & Pollution Control Physicochemical & Biological Parameters: pH, BOD, COD, TSS, TDS, DO, heavy metals, microbial contamination, Surface & Groundwater Quality Monitoring: Sampling techniques, hydrochemical analysis, Water Quality Indices (WQI), Emerging Contaminants

8 Lectures

Module IV

Soil Pollution Monitoring

Soil Quality Indicators: Soil texture, organic matter, pH, heavy metals, nutrient content, Soil Contamination & Remediation Strategies: Bioremediation, phytoremediation, chemical & physical methods.

8 Lectures

Module V

Noise Pollution Monitoring Sources, measurement techniques (sound level meters, noise mapping), Regulatory Framework for Noise Pollution: CPCB, WHO guidelines, industrial & urban noise standards, Impact of Noise Pollution on Health & Ecosystems: Psychological effects, biodiversity loss, mitigation strategies.

8 Lectures

Books recommended:

TEXTBOOKS:

1. "Environmental Pollution Monitoring and Control" – S. M. Khopkar
2. "Air Pollution: Monitoring, Measures, and Impact Assessment" – S. C. Bhatia
3. "Water Supply Engineering: Environmental Engineering Vol. 1" – S. K. Garg
4. "Environmental Chemistry" – A. K. De
5. "Environmental Noise and Its Control" – G. Gangadhar Rao

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus: **PO2, PO3**

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: **PO2, & PO3**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	3
CO2	3	2	2	2	3	3
CO3	2	1	2	1	3	3
CO4	2	1	1	2	3	3
CO5	2	2	2	2	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD6, CD7
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code : CE 527

Course title : ECOLOGICAL ENGINEERING

Pre-requisite(s) : -
Co-requisite : -
Credits : 3 (L:3 T:0 P:0)
Class schedule per week : 3
Class : M-Tech
Semester / Level : II/5
Branch : Civil Engineering
Name of Teacher :

COURSE OBJECTIVES

This course enables the students:

1	To provide an overview on ecological engineering concepts and Nature based solutions
2	To develop a basic understanding on the process of nature based treatment and management of resources
3	To understand the correlate sustainable development goals with natural resource restoration

COURSE OUTCOMES

After the completion of this course, students will be able to:

CO1.	Identify the importance of nature based solutions in Ecological management
CO2.	Understand the Services of various ecosystems and their interactions with biotic factors
CO3.	Understand the process of Constructed wetlands in treatment processes
CO4.	Understand the process of Ecological Engineering in natural resource management
CO5	Understand and apply the concepts of green infrastructure in urban ecology

SYLLABUS

Module I:

Challenges and Scope: Global environmental and future social challenges, Definition of Ecological Engineering and Technology (EET). Basic concepts. Nature-based Solutions. Green infrastructure. The role of the Environmental Engineers

8 Lectures

Module II:

Ecosystem Services and SDGs:Classification, Value and Origin. Land use and biodiversity. Ecosystem services design. Sustainable Development Goals and Transition to a circular problem-solving process.

8 Lectures

Module III:

Decentralized Water Ecology: Nature-Based Solutions. Introduction to the natural systems of Constructed Wetlands, Constructed wetlands: Types, components and processes. Role of wetlands in wastewater and sewage sludge management.

8 Lectures

Module IV:

Natural Resource Management : Remediation of contaminated soils and ecological rehabilitation. Ecosystem health, wildlife functions, ecohydrology and ecosystem restoration, conservation and optimization of natural resources management

8 Lectures

Module V:

Urban Ecology Green infrastructure in the urban environment. Eco-cities. Green roofs. Green water management surfaces. Green buildings, landscape architecture and regenerative design. Urban agriculture and aquaculture.

8 Lectures

Books recommended:

TEXT BOOKS:

Mitsch, W.J. and S.E. Jørgensen. 2004. Ecological Engineering and Ecosystem Restoration. J ohn Wiley and Sons, Inc., 411 pp.

Jørgensen, S.E. 2009. Applications in Ecological Engineering. Academic Press, 392 pp.

REFERENCE BOOKS:

- Kadlec, R.H., Wallace, S.D., 2009. Treatment wetlands, 2nd Edition, CRC Press, USA ISBN 978-1-56670-526-4.
- Stefanakis, A.I., Akratos, C.S., Tsihrintzis, V.A., 2014. Vertical Flow Constructed Wetlands. Elsevier Science, ISBN 978-0-12-404612-2.
- UN World Water Development Report, 2018. Nature-based Solutions for Water. Available online.
- Ballard, BW, Wilson, S., Udale-Clarke, H., Illman, S., Scott, T., Ashley, R., Kellagher, R., 2015. The SuDS Manual. CIRIA, UK, ISBN 978-0-86017-760-9
- Dumitru, A., Wndling, L., 2021. Evaluating the impact of Nature-Based Solutions. A Handbook for Practitioners. European Commission, Directorate-General for Research and Innovation, Directorate C - Healthy Planet, Unit C3 - Climate and Planetary Boundaries, Brussels, ISBN 978-92-76-22961-2.

Gaps in the syllabus (to meet Industry/Profession requirements) :

Syllabus is framed according to industrial and professional requirement.

Topics beyond syllabus/Advanced topics/Design:

Module 3 covers the design aspects and would involve expert lecturers from industry and academia.

POs met through Topics beyond syllabus/Advanced topics/Design: **..**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment:

3. Student Feedback on Faculty
4. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO 2	PO3	PO4	PO5	PO6
CO 1	3	3	3	2	3	3
CO 2	2	1	3	1	2	2
CO 3	3	3	3	3	3	2
CO 4	3	3	3	2	3	3
CO 5	1	2	2	2	2	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcome	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2, CD8, CD6
CO4	CD1, CD2, CD3
CO5	CD1 ,CD2,CD8,CD6

COURSE INFORMATION SHEET

Course code: CE591
Course title: WATER AND WASTEWATER ANALYSIS
Pre-requisite(s):
Co- requisite(s):
Credits: 2 L: 0 T: 0 P: 3
Class schedule per week: 4
Class: M.Tech.
Semester / Level:
Branch: Civil Engineering
Name of Teacher:

COURSE OBJECTIVES

This course enables the students:

A.	To describe the concept of water quality concerning different standards
B.	To apply different procedures for the physico-chemical and bacteriological analysis of water and wastewater
C.	To assess the optimum dosing of chemicals for water treatment

COURSE OUTCOMES

After the completion of this course, students will be able to:

1.	Explain the importance of water quality and various standards
2.	Choose different procedures for the physico-chemical and bacteriological analysis of water and wastewater samples.
3.	Understand and suggest water and wastewater treatment requirements.

SYLLABUS

1. Determination of pH, EC and turbidity of water
2. Determination of total solids, total dissolved solids and total suspended solids of wastewater
3. Determination of acidity and alkalinity of water and wastewater
4. Determination of total hardness of water
5. Determination of dissolved oxygen (DO) and BOD wastewater
6. Determination of COD of wastewater
7. Determination of chloride and residual chlorine of water
8. Determination of nitrate in water and wastewater
9. Determination of phosphate in water and wastewater
10. Determination of sulphate in water and wastewater
11. Determination of fluoride in water
12. Coliform count of water and wastewater samples by MPN method

TEXTBOOKS:

1. Standard Methods of Testing of Water and Wastewater" Use by APHA, AWWA, AND WPCF (USA)
2. Chemistry for Environmental Engineering, Clair N. Sawyer, Perry Mccarty, Gene F. Parkin, McGraw Hill Inc. New York, USA
3. Introduction to Environmental Engineering and Science, G.M. Masters & Wendell Ela, PHI Publishers

Gaps in the syllabus (to meet Industry/Profession requirements) POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	
Tutorials/Assignments	
Seminars	
Mini projects/Projects	
Laboratory experiments/teaching aids	
Industrial/guest lectures	
Industrial visits/in-plant training	
Self-learning, such as the use of NPTEL materials and the internet	
Simulation	

Gaps in the syllabus (to meet Industry/Profession requirements)
Design of real-time industrial projects.
POs met through Gaps in the Syllabus: PO4, PO5 & PO6.

POs met through Gaps in the Syllabus.

Topics beyond syllabus/Advanced topics/Design
POs met through Topics beyond syllabus/Advanced topics/Design: PO4, PO5 & PO6.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self-learning, such as the use of NPTEL materials and the internet
Simulation

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Quiz Marks	30
Assignment	10
Seminar	10
End Sem Examination Marks	50

Assessment Components	CO1	CO2	CO3
Quiz Marks	✓	✓	✓
End Sem Examination Marks	✓	✓	✓
Progressive Assessment	✓	✓	✓

Indirect Assessment:
1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

MAPPING OF COURSE OUTCOMES INTO PROGRAM OUTCOMES

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	2
CO2	3	2	2	3	2	2
CO3	3	2	3	2	2	2

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO 1, 2, 3	CD1 & CD2
CD2	Tutorials/Assignments		CO 1, 2, 3	CD1 & CD2
CD3	Seminars			
CD4	Mini projects/Projects			
CD5	Laboratory experiments/teaching aids		CO 1, 2, 3	CD5
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self-learning, such as the use of NPTEL materials and the internet			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: CE592
Course title: AIR AND SOIL ANALYSIS LABORATORY
Pre-requisite(s):
Co- requisite(s):
Credits: 2 L: 0 T: 0 P: 4
Class schedule per week: 4
Class: M. Tech
Semester / Level: 2ND SEMESTER/ LEVEL 5
Branch: M.Tech. Civil Engineering

COURSE OBJECTIVES

This course enables the students:

A.	To monitor and analyse the air pollution level of the ambient air. (K4)
B.	To determine some important soil properties and assess its effect on environmental quality. (K6)

COURSE OUTCOMES

After the completion of this course, students will be able to:

1.	Design and implement ambient air quality monitoring plan. (K6)
2.	Interpret the air quality data and evaluate the air pollution status. (K5)
3.	Examine some of the soil physico-chemical properties. (K3)
4.	Interpret soil environmental quality and fertility status. (K5)

SYLLABUS

1. Monitoring and analysis of PM_{10} and $PM_{2.5}$ in the ambient air.
2. Sampling and analysis of NOx by chemiluminescence method.
3. Sampling and analysis of CO_2 and CO by NDIR method.
4. Sampling and analysis of sulphur dioxide in ambient air (Improved West and Gaeke method)
5. Sampling and analysis of Lead, Nickel and Arsenic in ambient air.
6. Determination of particle size distribution in fine aggregates.
7. To determine the soil particle size distribution by hydrometer analysis.
8. To determine the moisture content of soil by gravimetric method.
9. To estimate NPK status of soil.
10. To determine the pH, EC of the soil solution.

TEXT BOOKS:

1. Soil Testing for Engineers- Lambe T.W., Wiley Eastern Ltd., New Delhi. 5. Manual of
2. Soil Laboratory Testing- Head K.H., (1986)- Vol. I, II, III, Princeton Press, London

REFERENCE BOOKS:

1. Guidelines for the Measurement of Ambient Air Pollutants, CPCB ,2013.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus
Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	✓
Tutorials/Assignments	
Seminars	
Mini projects/Projects	
Laboratory experiments/teaching aids	✓
Industrial/guest lectures	
Industrial visits/in-plant training	✓
Self- learning such as use of NPTEL materials and internets	✓
Simulation	

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Progressive Evaluation Marks	60
End Examination Marks	40

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**
Progressive Evaluation Marks	✓	✓	✓	✓
End Examination Marks	✓	✓	✓	✓

Indirect Assessment –

1. Student feedback on teaching quality and teaching methods adopted
2. Student feedback on course syllabus and course outcome

MAPPING OF COURSE OUTCOMES ONTO PROGRAM OUTCOMES

Course Outcome	Program Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
1	3	3	0	0	1	1
2	3	3	0	0	1	1
3	3	3	0	0	1	1
4	3	3	0	0	1	1

CD	**Course Delivery methods**	**Course Outcome**
CD 1	Lecture by use of boards/LCD projectors/OHP projectors	All COs
CD 2	Tutorials/Assignments	
CD 3	Seminars	
CD 4	Mini projects/Projects	
CD 5	Laboratory experiments/teaching aids	All COs
CD 6	Industrial/guest lectures	
CD 7	Industrial visits/in-plant training	
CD 8	Self- learning such as use of NPTEL materials and internets	
CD 9	Simulation	

COURSE INFORMATION SHEET

Course code : CE 593
Course title : Environmental Management
Pre-requisite(s) : -
Co-requisite : -
Credits : 3 (L:3 T:0 P:0)
Class schedule per week : 3
Class : M-Tech
Semester / Level : II/5
Branch : Civil Engineering
Name of Teacher :

COURSE OBJECTIVES

This course enables the students

1	To develop an understanding of international environmental standards
2	To develop basic knowledge on components of ISO 14000
3	To develop and apply knowledge on Energy Management.

COURSE OUTCOMES

After the completion of this course, students will be able to:

CO 1	Understand the need and origin of Environmental Management Standards
CO 2	Identify environmental aspects and impacts
CO 3	Prepare audit checklist and conduct mock auditing
CO 4	Understand the significance of ecolabels, and processes of life cycle assessment and performance evaluation
CO 5	Assess and understand energy audit and energy management

SYLLABUS

Module 1:

History and Origin: Industrial Pollution and need for pollution management, The evolution of environmental management standard, Technical Committee 207, ISO 14000 series, applicability of ISO 14000, legal considerations and requirements of ISO 14000.

8 Lectures

Module II:

Basic Concept: ISO 14000 based Environmental Management System: definition, principle, structure and benefits of Environmental Management System, Aspects and impacts, Preparation of documents for ISO 14000, ISO 14000 compliance.

8 Lectures

Module III:

Environmental Auditing: ISO 14010: EMS Audit-definition, objective, general principles, scope, types and guidelines of environmental auditing process. Registration process for implementing ISO 14000, registration problems.

8 Lectures

Module IV:

Eco Labels and LCA: ISO 14024: Eco-labelling communication to the public. Types of ecolabels, benefits of ecolabelling. Global Ecolabels, life cycle assessment, Ethics and Environmental performance

8 Lectures

Module V:

Case Studies: Application of environmental management: Forest, River, Grassland, Urban ecosystems

8 Lectures

Books recommended:

TEXT BOOKS:

1. Environmental Audit: A.K. Shrivastava. APH pub Corp. New Delhi
2. ISO 14000: Environmental Management 1st Edition, David L. Goetsch , Stanley Davis. ISBN- 13: 978-0130812360. Jenson Books Inc
3. ISO 14000 Environmental Management Standards: Engineering and Financial Aspects Alan S. Morris. ISBN:9780470851289 |Online ISBN:9780470090787. John Wiley & Sons, Ltd

REFERENCE BOOKS:

- Global Green standards: ISO 14000 and Sustainable Development. IISD pub. Minitoba
- ISO 14000 Answer Book: Environmental Management for the World Market (Wiley Quality Management) 1st Edition. by Dennis R. Sasseville W. Gary Wilson, Robert W. Lawson . ISBN-13: 978-0471179337. John Wiley and sons. Canada

Gaps in the syllabus (to meet Industry/Profession requirements) :
Syllabus is framed according to industrial and professional requirement.

Topics beyond syllabus/Advanced topics/Design:
Module 5 covers the application of various ecosystems.

POs met through Topics beyond syllabus/Advanced topics/Design: **..**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment:

5. Student Feedback on Faculty
6. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training

CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO 2	PO3	PO4	PO5	PO6
CO 1	3	3	3	2	3	3
CO 2	2	1	3	1	2	2
CO 3	3	3	3	3	3	2
CO 4	3	3	3	2	3	3
CO 5	1	2	2	2	2	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcome	**Course Delivery Method**
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2, CD8, CD6
CO4	CD1, CD2, CD3
CO5	CD1 ,CD2,CD8,CD6

COURSE INFORMATION SHEET

Course code	**:**	**CE594**
Course title	**:**	**NATURAL RESOURCE MANAGEMENT**
Pre-requisite(s)	**:**	**BTech**
Co-requisite	**:**	**-**
Credits	**:**	**3 (L:3 T:0 P:0)**
Class schedule per week	**:**	**3**
Class	**:**	**MTech**
Semester / Level	**:**	**I/5**
Branch	**:**	**Civil Engineering**
Name of Teacher	**:**	

COURSE OBJECTIVES

This course enables the students to:

1	To provide students with a comprehensive understanding of natural resource types, distribution, and challenges
2	Enhance Technical & Analytical Skills for Resource Monitoring & Conservation
3	To familiarize students with national and global policies related to resource governance

COURSE OUTCOMES

After the completion of this course, students will be able to:

CO1.	Comprehend the types, distribution, and management of natural resources and their role in sustainable development
CO2.	Analyze water, soil, and forest resources using modern monitoring tools and conservation strategies
CO3	Apply techniques like rainwater harvesting, agroforestry, and bioremediation for resource conservation and restoration
CO4	Evaluate the impact of climate change on resources and develop adaptation and mitigation strategies
CO5	Understand and apply policy frameworks related to resource management, including energy conservation and governance

SYLLABUS

Module I

Fundamentals of Natural Resource Management Types (renewable & non-renewable), distribution, global vs. Indian scenario, Resource Degradation & Sustainable Development: Causes, consequences, and sustainable management principles (UN SDGs), Ecosystem Services & Valuation of natural resources, Community-based Natural Resource Management (CBNRM): Role of indigenous knowledge, participatory approaches.

8 Lectures

Module II

Water Resource Management & Conservation Surface & groundwater resources, river basin management, water quality monitoring, treatment technologies, water quality indices, Rainwater Harvesting & Groundwater Recharge techniques, Climate Change Impact on Water Resources: Adaptation & mitigation strategies.

8 Lectures

Module III

Forest & Biodiversity Conservation Types of forests, afforestation, REDD+ initiatives, Biodiversity Conservation Strategies: In-situ & ex-situ conservation, wildlife protection laws, Forest Resource Utilization & Agroforestry: Sustainable extraction, community forestry models, use of Remote sensing techniques for forest cover mapping.

8 Lectures

Module IV

Land & Soil Resource Management Soil Degradation & Conservation: Causes (erosion, desertification), soil conservation techniques, Integrated Farming Systems & Agroecology: Sustainable agriculture, permaculture, organic farming, Soil Carbon Sequestration & Climate Change Mitigation, Land Restoration & Reclamation Strategies: Bioremediation, phytoremediation.

8 Lectures

Module V

Energy & Mineral Resource Management Renewable Energy Resources: Solar, wind, hydro, bioenergy, Fossil Fuel & Mineral Resource Depletion, Energy Efficiency & Conservation Strategies: Green buildings, circular economy, Policy & Governance in Resource Management: National Mineral Policy, Energy Conservation Act.

8 Lectures

Books recommended:

TEXTBOOKS:

1. "Natural Resource Conservation: An Ecological Approach" – P.K. Sharma
2. "Water Resources Engineering" – B.C. Punmia, B.B. Lal, and A.K. Jain
3. "Forest Ecology and Management" – H.S. Sharma
4. "Soil and Water Conservation Engineering" – R.K. Sharma
5. "Renewable Energy Resources" – G.D. Rai

REFERENCE BOOKS:

1. "Principles of Environmental Science and Engineering" – K. S. Rao
2. "Environmental Science and Engineering" – J. Gilbert

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus: **PO5 & PO6**

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

1. Student Feedback on Faculty

2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	2	3	2
CO2	2	2	1	3	3	3
CO3	2	2	3	3	2	2
CO4	2	2	1	2	3	3
CO5	3	3	1	2	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4, CD6
CO2	CD1, CD2, CD3, CD4, CD6
CO3	CD1, CD2, CD3, CD4, CD6
CO4	CD1, CD2, CD4, CD6
CO5	CD1, CD2, CD4, CD6

COURSE INFORMATION SHEET

Course code: CE577

Course title: INDUSTRIAL POLLUTION AND CONTROL (OPEN ELECTIVE)

Pre-requisite(s): Basic concepts of Environmental Science

Co- requisite(s): NA

Credits: 3, L:3, T:0, P:0
Class schedule per week: 3
Class: M.Tech.

Semester / Level: /5
Branch: All

Name of Teacher:

COURSE OBJECTIVES:

This course enables the students to:

1.	To develop a general understanding of various types of industrial pollutions.
2.	To analyze the cause and effect of industrial pollution and plan necessary mitigation techniques, reclamation measures.
3.	To understand the importance of occupational health and industrial safety measures.
4.	To relate with the existing laws and policies for industrial pollution control.

COURSE OUTCOMES:

At the end of the course, a student should be able to:

CO1	Able to identify sources, types, and control equipment required for industrial air pollution.
CO2	Able to analyze the causes and effects of wastewater generation from industries and to select a suitable method for wastewater treatment for an industry
CO3	Able to distinguish the role of industry in the generation of solid waste and to construct a suitable industrial waste management plan.
CO4	Able to interpret the causes of land degradation due to industrialization and devise its reclamation.
CO5	Able to conduct investigations to identify the causes of industrial risks and hazards and judge the applicability of pollution control laws in industries

SYLLABUS

Module I

Introduction to industrial Pollution Industrial pollution, Types of industrial pollution and pollutants, causes, Environmental impact of industrial pollution, Sampling and analysis of industrial pollutants, Environmental laws and standards concept of industrial ecosystem.

8 Lectures

Module II

Industrial air pollution

Classification of industrial air pollutants, Health effects, air pollution disasters of industry, control techniques for industrial air pollution. Case studies of air pollution from various industries (thermal power plant, cement industry).

8 Lectures

Module III

Industrial water pollution Constituents of aquatic environment, industrial use of water, effect of oxygen demanding industrial waste on natural water and aquatic life, methods of wastewater treatment in industries, case studies of specific industries (pulp and paper, and textile industry)

8 Lectures

Module IV

Industrial solid waste management Classification of solid wastes, functional elements of solid waste management, treatment of solid waste, existing types of solid waste generated from industry, impacts of industrial solid waste dumps on ecosystem and humans, concept of cleaner production in industries for reduction of waste.

8 Lectures

Module V

Land degradation and reclamation, Occupational Safety, hazards and health

Land degradation due to industrialization, eco restoration and land reclamation, Rehabilitation and resettlement (R & R) issues due to industrialisation, Safety standards (OSHA) and Environmental management systems, ISO 18000. Occupational diseases: pneumoconiosis, silicosis, asbestosis, byssinosis, bagassosis, metal poisoning (lead, mercury, manganese, copper etc)

8 Lectures

RECOMMENDED BOOKS:

TEXT BOOK

1. Introduction to Environmental Engineering – Gilbert and Masters v. Wastewater engineering: Metcalf & Eddy, et.al., Mcgraw Hill Pub. **(T1)**
2. Textbook of Environmental Sudies – by E. Bharucha. **(T2)**

REFERENCE BOOK

1. Handbook of Industrial pollution & Control- Vol 1 & 2, S. C. Bhatia, CBS Publishers.
   (R1)
2. Industrial waste treatment Handbook- Woodward and Cirran, Elsevier Pub **(R2)**
3. Industrial Pollution Control Handbook- Edited by Herbert, F. Lund, McGrawhill Pub (R**3)**

Gaps in the syllabus (to meet Industry/Profession requirements):

Topics beyond syllabus/Advanced topics/Design:

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	3	2	3
CO2	1	1	3	3	2	2
CO3	1	1	3	3	2	2
CO4	1	2	1	1	1	1
CO5	2	3		3	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1,CD2
CO6	CD1, CD2
CO7	CD1, CD2

COURSE INFORMATION SHEET

Course code	**:**	**CE578**
Course title	**:**	**WASTE MANAGEMENT**
Pre-requisite(s)	**:**	**Environmental Science**
Co- requisite(s)	**:**	**-**
Credits	**:**	**3 (L: 3 T: 0 P: 0)**
Class per week	**:**	**3**
Class	**:**	**M.Tech./M.Sc.**
Semester / Level	**:**	**II/5**
Branch	**:**	
Name of Teacher	**:**	

COURSE OBJECTIVES:

The course aims to develop a concept of solid and liquid municipal and hazardous waste collection, transfer, and transport, as well as to use treatment options and study operations of various material, resource, and energy recovery facilities in an environment-friendly manner.

COURSE OUTCOMES:

CO1	Understand, Identify and interpret the criteria for the classification of wastes along with waste minimisation source reduction and describe the procedures of various waste processing options
CO2	Apply and interpret the regulations concerning the handling, transportation and disposal of municipal, hazardous, radioactive and biomedical wastes.
CO3	Apply the treatment and management of municipal solid wastes, hazardous wastes, radioactive wastes and biomedical wastes
CO4	Implement and assess various physical/chemical/biological treatment techniques for converting waste to resources.
CO5	analyse and evaluate various treatment technologies for wastewater management.

SYLLABUS

Module I

Management of municipal solid wastes (MSW) Sources, physical and chemical characteristics, MSW sampling and analysis, collection, storage, transport and disposal methods. Sanitary landfills - design, operation and closure. Reduction, reuse and recycling of solid wastes. Technologies for processing of MSW: Incineration, composting, pyrolysis

8 Lectures

Module II

Hazardous waste management Sources and characteristics, Classification, health and environmental impacts. Safe storage, transport and treatment of hazardous waste, Hazardous waste management, handling and transboundary movement rules.

8 Lectures

Module III

Radioactive and biomedical waste management sources, classification, health and safety aspects, management of radioactive wastes; Biomedical wastes: sources and categories of biomedical wastes, segregation and colour coding, treatment and disposal of biomedical wastes, biomedical wastes management and handling rules.

8 Lectures

Module IV

Waste to Resources Incineration, composing, pyrolysis; Energy from biomass, agricultural and industrial wastes. Biogas production, Biofuels: ethanol, methanol, hydrogen.

8 Lectures

Module V

Wastewater Treatment

Physico-chemical treatment, aerobic and anaerobic treatment, attached and suspended growth processes. Industrial wastewater treatment - textile, paper, tanneries, distiller.

8 Lectures

RECOMMENDED BOOKS

TEXTBOOKS:

1. Integrated Solid Waste Management, George Tchobanoglous, McGraw-Hill Publishers. (T1)

2. Introduction to Environmental Engineering and Science – G.M. Masters & W. Ela, PHI Publishers.

3. Environmental Engineering, Peavey, Rowe & George Tchobanoglous

4. Textbook of Solid Wastes Management, I.H. Khan & N Ahsan

REFERENCE BOOKS:

1. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi
2. Solid and hazardous waste management, Liu and Liptak.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus: Syllabus is framed according to industrial and professional requirement

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design: Advanced Smart water systems already included in syllabus covers the recent advances in the water supply systems

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS AND EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes	30 (3 X 10)
Assignment(s)	10
Seminar before a Committee	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

5. Student Feedback on Faculty
6. Student Feedback on Course

Course Delivery Methods

CD1: Lecture by use of boards/LCD projectors/OHP projectors

CD2: Assignments/Seminars

CD3: Laboratory experiments/teaching aids

CD4: Industrial/guest lectures

CD5: Industrial visits/in-plant training

CD6: Self- learning such as the use of NPTEL materials and the internet

CD7: Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	
CO2	3	3	2	3	1	2
CO3	2	2	2	3	2	3
CO4	2	3	3	1	3	3
CO5	2	3	3	1	3	3

If satisfying and < 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

CO1: CD1, CD2, CD3, CD6

CO2: CD1, CD2, CD3, CD5, CD6

CO3: CD1, CD2, CD3, CD6

CO4: CD1, CD2, CD3, CD4, CD5, CD6

CO5: CD1, CD2, CD3, CD6