



OFFICE OF THE REGISTRAR MANIPUR TECHNICAL UNIVERSITY, IMPHAL

(A University established under the Manipur Technical University Act, 2016)
Recognised by UGC under Section 2(f) and Section 22 of UGC Act, 1956
www.mtu.ac.in

REGULATIONS (COURSES AND SYLLABI FOR MASTER OF TECHNOLOGY PROGRAMS IN CIVIL ENGINEERING)

NOTIFICATION

Imphal, 7th September, 2026

AC-MTU-1/2/2026-MTU-MTU: It is notified to all that in exercise of the powers conferred by Section 45 of the Manipur Technical University Act, 2016, on recommendation of Board of Studies and as approved by the Academic Council of Manipur Technical University in its 9th meeting held on 30th May, 2026, hereby makes the following Regulations (Courses and Syllabi of Master of Technology program in Civil Engineering), namely:-

1. Short title and commencement:

- (a) These Regulations may be called the Regulations (Courses and Syllabi for Master of Technology program in Civil Engineering) 2026
- (b) They shall come into effect from the academic session 2026-27

2. Definitions:

(1) In these Regulations, unless the context otherwise requires, -

- (a) “Act” shall mean the Manipur Technical University Act, 2016
- (b) “Board of Studies” means the board of studies of a Department
- (c) “L”, “T”, “P”, “C”, shall mean respectively lecture hours per week, tutorial class hours per week, practical/ lab hours per week, credits per week.

(2) Words and expressions not defined in the Regulations but defined in the Statutes and Ordinances shall have the same meanings as assigned to them in the Statutes and Ordinances.

3. The Course Structure for the Master of Technology program in Civil Engineering-

The Course Structure for the Master of Technology program in Civil Engineering shall be as follows, with the detailed course for I semester, II semester, III semester and IV semester along with contents as given at Appendix.

DEPARTMENT OF CIVIL ENGINEERING
MANIPUR TECHNICAL UNIVERSITY

(A University established under the Manipur Technical University Act, 2016)

Takyelpat, Imphal West, Manipur-795004

Website: www.mtu.ac.in

Curriculum and Syllabus
for
Master of Technology
in
Structural Engineering



MANIPUR TECHNICAL UNIVERSITY,
TAKYELPAT IMPHAL - 795004

Programme Outcome (PLO)		
Sl. No.	Element of the Descriptor	Programme Learning Outcome (PLO)
PLO1	Knowledge and understanding	Exhibit a strong foundational understanding of Structural Engineering, including structural analysis, design of reinforced concrete and steel structures, advanced construction materials, earthquake engineering, and their applications in solving complex civil engineering problems.
PLO2	Knowledge and understanding	Engage effectively in laboratory work, structural modelling, software-based analysis, and practical activities that prepare students for professional employment, research and development, teaching, consultancy, and public sector services in Structural Engineering.
PLO3	Skills related to one's specialization	Apply advanced knowledge and analytical skills in Structural Engineering to design, analyse, and assess structures under various loading and environmental conditions using modern engineering tools and relevant codes of practice.
PLO4	Application of knowledge and skills	Identify and apply appropriate engineering principles, methodologies, and computational techniques to solve complex structural engineering problems involving buildings, bridges, industrial structures, and infrastructure systems.
PLO5	Generic learning outcomes	Clearly and effectively communicate technical reports, project findings, experimental results, and research outcomes related to Structural Engineering, demonstrating a strong connection between theoretical concepts and practical applications.
PLO6	Generic learning outcomes	Analyse structural engineering problems critically, interpret experimental and analytical data accurately, develop logical conclusions, and demonstrate professional ethics, teamwork, and effective communication skills in multidisciplinary engineering environments.

*** Rating Scale for CLO-PLO Mapping:**

- 3** – High Correlation,
- 2** – Moderate Correlation,
- 1** – Low Correlation

Course Structure for M.Tech. in Structural Engineering

PROGRAMME STRUCTURE

SEMESTER - I							
Sl. No.	Course category	Course code	Name of the course	L	T	P	C
1.	PCC	CE501	Advanced Structural Analysis	3	0	0	3
2.	PCC	CE502	Continuum Mechanics	3	0	0	3
3.	PCC	CE503	Research Methodology and IPR	4	0	0	4
4.	PEC	CE52X	Program Elective Course- I	3	0	0	3
5.	PEC	CE53X	Program Elective Course- II	3	0	0	3
6.	OEC	XXxxx	Open Elective Course - I	2	0	0	2
PRACTICAL							
7.	PLC	CE504	Structural Design Lab	0	0	2	1
8.	PLC	CE505	Model Testing Lab	0	0	2	1
Total				16	2	4	20
SEMESTER-II							
1.	PCC	CE506	Finite Element Method	3	0	0	3
2.	PCC	CE507	Structural Dynamics	3	0	0	3
3.	PCC	CE508	Advanced Concrete Technology	3	0	0	3
4.	PEC	CE55X	Program Elective Course-III	3	0	0	3
5.	PEC	CE56X	Program Elective Course-IV	3	0	0	3
6.	OEC	YYyyy	Open Elective Course - II	2	0	0	2
PRACTICAL							
7.	PCC	CE511	Seminar - I	0	0	2	1
8.	PLC	CE509	Advanced Concrete Lab	0	0	2	1
9.	PLC	CE510	Computational Lab	0	0	2	1
Total				16	1	6	20
➤ Exit option to qualify for a PG Diploma in Civil Engineering with a specialization in Structural Engineering: Students opting for the exit option must complete a six- to eight-week industrial training from a reputed industry. ➤ Continuation for M. Tech. in Structural Engineering: Students who continue in the program must also complete a four- to six-week industrial/academic training during the vacation period.							
SEMESTER-III							
1.	SI	CE601	Summer Internship Evaluation	0	0	0	2
2.	PRP	CE602	Project Phase -I	0	0	36	18
Total				0	0	36	20
SEMESTER- IV							
1.	PRP	CE603	Project Phase- II	0	0	40	20
Total				0	0	40	20
Total Credit is 80							

LIST OF PROGRAM ELECTIVES							
Sl. No	Course Category	Course Code	Course	L	T	P	C
Program Elective Course-I							
1.	PEC	CE520	Theory of Plates and Shells	3	0	0	3
2.	PEC	CE521	Theory and Applications of Cement Composites	3	0	0	3
3.	PEC	CE522	Design of Prestressed Concrete Structures	3	0	0	3
4.	PEC	CE523	Environmental Impact Assessment for Infrastructure Projects	3	0	0	3
5.	PEC	CE524	Earth Retaining Structures	3	0	0	3
Program Elective Course-II							
6.	PEC	CE530	Numerical Methods	3	0	0	3
7.	PEC	CE531	Structural Health Monitoring	3	0	0	3
8.	PEC	CE532	Structural Optimization	3	0	0	3
9.	PEC	CE533	Project Management in Construction	3	0	0	3
10.	PEC	CE534	Advanced Bridge Engineering	3	0	0	3
Program Elective Course-III							
11.	PEC	CE550	Advanced Steel Design	3	0	0	3
12.	PEC	CE551	Soil Structure Interaction	3	0	0	3
13.	PEC	CE552	Design of High Rise Structures	3	0	0	3
14.	PEC	CE553	Design of Masonry Structures	3	0	0	3
15.	PEC	CE554	Waste to Energy in Civil and Environmental Infrastructure	3	0	0	3
16.	PEC	CE555	Quality and safety management in Construction	3	0	0	3
Program Elective Course-IV							
17.	PEC	CE560	Advanced RC Design	3	0	0	3
18.	PEC	CE561	Advanced Design of Foundations	3	0	0	3
19.	PEC	CE562	Design of Industrial Structure	3	0	0	3
20.	PEC	CE563	Construction Methods and Equipment Management	3	0	0	3
21.	PEC	CE564	Machine Learning in Civil Engineering	3	0	0	3
Open Elective - I							
22.	OEC	CE540	Disaster Risk Reduction	2	0	0	2
23.	OEC	CE541	English for Technical Writing	2	0	0	2
Open Elective - II							
24.	OEC	CE570	IKS in Civil Engineering	2	0	0	2
25.	OEC	CE571	Introduction to Remote Sensing and GIS	2	0	0	2

Notes:

1. Any course of 8/12 weeks offered by Swayam -NPTEL during the respective semester as electives with the prior approval from the Program Coordinator.
2. A list of electives offered in each semester will be announced by the Departments based on the requirements and availability of faculty.
3. The evaluation (Online elective courses) will be based on assignments and internal assessments conducted by the concerned course instructor and examinations as per the MTU P.G ordinance.
4. Internship Evaluation will be performed based on presentation within 1st month of 3rd semester.
5. Project Phase II is the continuation of Project Phase I.

SEMESTER I
MASTER OF TECHNOLOGY
IN
STRUCTURAL ENGINEERING

Code	Course	L	T	P	C
CE501	Advanced Structural Analysis	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Understand and analyse structural systems using influence coefficients considering settlement, temperature effects, and lack of fit.

CLO2. Apply stiffness matrix methods using local and global coordinate systems for analysing structural frames and grids.

CLO3. Formulate, assemble, and solve stiffness matrix equations to evaluate displacements, reactions, and member forces in structures.

CLO4. Analyse beams, trusses, rigid jointed frames, and grid structures using structure and member approaches.

CLO5. Apply numerical and finite element methods, including Modified Galerkin Method and shape functions, for solving one-dimensional boundary value and equilibrium problems.

CLO and PLO Mapping

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	3	3	1	2
CLO2	3	2	3	3	1	2
CLO3	3	2	3	3	2	3
CLO4	3	2	3	3	2	2
CLO5	3	2	3	3	1	3

Syllabus Contents:

Module 1: Review of basic concepts in structural analysis: structure (structural elements, joints and supports, stability, rigidity and static indeterminacy, kinematic indeterminacy); loads (direct actions, indirect loading); response (equilibrium, compatibility, force-displacement relations); levels of analysis; analysis of statically determinate structures; applications of principle of virtual work and displacement-based and force-based energy principles; deriving stiffness and flexibility coefficients.

Module 2: Review of analysis of indeterminate structures: Force methods: Statically indeterminate structures (method of consistent deformations; theorem of least work). Displacement Methods Kinetically indeterminate structures (slope-deflection method; moment distribution method).

Module 3: Matrix concepts and Matrix analysis of structures: Matrix; vector; basic matrix operations; rank; solution of linear simultaneous equations; eigenvalues and eigenvectors. Introduction; coordinate systems; displacement and force transformation

matrices; Contra-gradient principle; element and structure stiffness matrices; Element and structure flexibility matrices; equivalent joint loads; stiffness and flexibility approaches.

Module 4: Matrix analysis of structures with axial elements: Introduction: Axial stiffness and flexibility; stiffness matrices for an axial element, plane truss element and space truss element; One-dimensional axial structures: Analysis by conventional stiffness method and reduced element stiffness method; Analysis by flexibility method; Plane trusses: Analysis by conventional stiffness method and reduced element stiffness method; Analysis by flexibility method; Space trusses: Analysis by conventional stiffness method and reduced element stiffness method.

Module 5: Matrix analysis of beams and grids: Conventional stiffness method for beams: Beam element stiffness; generation of stiffness matrix for continuous beam; dealing with internal hinges, hinged and guided-fixed end supports; accounting for shear deformations; Reduced stiffness method for beams: Beam element stiffness; dealing with moment releases, hinged and guided-fixed end supports; Flexibility method for fixed and continuous beams: Force transformation matrix; element flexibility matrix; solution procedure; Stiffness method for grids

Module 6: Matrix analysis of plane and space frames: Conventional stiffness method for plane frames: Element stiffness (six dof); generation of structure stiffness matrix and solution procedure; dealing with internal hinges and various end conditions; Reduced stiffness method for plane frames; Flexibility method for plane frames; Stiffness method for space frames

Module 7: Analysis of elastic instability and second-order effects: Effects of axial force on flexural stiffness: Review of buckling of ideal columns; flexural behaviour and stiffness measures for beam-columns - braced and unbraced, under axial compression; Solution by slope deflection method: Slope deflection equations for prismatic beam columns using stability functions; modifications for pinned and guided-fixed-end conditions; fixed end moments in beam-columns; Solution by matrix method: Stiffness matrix for prismatic beam column element; estimation of critical elastic buckling loads; second-order analysis;

Text Books

1. Devdas Menon, "Advanced Structural Analysis", Narosa Publishing House, 2009.
2. Asslam Kassimali, "Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.
3. Weaver W, Gere JM. Matrix analysis framed structures", Springer science & business media; 2012 Dec 6.
4. Lewis P. E. and WardJ. P., "The Finite Element Method ", Addison-Wesley Publication Co.

References

1. Bhavikatti SS. Finite element analysis. New Age International; 2005.
2. Amin Ghali, Adam M Neville and Tom G Brown, "Structural Analysis: A Unified Classical and Matrix Approach", Sixth Edition, 2007, Chapman & Hall.
3. Meek JL. Computer methods in structural analysis. CRC Press; 2017 Dec 14.
4. Devdas Menon, "Structural Analysis", Narosa Publishing House, 2008.

Code	Course	L	T	P	C
CE502	Continuum Mechanics	3	0	0	3

Course Learning Outcome: At the end of the course, students will be able to

CLO1. Apply tensor algebra and calculus in continuum mechanics formulations.

CLO2. Analyze deformation, strain, and motion of continuous media.

CLO3. Formulate stress relations and governing balance laws for deformable bodies.

CLO4. Develop constitutive models for elastic and introductory elastic–plastic behavior.

CLO5. Apply elasticity and variational principles to solve boundary-value problems.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	1	3	2	1	2
CLO2	3	2	3	3	1	2
CLO3	3	1	3	3	1	2
CLO4	3	2	3	3	1	2
CLO5	3	2	3	3	2	3

Syllabus Contents:

Module 1: Introduction to Tensors: Vector and tensor algebra, Indicjal notation, Coordinate transformations, Eigenvalues and eigenvectors, Tensor calculus, Directional derivatives, Integral Theorems.

Module 1: Kinematics of Deformation: Lagrangian and Eulerian description of deformation, Deformation gradient, Polar decomposition, Material time derivative, Velocity and velocity gradient, Strain measures: infinitesimal and finite strains, Compatibility conditions.

Module 3: Stress and Balance Laws: Traction vector, Cauchy stress tensor, Principal stresses and invariants, Piola-Kirchhoff stress tensors, Transport theorem, Balance laws: mass, linear and angular momentum, energy.

Module 4: Constitutive Theory: Constitutive relations, Material symmetry and isotropy, Material frame indifference, Linear elastic constitutive equations, Strain energy density, Elements of plasticity, Yield criteria, Flow rule and hardening, Plastic stress–strain relations.

Module 5: Linear Elasticity: Equations of linear elasticity, Stress-strain relations, Elastic moduli, Plane stress and plane strain problems, St. Venant's principle, Pressure vessels, bending and torsion.

Module 6: Variational Formulations: Principle of virtual work, Total potential and complementary energy, Weak formulation of boundary-value problems, Variational principles in elasticity.

Text Books

1. Continuum Mechanics of Solids, L. Anand and S. Govindjee, Oxford University Press, 2020.
2. An Introduction to Continuum Mechanics, M. E. Gurtin, Academic Press, 1981.
3. Foundations and Applications of Mechanics: Volume I: Continuum Mechanics, C. S. Jog, Cambridge University Press, 2015.

References

1. Nonlinear Continuum Mechanics for Finite Element Analysis, J. Bonet and R. D. Wood, Cambridge University Press, 2008.
2. A First Course in Continuum Mechanics, Y. C. Fung, Prentice Hall, 1977.
3. Introduction to Continuum Mechanics, W. M. Lai, D. Rubin, and E. Krempl, Butterworth-Heinemann, 2010.

Code	Course	L	T	P	C
CE503	Research Methodology & Intellectual Property Rights	4	0	0	4

Course Learning Outcomes: At the end of this course, students will be able to

CLO1. Understand research problem formulation.

CLO2. Analyze research related information

CLO3. Follow research ethics

CLO4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

CLO5. Understanding that when IPR would take such important place in growth of individuals & Nation, it is needless to emphasis the need of information about Intellectual Property

CLO and PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	2	2	1	2
CLO2	3	2	3	2	2	3
CLO3	2	2	1	1	2	2
CLO4	2	1	3	2	1	2
CLO5	2	1	2	1	1	1

Syllabus Contents:

Module 1: Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Module 2: Effective literature studies approaches, analysis Plagiarism, Research ethics,

Module 3: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Module 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.

International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Module 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Module 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students."
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.

References

1. Niebel, "Product Design", McGraw Hill, 1974.
2. Asimov, "Introduction to Design", Prentice Hall, 1962.
3. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property
4. in New Technological Age", 2016.
5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Code	Course	L	T	P	C
CE504	Structural Design Lab	0	0	2	1

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Design and Detail all the Structural Components of Frame Buildings.

CLO2. Design and Detail complete Multi-Storey Frame Buildings.

CLO and PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	1	3	3	1	2
CLO2	3	2	3	3	2	2

Syllabus Content:

Module 1. Design and detailed drawing of complete G+ 3 structures by an individual student using the latest relevant IS codes.

Text Books

1. Adv. R. C. C Design Vol-II, by S.S. Bhavikatti, New Age International (P) Limited, New Delhi
2. Adv. R. C. C Design, by N.K. Raju, CBS Publishers & Distributor, New Delhi
3. Reinforced Concrete, 6th Edition, by S.K. Mallick and A.P. Gupta, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, 1996.
4. Reinforced Concrete Design, 2nd Edition, by S. Unnikrishna Pillai and Devdas Menon, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003

References

1. IS 456: 2000, Indian Standard Plain and Reinforced Concrete – Code of Practice (4th Revision), BIS, New Delhi.
2. IS 3370 (I, II, IV): 2009 & 1965, Concrete structures for storage of Liquids- Code of practice (1st Revision), BIS, New Delhi.
3. IS 1893 (I): 2016, Criteria for earthquake resistance design of Structures- General provisions and building (6th Revision), BIS, New Delhi.
4. IS 13920: 2016, Ductile design & detailing of R. C. structures subjected to seismic forces- code of practice (1st Revision), BIS, New Delhi
5. ACI-318-19, Building Code Requirements for Structural Concrete and Commentary
6. EC-2: 1992, Design of concrete structures
7. AS-3600: 2018, Standards for Concrete Structures.

Code	Course	L	T	P	C
CE505	Model Testing Lab	0	0	2	1

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Understand the response of structures.

CLO2. Prepare the models.

CLO3. Conduct model testing for static loading

CLO4. Conduct model testing for free and forced vibrations

CLO and PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	2	2	1	2
CLO2	2	3	3	3	1	2
CLO3	2	3	2	3	2	3
CLO4	3	3	3	3	2	3

Syllabus Content:

Module 1: Response of structures and its elements against extreme loading events.

Module 2: Model Testing: Static - testing of plates, shells, and frames models.

Module 3: Model Testing: Free and forced vibrations, Evaluation of dynamic modulus.

Module 4: Beam vibrations, Vibration isolation, Shear wall building model, Time and frequency-domain study, Vibration Characteristics of RC Beams using Piezoelectric Sensors etc.

Text Books

1. Harry G. Harris and Gajanan M. Sabnis, *Structural Modeling and Experimental Techniques*, CRC Press.
2. Mario Paz and William Leigh, *Structural Dynamics: Theory and Computation*, Springer.
3. Anil K. Chopra, *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, Pearson Education.
4. J. M. Biggs, *Introduction to Structural Dynamics*, McGraw Hill.
5. R. W. Clough and J. Penzien, *Dynamics of Structures*, McGraw Hill.
6. Humar J. L., *Dynamics of Structures*, CRC Press.

References

1. Tedesco, McDougal and Ross, *Structural Dynamics: Theory and Applications*, Addison Wesley.
2. C. S. Krishnamoorthy, *Finite Element Analysis: Theory and Programming*, Tata McGraw Hill.
3. Srinath L. S., *Experimental Stress Analysis*, McGraw Hill Education.
4. Blevins R. D., *Formulas for Natural Frequency and Mode Shape*, Wiley.
5. Ewins D. J., *Modal Testing: Theory, Practice and Application*, Research Studies Press.
6. Craig R. R. and Kurdila A. J., *Fundamentals of Structural Dynamics*, Wiley.
7. Leonard Meirovitch, *Elements of Vibration Analysis*, McGraw Hill.
8. Chopra A. K., *Earthquake Resistant Design of Structures*, Pearson Education.
9. ASTM Standards on Structural Testing and Material Evaluation.

Code	Course	L	T	P	C
CE520	Theory of Plates and Shells	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Understand the fundamental behaviour and governing equations of thin plates and shell structures.

CLO2. Use analytical methods for the solution of thin plates and shells.

CLO3. Use analytical methods for the solution of shells.

CLO4. Apply the numerical techniques and tools for the complex problems in thin plates.

CLO5. Apply the numerical techniques and tools for the complex problems in shells.

CLO and PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	2	2	1	2
CLO2	3	2	3	3	1	2
CLO3	3	2	3	3	1	3
CLO4	2	3	3	3	1	3
CLO5	2	3	3	3	1	3

Syllabus Contents:

Module 1: Introduction: Space Curves, Surfaces, Shell Co-ordinates, Strain Displacement Relations, Assumptions in Shell Theory, Displacement Field Approximations, Stress Resultants, Equation of Equilibrium using Principle of Virtual Work, Boundary Conditions.

Module 2: Static Analysis of Plates: Governing Equation for a Rectangular Plate, Navier Solution for Simply- Supported Rectangular Plate under Various Loadings, Levy solution for Rectangular Plate with other Boundary Conditions.

Module 3: Circular Plates: Analysis under Axi- Symmetric Loading, Governing Differential Equation in Polar Co-ordinates. Approximate Methods of Analysis- Rayleigh-Ritz approach for Simple Cases in Rectangular Plates.

Module 4: Static Analysis of Shells: Membrane Theory of Shells - Cylindrical, Conical and Spherical Shells,

Module 5: Shells of Revolution: with Bending Resistance - Cylindrical and Conical Shells, Application to Pipes and Pressure Vessels.

Module 6: Thermal Stresses in Plate/ Shell

Text Books

1. Theory of Plates and Shells, Timoshenko S. and Krieger W., McGraw Hill.
2. Stresses in Plates and Shells, Ugural Ansel C., McGraw Hill.
3. Thin Elastic Shells, Kraus H.. John Wiley and Sons.

References

1. Theory of Plates, Chandrashekhara K., Universities Press.
2. Design and Construction of Concrete Shells, Ramaswamy G.S.

Code	Course	L	T	P	C
CE521	Theory and Applications of Cement Composites	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Formulate constitutive behaviour of composite materials – Ferrocement, SIFCON and Fibre Reinforced Concrete - by understanding their strain- stress behaviour.

CLO2. Classify the materials as per orthotropic and anisotropic behaviour.

CLO3. Estimate strain Constants using theories applicable to composite materials.

CLO4. Evaluate the mechanical behaviour and performance of cement composite materials under different loading conditions.

CLO5. Analyse and design structural elements made of cement composites.

CLO and PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	2	2	1	2
CLO2	3	2	3	3	1	2
CLO3	2	2	3	3	1	3
CLO4	3	3	3	3	2	3
CLO5	3	2	3	3	2	3

Syllabus Content:

Module 1: Introduction: Classification and Characteristics of Composite Materials- Basic Terminology, Advantages. Stress-Strain Relations- Orthotropic and Anisotropic Materials, Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Plane Stress Problem, Biaxial Strength, Theories for an Orthotropic Lamina.

Module 2: Mechanical Behaviour: Mechanics of Materials Approach to Stiffness- Determination of Relations between Elastic Constants, Elasticity Approach to Stiffness- Bounding Techniques of Elasticity, Exact Solutions - Elasticity Solutions with Continuity, Halpin, Tsai Equations, Comparison of approaches to Stiffness.

Module 3: Cement Composites: Types of Cement Composites, Terminology, Constituent Materials and their Properties, Construction Techniques for Fibre Reinforced Concrete - Ferrocement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing.

Module 4: Mechanical Properties of Cement Composites: Behaviour of Ferrocement, Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion.

Module 5: Application of Cement Composites: FRC and Ferrocement- Housing, Water Storage, Boats and Miscellaneous Structures. Composite Materials- Orthotropic and Anisotropic behaviour, Constitutive relationship, Elastic Constants.

Module 6: Analysis and Design of Cement Composite Structural Elements - Ferrocement, SIFCON and Fibre Reinforced Concrete.

Text Books

1. Mechanics of Composite Materials, Jones R. M., 2nd Ed., Taylor and Francis, BSP Books, 1998.
2. Ferrocement – Theory and Applications, Pama R. P., IFIC, 1980.

References

1. New Concrete Materials, Swamy R.N., 1stEd., Blackie, Academic and Professional, Chapman & Hall, 1983.

Code	Course	L	T	P	C
CE522	Design of Prestressed Concrete Structures	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Understand the fundamentals of prestressed concrete, prestressing systems, materials, and losses in prestress.

CLO2. Analyse prestressed concrete flexural members, deck slabs, beams, and girders under service and ultimate loads.

CLO3. Design prestressed concrete beams, girders, slabs, and indeterminate structures as per codal provisions.

CLO4. Evaluate anchorage zone stresses, transmission of prestress, shear, torsion, creep, and shrinkage effects in prestressed concrete members.

CLO5. Analyse and design special prestressed concrete structural elements such as end blocks, pipes, columns, and composite sections.

CLOs and PLOs Mapping:

CLOs/PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	2	2	1	2
CLO2	3	2	3	3	1	3
CLO3	3	2	3	3	1	3
CLO4	3	2	3	3	2	3
CLO5	3	2	3	3	2	3

Syllabus Contents:

Module 1: Introduction to prestressed concrete: types of prestressing, systems and devices, materials, losses in prestress. Analysis of PSC flexural members: basic concepts, stresses at transfer and service loads, ultimate strength in flexure, code provisions.

Module 2: Statically determinate PSC beams: design for ultimate and serviceability limit states for flexure, analysis and design for shear and torsion, code provisions.

Module 3: Transmission of prestress in pretensioned members; Anchorage zone stresses for posttensioned members.

Module 4: Statically indeterminate structures - Analysis and design - continuous beams and frames, choice of cable profile, linear transformation, and concordancy.

Module 5: Composite construction with precast PSC beams and cast-in-situ RC slab - Analysis and design, creep and shrinkage effects. Partial prestressing - principles, analysis and design concepts, crack width calculations

Module 6: Analysis and design of prestressed concrete pipes, columns with moments.

Text Books

1. Design of Prestressed Concrete Structures, Lin T.Y., Asia Publishing House, 1955.
2. Prestressed Concrete, Krishnaraju N., Tata McGraw Hill, New Delhi, 1981.
3. Limited State Design of Prestressed Concrete, Guyan Y., Applied Science Publishers, 1972.

References

1. IS: 1343- Code of Practice for Prestressed Concrete
2. IRC: 112

Code	Course	L	T	P	C
CE523	Environmental Impact Assessment for Infrastructure Projects	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to:

CLO1. Explain the purpose, scope and regulatory framework of EIA for infrastructure projects.

CLO2. Identify baseline environmental components and likely impacts of civil engineering projects.

CLO3. Apply EIA methods such as checklist, matrix, overlay and network methods.

CLO4. Suggest mitigation measures and prepare basic Environmental Management Plans.

CLO5. Explain the environmental clearance process, public consultation and compliance requirements.

CLO6. Analyse infrastructure EIA case studies and recommend environmentally responsible project decisions.

CLO–PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	2	2	2	2	2	3
CLO2	2	3	3	3	1	2
CLO3	2	2	3	3	2	2
CLO4	2	3	3	3	2	3
CLO5	1	2	2	2	3	3
CLO6	2	2	3	3	3	3

Syllabus Content:

Module 1. Introduction to EIA and Infrastructure Development, Meaning, need and objectives of Environmental Impact Assessment; evolution of EIA; rapid and comprehensive EIA; project life cycle and environmental concerns; types of infrastructure projects requiring environmental appraisal; environmental, social and economic dimensions of infrastructure development; role of EIA in sustainable civil engineering.

Module 2: EIA Process and Regulatory Framework Screening, scoping, terms of reference, baseline data collection, impact prediction, mitigation, reporting and review; Environmental Impact Statement; Environmental Management Plan; overview of EIA Notification, 2006 and amendments; project categorisation; environmental clearance

procedure; role of MoEFCC, SEIAA, EAC and SEAC; public consultation and public hearing.

Module 3: Baseline Studies and Impact Identification Baseline environmental components: land, air, water, noise, soil, ecology and socio-economic environment; data requirements for infrastructure projects; impact identification during planning, construction, operation and decommissioning stages; impacts due to land acquisition, vegetation removal, earthwork, quarrying, borrow areas, construction camps, traffic, waste generation and resource use.

Module 4: EIA Methods and Impact Prediction Checklist method; matrix method; Leopold matrix; overlay method; network method; environmental indices; qualitative and quantitative impact prediction; risk and consequence analysis: basic concepts; cumulative impacts; carrying capacity concept; significance evaluation of impacts; limitations of EIA methods.

Module 5: EIA for Civil Infrastructure Projects- EIA considerations for buildings, townships, highways, bridges, railways, dams, riverfront works, industrial structures and urban infrastructure; impacts of construction materials, batching plants, crushers, hot-mix plants and demolition activities; drainage, erosion, sedimentation, dust, noise, vibration and traffic impacts; environmental safeguards in hill, floodplain, wetland and ecologically sensitive areas.

Module 6: Environmental Management, Monitoring and Case Studies, Mitigation hierarchy; Environmental Management Plan; environmental monitoring plan; institutional responsibility and budget provision; environmental audit and compliance reporting; post-project monitoring; green construction practices; case studies of EIA for roads, buildings, dams, industrial estates and urban infrastructure projects; preparation of case-based environmental recommendations.

Text Books

1. Canter, L. W. Environmental Impact Assessment. McGraw-Hill.
2. Glasson, J., Therivel, R., and Chadwick, A. Introduction to Environmental Impact Assessment. Routledge.
3. Morris, P., and Therivel, R. Methods of Environmental Impact Assessment. Routledge.
4. Rau, J. G., and Wooten, C. D. Environmental Impact Analysis Handbook. McGraw-Hill.
5. Nageswara Rao, K. Environmental Impact Assessment. BS Publications.

References

1. MoEFCC, Government of India. EIA Notification, 2006 and subsequent amendments.
2. MoEFCC and CPCB. Sector-specific EIA manuals and environmental guidelines.
3. World Bank. Environmental and Social Framework.
4. Asian Development Bank. Safeguard Policy Statement.
5. Jain, R. K., Urban, L. V., Stacey, G. S., and Balbach, H. E. Environmental Assessment. McGraw-Hill.
6. Petts, J. Handbook of Environmental Impact Assessment. Blackwell Science.

7. Divan, S., and Rosencranz, A. Environmental Law and Policy in India. Oxford University Press.
8. Relevant Indian Standards, IRC guidelines and environmental regulations applicable to infrastructure projects.

Code	Course	L	T	P	C
CE524	Earth Retaining Structures	3	0	0	3

Course Learning Outcomes: At the end of the course, the student will be able to:

CLO1. Understand the theories of earth pressure and evaluate active, passive, and at-rest earth pressures for different soil and surcharge conditions.

CLO2. Analyse and design retaining walls, reinforced earth retaining walls, and sheet pile walls, considering stability and soil–structure interaction.

CLO3. Evaluate the behaviour and design aspects of bulkheads, anchor systems, tunnels, conduits, and arching in soils.

CLO4. Analyse braced excavations and assess earth pressure distribution, excavation stability, and heave problems in soft soils.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	1	2	2	1	1
CLO2	3	2	3	3	1	2
CLO3	2	2	3	3	1	2
CLO4	2	2	3	3	2	3

Syllabus Contents:

Module 1: Earth Pressure: Rankine and Coulomb theories, active, passive and pressure at rest; concentrated surcharge above the backfill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill.

Module 2: Retaining walls: Proportioning of retaining walls, stability of retaining walls, mechanically stabilized retaining walls/reinforced earth retaining walls

Module 3: Sheet Pile wall: free earth system, fixed earth system

Module 4: Bulkheads: bulkheads with free and fixed earth supports, equivalent beam method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates

Module 5: Tunnel and Conduit: Stress distribution around tunnels, Types of conduits, Load on projecting conduits; Arching and Open Cuts: Arching in soils,

Module 6: Braced excavations: Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays

Text Books

1. Das, Braja M., “Principles of Foundation Engineering”, PWS Publishing. 1998
2. Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.

References

1. W.C. Huntington (2013), Earth pressure on retaining walls, Literary Licensing. o
2. Jones (1996), Earth Reinforcements and Soil structures, Thomas Telford Ltd. o
3. S. Prakash, G. Ranjan & S. Swaran (1979), Analysis & Design of Foundations & Retaining Structures, Sarita Prakashan.

Code	Course	L	T	P	C
CE530	Numerical Methods	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Solve ordinary and partial differential equations in structural mechanics using numerical methods.

CLO2. Write a program to solve a mathematical problem.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	3	2	1	2
CLO2	2	3	3	3	1	2

Syllabus Contents:

Module 1: Fundamentals of Numerical Methods: Error Analysis, Polynomial Approximations and Interpolations, Curve Fitting; Interpolation and extrapolation.

Module 2: Solution of Nonlinear Algebraic and Transcendental Equations

Module 3: Elements of Matrix Algebra: Solution of Systems of Linear Equations, Eigen Value Problems.

Module 4: Numerical Differentiation & Integration: Solution of Ordinary and Partial Differential Equations.

Module 5: Finite Difference scheme: Implicit & Explicit scheme.

Module 6: Computer Algorithms: Numerical Solutions for Different Structural Problems, Fuzzy Logic and Neural Network.

Text Books

1. An Introduction to Numerical Analysis, Atkinson, K.E., J. Wiley and Sons, 1989.
2. Theory and Problems of Numerical Analysis, Scheid F, McGraw Hill Book Company, (Shaum Series), 1988.

References

1. Introductory Methods of Numerical Analysis, Sastry S. S, Prentice Hall of India, 1998.

Code	Course	L	T	P	C
CE531	Structural Health Monitoring	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Diagnosis the distress in the structure understanding the causes and factors.

CLO2. Assess the health of structure using static field methods.

CLO3. Assess the health of structure using dynamic field tests.

CLO4. Suggest repairs and rehabilitation measures of the structure

CLOs and PLOs Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	2	2	1	2
CLO2	3	3	3	3	1	3
CLO3	3	3	3	3	2	3
CLO4	3	2	3	3	2	3
CLO5	3	2	3	3	2	3

Syllabus Contents:

Module 1: Structural Health Monitoring: Concepts, Various Measures, Structural Safety in Alteration.

Module 2: Structural Audit: Assessment of the Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures.

Module 3: Static Field Testing: Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.

Module 4: Dynamic Field Testing: Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.

Module 5: Introduction to Repairs and Rehabilitations of Structures: Case Studies (Site Visits), piezo– electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique.

Text Books

1. Structural Health Monitoring, Daniel Balageas, Claus_Peter Fritzen, Alfredo Güemes, John Wiley and Sons, 2006.

2. Health Monitoring of Structural Materials and Components_Methods with Applications, Douglas E Adams, John Wiley and Sons, 2007.

References:

1. Structural Health Monitoring and Intelligent Infrastructure, Vol1, J. P. Ou, H. Li and Z. D. Duan, Taylor and Francis Group, London, UK, 2006.
2. Structural Health Monitoring with Wafer Active Sensors, Victor Giurgutiu, Academic Press Inc, 2007.

Code	Course	L	T	P	C
CE532	Structural Optimization	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1: Develop optimization models for any engineering system.

CLO2: Solve optimization problems.

CLO3: To learn about modern optimization methods

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	2	1	3	3	1	2
CLO2	2	2	3	3	1	2
CLO3	2	2	3	2	1	2

Syllabus Contents:

Module 1: Introduction: Model, Steps in modeling: Formulation, Deduction, Interpretation, Ten Principles of Modeling, Design Process, Differences Between Engineering Analysis and Design, Comparison Between Conventional Design and Optimal Design.

Module 2: Introduction to optimization model formulation in engineering design: Objective & Constraint function, Development of objective & constraint functions, Example formulations, Classification of optimization models.

Module 3: Solution Techniques: Linear programming: Linear Programming Problem, Graphical Solution, Linear Programming in Standard Form, Handling Inequality Constraints, Handling Variables Unrestricted in Sign, Basic Definitions in LP, Canonical reduction, Principles of the Simplex Method, Simplex Method in TABLEAU Form, Computational Problems, Big M Simplex Method, Two-Phase Simplex Method. Revised Simplex Method, Integer Programming, Fixed Charge Problem Formulation.

Module 4: Nonlinear programming – 1: Single variable unconstrained minimization, Basic Definitions, Optimality Criteria, Introduction to line search techniques.

Nonlinear programming – 2: Multivariable unconstrained optimization, Optimality Criteria, Introduction to various Algorithms for Minimization.

Nonlinear programming – 3: Multivariable constrained optimization, Equality Type Constraints, Lagrange Multiplier, Inequality Type Constraints, Optimality Criteria Transformation Methods, Penalty Function Algorithm, Linearization Methods, Reduced Gradient Method, quadratic programming, Introduction to projected augmented Lagrangian Method.

Module 5: Introduction to Advanced topics: Dynamic & Geometric programming, Chance constrained & Multiple objective optimization, Soft computing techniques - Genetic Algorithm, Simulated Annealing Technique, Fuzzy logic, Artificial Neural Networks.

Text Books

1. Engineering Hydrology by R. S. Varshney, Nem Chand & Bros. Roorkee (U.P.) 1986.
2. Operations Research – Principles and Practice by A. Ravindran, D. J. Philips and J. J. Solberg, 2nd Edition, John Wiley & Sons, New York, 1987.
3. Engineering Optimization – Theory and Practice by S. S. Rao, 3rd Edition, New Age Int. (P) Ltd. Publishers, New Delhi, 2001.

References

1. Optimization: Theory and Applications by S.S.Rao
2. Nonlinear Programming – Theory and Algorithms by M. S. Bazaraa & C. M. Shetty, John Wiley & Sons, New York, 1990.
3. Introduction to Optimum Design by J. S. Arora, McGraw Hill Int. Editions, McGraw Hill Book Co. Singapore, 1989.

Code	Course	L	T	P	C
CE533	Project Management in Construction	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1: Understand the fundamental concepts, processes, and functions involved in project management and project integration management.

CLO2: Apply techniques for project scope, time, and cost management, including scheduling, budgeting, and resource allocation.

CLO3: Analyze project schedules using tools such as CPM, PERT, line-of-balance method, and resource-constrained scheduling techniques.

CLO4: Evaluate project performance through quality management, risk management, earned value analysis, and time–cost trade–off studies.

CLO5: Demonstrate knowledge of procurement, material management, life-cycle costing, value management, and knowledge management in construction projects.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	2	1	1	2	1	1
CLO2	2	1	3	2	1	2
CLO3	2	2	3	3	1	2
CLO4	1	3	2	3	2	3
CLO5	1	2	2	2	3	2

Syllabus Contents:

Module 1: Introduction to project management processes - Initiating, Planning, Executing, Controlling, and Closing processes;

Module 2: Project Integration Management - Project plan development, Project plan execution, and Overall change control; Project Scope Management - Initiation, Scope planning, Scope definition, Scope verification, and Scope change control;

Module 3: Project Time Management - Activity definition - work breakdown structure, Activity sequencing – scheduling logic, precedence diagramming method, arrow diagramming method, Activity duration estimation, Schedule development and analysis - critical path method, program evaluation and review technique, production curves, line-of-balance method, Duration compression, Resource constrained scheduling, Schedule control;

Module 4: Project Cost Management - Resource planning, Cost estimating, Cost budgeting, and Cost control – earned value method;

Module 5: Project Resource Management - Resource aggregation, Resource leveling – method of moments, double moments, Resource allocation; Time-cost Tradeoff;

Module 6: Project Quality Management - Quality planning, Quality assurance, and Quality control; Project Risk Management - Risk identification, Risk quantification, Risk response development and control;

Module 7: Project Procurement Management - Procurement planning, Solicitation planning, Solicitation, Source selection, Contract administration, and Contract close-out; Material Management; Life-cycle Costing; Value Management; Knowledge Management.

Text Books

1. T. Hegazy, Computer-based construction project management, Prentice Hall, New Jersey, 2002.
2. S. M. Levy, Project management in construction, 5th ed., McGraw Hill, New York, 2007.
3. PMI, A guide to the project management body of knowledge, 3rd ed., Project Management Institute, Pennsylvania, 1996.

References

1. M. Mawdesley, W. Askew and M. O'Reilly, Planning and controlling construction projects, Addison Wesley Longman Limited, Essex, 1997.
2. J. Kelly, S. Male and D. Graham, Value management of construction projects, Blackwell Publishing, Oxford, 2003.

Code	Course	L	T	P	C
CE534	Advanced Bridge Engineering	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Acquire knowledge to select different type bridges by assessing their material, capacity, quality & suitability.

CLO2. Ability to make a bridge plan and design following requisite criteria.

CLO3. Supervise the construction procedure of different components of a bridge.

CLO4. Assess the quality and roles of various components of bridge.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	1	2	2	1	1
CLO2	3	2	3	3	1	2
CLO3	2	3	3	3	1	3
CLO4	2	2	2	3	2	3

Syllabus Contents:

Module 1: Hydraulic design: Survey, Catchment, Site selection, Hydraulic geometry, Linear waterways, Economic span, Afflux and Scour.

Module 2: Loads on bridge: Different types of load acting on bridge along with numerical; Slab and box culvert: Analysis of deck slab - effective width & length method and numerical example with different type of live load. R.C. beam-slab and steel composite bridges: R.C. T-beam bridge and steel composite bridge design using Pigeaud's method and Courbon's method

Module 3: Dynamic response of bridge deck: General features, factor affecting vibration, practical approach for vibration analysis and numerical examples.

Module 4: Prestressed concrete bridge: General features, advantage of P.S.C. Bridge, design details of pre-tensioned and post-tensioned bridge and numerical; Bridge bearing: Introduction, types of bearing, design principles of different bearing and numerical examples

Module 5: Substructure: Introduction, type of piers, forces acting on piers, stability analysis of abutment, types of wing wall and numerical examples of Pier and Abutment; Bridge foundation: General aspect, types of foundations, design aspect of pile and well foundations and numerical examples of pile and well foundations.; R.E. Wall: Brief introduction to R.E. wall, methodology, analysis and design.

Module 6: Special Topics: Brief idea on Pipe culvert, Masonry arch, Skew bridges, Rigid frame bridge, Plate girder bridge, Steel trussed bridge, Balanced cantilever bridge, Continuous bridge and Cable stayed bridges.

Text Books

1. Bridge Engineering by S. Ponnuswamy, Tata McGraw-Hill Publishing Company Limited, New Delhi.

References

1. IRC: 6-2017 Standard Specifications and Code of Practice for Road Bridges
2. Design and construction of Highway Bridges by K. S. Rakshit, New Central Book Agency (P)

SEMESTER II
MASTER OF TECHNOLOGY
IN
STRUCTURAL ENGINEERING

Code	Course	L	T	P	C
CE506	Finite Element Method	3	0	0	3

Course Learning Outcome: At the end of the course, students will be able to

CLO1. Analyze structural systems such as bars, beams and frames using the Finite Element Method.

CLO2. Formulate weak forms of boundary value problems using variational principles and the method of weighted residuals.

CLO3. Solve two and three-dimensional continuum problems using the Finite Element Method.

CLO4. Implement finite element algorithms using computational tools.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	3	3	1	2
CLO2	3	1	3	2	1	2
CLO3	3	2	3	3	1	3
CLO4	2	3	3	3	2	3

Syllabus Contents:

Module 1: Introduction: History and applications, General procedure of FEM, Spring and bar elements, Direct stiffness method, Assembly of global stiffness matrix, Element strain and stress.

Module 2: Variational Methods: Calculus of variations, Weak formulation of differential equations, Method of Weighted Residuals, Galerkin Finite Element Method, Interpolation functions, Convergence and error estimates.

Module 3: Beams and Frames: Euler–Bernoulli beam theory, Beam Element, Consistent Load Vector, Analysis of plane frames, Symmetry and anti-symmetry conditions.

Module 4: Two and Three-Dimensional Finite Elements: Triangular Elements, Rectangular Elements, Three-Dimensional Elements, Isoparametric Formulation, Transition Elements, Numerical Integration, Gaussian Quadrature.

Module 5: Application to Solid Mechanics: Plane stress and plane strain problems, Constant Strain Triangle (CST) Element, 2D and 3D stress analysis, Axi-symmetric solids, Initial-Boundary Value Problems, Mixed Finite Elements.

Module 6: Computer Implementation of FEM: Mesh generation and connectivity, Assembling the stiffness matrix, Application of boundary conditions, MATLAB/Python

implementation of FEM solvers, post-processing, Introduction to commercial FEM software

Text Books

1. A First Course in Finite Element Analysis, Logan, D. L., PWS Publishing, Boston, 1993.
2. Concepts and Applications of Finite Element Analysis, Cook R. D., Wiley J., New York, 1995.
3. Finite Element Procedure, Bathe, K. J., Prentice Hall of India, New Delhi, 2001.
4. Finite Element Method, Zienkiewicz O.C. & Taylor R.L. Vol. I, II & III, Elsevier, 2000.

References

1. The Finite Element Method: Linear Static and Dynamic Finite Element Analysis, Hughes, T. J. R., Dover Publications, 2000.
2. An Introduction to the Finite Element Method, Reddy, J. N., McGraw Hill, New York, 1993.
3. Finite Element Method with Applications in Engineering, Desai, C. S., Pearson Education, 2011.

Code	Course	L	T	P	C
CE507	Structural Dynamics	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Understand the fundamentals of structural dynamics, mathematical modelling of dynamic systems, and the importance of vibration analysis in civil engineering structures.

CLO2. Analyse the response of single degree of freedom (SDOF) systems subjected to free and forced vibrations with and without damping under different dynamic loading conditions.

CLO3. Apply numerical methods such as Newmark Method, Wilson Method, and direct integration techniques for solving dynamic response problems.

CLO4. Analyse multiple degree of freedom (MDOF) systems to determine natural frequencies, mode shapes, and dynamic response using modal superposition and direct integration methods.

CLO5. Understand the dynamic behaviour of structures under wind, moving loads, traffic, blasting, machinery vibrations, and the concept of base isolation in earthquake-resistant design.

CLO and PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	3	3	1	2
CLO2	3	2	3	3	1	2
CLO3	2	2	3	3	1	3
CLO4	3	2	3	3	1	3
CLO5	3	1	2	3	2	2

Syllabus Contents:

Module 1: Introduction: Objectives, Importance of Vibration Analysis, Nature of Exciting Forces, Mathematical Modelling of Dynamic Systems.

Module 2: Single Degree of Freedom System: Free and Forced Vibration with and without Damping, Response to Harmonic Loading, Response to General Dynamic Loading using Duhamel's Integral, Fourier Analysis for Periodic Loading, State Space Solution for Response.

Module 3: Numerical Solution to Response using Newmark _ Method and Wilson _ Method, Numerical Solution for State Space Response using Direct Integration.

Module 4: Multiple Degree of Freedom System (Lumped parameter): Two Degree of Freedom System, Multiple Degree of Freedom System, Inverse Iteration Method for Determination of Natural Frequencies and Mode Shapes, Dynamic Response by Modal Superposition Method, Direct Integration of Equation of Motion.

Module 5: Multiple Degree of Freedom System (Distributed Mass and Load): Single Span Beams, Free and Forced Vibration, Generalised Single Degree of Freedom System.

Module 6: Special Topics in Structural Dynamics (Concepts only): Dynamic Effects of Wind Loading, Moving Loads, Vibrations caused by Traffic, Blasting and Pile Driving, Foundations for Industrial Machinery, Base Isolation.

Text Books

1. Dynamics of Structures, Clough R. W. and Penzien J., Mc Graw Hill.
2. Structural Dynamics and Introduction to Earthquake Engineering, Chopra A. K.
3. Vibration of Structures - Application in Civil Engineering Design, Smith J. W., Chapman and Hall.

References

1. Dynamics of Structures, Humar J. L., Prentice Hall.
2. Structural Dynamics - Theory and Computation, Paz Mario, CBS Publication.
3. Dynamics of Structures, Hart and Wong.

Code	Course	L	T	P	C
CE508	Advanced Concrete Technology	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Understand the properties and materials used in concrete production.

CLO2. Apply concrete mix design principles for different types of concrete.

CLO3. Analyse the behaviour and workability of fresh concrete.

CLO4. Evaluate the properties of hardened concrete using testing methods.

CLO5. Understand the applications of special and special-purpose concretes.

CLO and PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	2	2	1	2
CLO2	3	2	3	3	1	2
CLO3	3	2	3	3	1	2
CLO4	3	3	3	3	2	3
CLO5	3	2	2	3	2	2

Syllabus Contents:

Module 1: Brief Introduction to Concrete: Classification of concrete, Properties of concrete, Grades of concrete, Advantages and disadvantages of concrete as a construction material.

Module 2: Brief Introduction to Concrete Making Materials: Cement, Aggregates, Water, Admixture: Brief review of types, properties and application, Codal provisions.

Module 3: Concrete Mix Design: Factors influencing design of mix, IS methods of design of mixes for ordinary, high-strength concrete, self-compacted concrete, mass concrete.

Module 4: Fresh Concrete: Rheology of concentrated suspensions, pastes, mortars and concretes; workability, segregation and bleeding. Theory and principles governing the correct placing and compaction of concrete.

Module 5: Properties of Hardened Concrete: Strength; deformation under load; elasticity; creep; drying shrinkage and other volume changes. Thermal properties, Destructive and non-destructive tests.

Module 6: Special Concretes: Lightweight concrete: autoclaved aerated concrete, Ready-mix concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete, high-strength concrete; refractory concrete; high-density and radiation-shielding concrete; polymer concrete; fibre-reinforced concrete; recycled concrete.

Module 7: Special Purpose Concrete: Sprayed concrete, underwater concrete, grouts and grouted concrete, mass concrete, pumped concrete, concrete for liquid retaining structures.

Text Books

1. Concrete Technology by M. S. Shetty, S. Chand & Co. Ltd., 2005.
2. Concrete Technology by A. M. Neville & J. J. Brooks, Pearson Education, 2008

References

1. Concrete Mix Proportioning-Guidelines, IS 10262: 2019.
2. Coarse and Fine Aggregate for Concrete – Specification, IS 383: 2016.
3. Plain and Reinforced Concrete – Code of Practice, IS 456: 2000.
4. Advance Concrete Technology by John Newman & Ban Seng Cho, Elsevier, 2003.
5. Concrete Technology by M. L. Gambhir, Tata McGraw Hill, 2007.

Code	Course	L	T	P	C
CE509	Advanced Concrete Lab	0	0	2	1

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Design high grade concrete and study the parameters affecting its performance.

CLO2. Conduct Non-Destructive Tests on existing concrete structures.

CLO3. Apply engineering principles to understand behavior of structural/ elements.

CLO and PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	3	3	1	2
CLO2	2	3	2	3	2	3
CLO3	3	2	3	3	1	3

List of Experiments/Assignments:

1. Study of stress-strain curve of high strength concrete, Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
3. Effect of cyclic loading on steel.
4. Non-Destructive testing of existing concrete members.
5. Behavior of Beams under flexure, Shear and Torsion.

Text Books

1. Properties of Concrete, Neville A. M., 5th Edition, Prentice Hall, 2012.
2. Concrete Technology, Shetty M. S., S. Chand and Co., 2006.

References

1. Concrete Mix Proportioning-Guidelines, IS 10262: 2019.
2. Coarse and Fine Aggregate for Concrete – Specification, IS 383: 2016.
3. Plain and Reinforced Concrete – Code of Practice, IS 456: 2000.
4. Advance Concrete Technology by John Newman & Ban Seng Cho, Elsevier, 2003.
5. Concrete Technology by M. L. Gambhir, Tata McGraw Hill, 2007.

Code	Course	L	T	P	C
CE510	Computational Lab	0	0	2	1

Course Learning Outcome: At the end of the course, students will be able to

CLO1. Program numerical scripts in MATLAB/Python to handle sparse matrices, solvers, and structural eigenvalue problems.

CLO2. Develop finite element codes for truss, beam, CST, and Q4 elements.

CLO3. Model complex structural systems using commercial FEA software.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	2	3	3	3	1	2
CLO2	2	3	3	3	2	3
CLO3	3	3	3	3	2	3

Syllabus Contents:

Module 1: Scientific Computing Fundamentals: Introduction to MATLAB/Python syntax, data structures, and vectorized operations, sparse matrices, direct and iterative solvers, eigenvalue problems for structural systems.

Module 2: Finite Element Programming: Development of computational scripts for truss, beam, plane stress and plane strain problems using CST and Isoparametric Q4 elements, Numerical integration via Gauss Quadrature and element stiffness matrix assembly, boundary conditions and solver implementation.

Module 3: Advanced Finite Element Modelling using Commercial Software: Finite element modelling of complex structures (e.g., multi-story frames, shear walls, or plates) using commercial packages, selection of finite elements, mesh refinement techniques, convergence studies

Code	Course	L	T	P	C
CE550	Advanced Steel Design	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1: Understand the design aspects, principles of few steel structures as a whole.

CLO2: Apply basic knowledge of steel design of components for design solutions of whole structure.

CLO3: Understand various methods /principles to evaluate horizontal effect /wind load on steel structures.

CLO4: Formulate, analyse, and design of various Civil Engineering Steel structures with reference to the IS code of practice.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	1	2	2	1	1
CLO2	3	2	3	3	1	2
CLO3	3	2	3	3	1	2
CLO4	3	2	3	3	2	2

Syllabus Contents:

Module 1: Properties of Steel: Mechanical Properties, Hysteresis, Ductility. Hot Rolled Sections: compactness and non-compactness, slenderness, residual stresses.

Module 2: Design of Steel Structures: Inelastic Bending Curvature, Plastic Moments, Design Criteria Stability, Strength, Drift.

Module 3: Stability of Beams: Local Buckling of Compression Flange & Web, Lateral Torsional Buckling.

Module 4: Stability of Columns: Slenderness Ratio, Local Buckling of Flanges and Web, Bracing of Column about Weak Axis.

Module 5: Method of Designs: Allowable Stress Design, Plastic Design, Load and Resistance Factor Design;

Module 6: Strength Criteria: Beams - Flexure, Shear, Torsion, Columns - Moment Magnification Factor, Effective Length, PM Interaction, Biaxial Bending, Joint Panel Zones.

Module 7: Drift Criteria: P Effect, Deformation Based Design;

Connections: Welded, Bolted, Location Beam Column, Column Foundation, Splices.

Text Books

1. Design of Steel Structures - Vol. II, Ramchandra. Standard Book House, Delhi.
2. Design of Steel Structures - Arya A. S., Ajmani J. L., Nemchand and Bros., Roorkee.

References

1. The Steel Skeleton- Vol. II, Plastic Behaviour and Design - Baker J. F., Horne M. R., Heyman J., ELBS.
2. Plastic Methods of Structural Analysis, Neal B. G., Chapman and Hall London.
3. IS 800: 2007 – General Construction in Steel - Code of Practice, BIS, 2007.
4. SP – 6 - Handbook of Structural Steel Detailing, BIS, 1987

Code	Course	L	T	P	C
CE551	Soil Structure Interaction	3	0	0	3

Course Learning Outcomes: At the end of this course, students will be able to

CLO1. Students can apply different soil response models for specific problem based on the requirement.

CLO2. Students can analyze footings/rafts resting on soil as beams/plates on elastic foundation and work out design bending moments/shear and displacements.

CLO3. Student can compute pile response for various loading condition for design purpose.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	3	3	1	2
CLO2	3	2	3	3	1	2
CLO3	3	2	3	3	1	2

Syllabus Contents:

Module 1: Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behavior, Time dependent behavior.

Module 2: Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness.

Module 3: Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

Module 4: Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

Module 5: Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. An introduction to soil-foundation interaction under dynamic loads.

Text Books

1. Elastic Analysis of Soil-Foundation Interaction — A.P.S. Selvadurai, Elsevier, 1979.
2. Pile Foundation Analysis and Design — John Wiley & Sons, 1980.

3. Foundation Analysis — Prentice Hall, 1981.
4. Soil Structure Interaction – State of the Art Report — Institution of Structural Engineers, 1978.
5. Suggested Analysis and Design Procedures for Combined Footings and Mats — American Concrete Institute, 1988.

References

1. Selvadurai, A.P.S, Elastic Analysis of Soil-Foundation Interaction, Elsevier, 1979
2. Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley, 1980.
3. Scott, R.F., Foundation Analysis, Prentice Hall, 1981.
4. Structure Soil Interaction - State of Art Report, Institution of Structural Engineers, 1978.
5. ACI 336. (1988), Suggested Analysis and Design Procedures for combined footings and Mats, American Concrete Institute.

Code	Course	L	T	P	C
CE552	Design of High Rise Structures	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Analyse, design and detail Transmission/ TV tower, Mast and Trestles with different loading conditions.

CLO2. Analyse, design and detail the RC and Steel Chimney.

CLO3. Analyse, design and detail the tall buildings subjected to different loading conditions using relevant codes.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	3	3	1	2
CLO2	3	2	3	3	1	2
CLO3	3	2	3	3	2	2

Syllabus Content:

Module 1: Design of transmission/ TV tower, Mast and trestles: Configuration, bracing system, analysis and design for vertical transverse and longitudinal loads.

Module 2: Analysis and Design of RC and Steel Chimney, Foundation design for varied soil strata.

Module 3: Tall Buildings: Structural Concept, Configurations, various systems, Wind and Seismic loads, Dynamic approach, structural design considerations and IS code provisions. Firefighting design provisions.

Module 4: Application of software in analysis and design.

Text Books

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

References

1. Design 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 Graw Hill Publishing Company, New Delhi

Code	Course	L	T	P	C
CE553	Design of Masonry Structures	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Understand the masonry design approaches.

CLO2. Analyse Reinforced Masonry Members.

CLO3. Determine interactions between members.

CLO4. Determine shear strength and ductility of Reinforced Masonry members.

CLO5. Check the stability of the walls.

CLO6. Perform elastic and Inelastic analysis of masonry walls.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	1	2	2	1	1
CLO2	3	2	3	3	1	2
CLO3	2	2	3	3	1	2
CLO4	3	2	3	3	1	2
CLO5	2	1	2	3	1	2
CLO6	3	2	3	3	2	3

Syllabus Contents:

Module 1: Introduction: Historical Perspective, Masonry Materials, Masonry Design Approaches, Overview of Load Conditions, Compression Behaviour of Masonry, Masonry Wall Configurations, Distribution of Lateral Forces.

Module 2: Flexural Strength of Reinforced Masonry Members: In-plane and Out-of-plane Loading.

Module 3: Interactions: Structural Wall, Columns and Pilasters, Retaining Wall, Pier and Foundation.

Module 4: Shear Strength and Ductility of Reinforced Masonry Members.

Module 5: Prestressed Masonry - Stability of Walls, Coupling of Masonry Walls, Openings, Columns, Beams.

Module 6: Elastic and Inelastic Analysis, Modelling Techniques, Static Push Over Analysis and use of Capacity Design Spectra.

Text Books

1. Design of Reinforced Masonry Structures, Narendra Taly, ICC, 2nd Edn,
2. Masonry Structures: Behavior and Design, Hamid Ahmad A. and Drysdale Robert G., 1994.

References

1. Mechanics of Masonry Structures, Editor: Maurizio Angelillo, 2014.
2. Earthquake-resistant Design of Masonry Buildings, Tomašević Miha, Imperial College Press, 1999

Code	Course	L	T	P	C
CE554	Waste to Energy in Civil and Environmental Infrastructure	3	0	0	3

Course Learning Outcome:

CLO1: Explain the concept, scope and need of waste-to-energy systems in urban infrastructure.

CLO2: Characterize municipal solid waste and assess its energy recovery potential.

CLO3: Describe major biological and thermal waste-to-energy technologies.

CLO4: Explain civil engineering requirements for WtE plants, biomethanation units and landfill gas systems.

CLO5: Identify environmental impacts related to emissions, ash, odour, leachate and residual waste.

CLO6: Evaluate basic feasibility and case studies of waste-to-energy projects.

CLO–PLO Mapping

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	2	2	2	2	1	2
CLO2	2	3	3	3	1	2
CLO3	2	2	3	2	1	2
CLO4	2	3	3	3	1	2
CLO5	2	2	3	3	2	3
CLO6	2	2	3	3	3	3

Syllabus Contents:

Module 1: Introduction to Waste to Energy and Urban Waste Systems- Concept and need of waste-to-energy; waste as a resource; classification of waste: municipal solid waste, organic waste, agricultural residue, sewage sludge, industrial non-hazardous waste and construction-related waste; solid waste generation and composition; source segregation; collection, transportation and transfer stations; integrated solid waste management hierarchy; role of urban local bodies and civil infrastructure.

Module 2: Waste Characterization and Energy Potential - Physical and chemical characteristics of municipal solid waste; moisture content, density, volatile matter, ash content, fixed carbon, calorific value and C/N ratio; biodegradable and combustible fractions; waste sampling and analysis; suitability of waste for composting,

biomethanation, RDF and thermal treatment; pre-processing, shredding, drying, screening and material recovery facilities.

Module 3: Biological Waste-to-Energy Systems -Anaerobic digestion and biomethanation; principles of biogas generation; feedstock suitability; wet and dry digestion; single-stage and two-stage systems; design considerations for digesters; biogas composition, storage, cleaning and utilization; compressed biogas from municipal solid waste; digestate handling; integration of biomethanation plants with markets, institutions, slaughterhouses, STPs and urban organic waste streams.

Module 4: Thermal Waste-to-Energy Systems- Refuse-derived fuel: preparation, quality requirements and use; incineration of municipal solid waste; pyrolysis and gasification: basic principles and comparison; mass burn and RDF-based systems; civil engineering aspects of WtE plants: site selection, plant layout, waste receiving area, tipping floor, storage bunker, foundations, internal roads, drainage, fire safety and utility systems; integration with power generation and heat recovery.

Module 5: Landfill Gas Recovery and Environmental Controls- Engineered landfill concepts; landfill gas generation and composition; gas collection wells, headers and flaring systems; energy recovery from landfill gas; leachate generation and collection systems; ash and residue management from WtE plants; bottom ash and fly ash handling; air pollution control systems; odour, noise, wastewater and stormwater management; environmental monitoring and regulatory compliance.

Module 6: Feasibility, Policy and Case Studies: Techno-economic feasibility of WtE projects; quantity and quality of waste, land requirement, transportation distance, capital cost, operation and maintenance cost, revenue streams and tipping fee; public-private partnership models; environmental clearance and public acceptance issues; role of Solid Waste Management Rules, Swachh Bharat Mission and urban waste policies; Indian and international case studies of biomethanation, RDF, incineration and landfill gas recovery projects.

Text Books

1. Tchobanoglous, G., Theisen, H., and Vigil, S. A. *Integrated Solid Waste Management: Engineering Principles and Management Issues*. McGraw-Hill.
2. Vesilind, P. A., Worrell, W., and Reinhart, D. *Solid Waste Engineering*. Cengage Learning.
3. Khan, I. H., and Ahsan, N. *Textbook of Solid Waste Management*. CBS Publishers.
4. Rao, M. N., and Sultana, R. *Solid and Hazardous Waste Management*. BS Publications.
5. Khandelwal, K. C., and Mahdi, S. S. *Biogas Technology: A Practical Handbook*. Tata McGraw-Hill.
6. Ministry of Housing and Urban Affairs, Government of India. *Manual on Municipal Solid Waste Management*.

Reference Books / Guidelines

1. Central Pollution Control Board. Guidelines and standards related to municipal solid waste processing, waste-to-energy plants and emission control.
2. Ministry of Environment, Forest and Climate Change. *Solid Waste Management Rules, 2016* and subsequent amendments.

3. Swachh Bharat Mission-Urban. Guidelines, advisories and technical resources on solid waste management and compressed biogas.
4. Niessen, W. R. *Combustion and Incineration Processes*. CRC Press.
5. Young, G. C. *Municipal Solid Waste to Energy Conversion Processes*. Wiley.
6. Cheremisinoff, N. P. *Handbook of Solid Waste Management and Waste Minimization Technologies*. Butterworth-Heinemann.
7. World Bank. Technical guidance documents on municipal solid waste management and landfill gas recovery.

Code	Course	L	T	P	C
CE555	Quality And Safety Management In Construction	3	0	0	3

Course Learning Outcome:

CLO1: Understand the concepts, evolution, principles, and importance of quality management systems in construction engineering.

CLO2: Apply quality control, quality assurance, ISO standards, and Total Quality Management (TQM) tools and techniques in design and construction practices.

CLO3: Analyse construction hazards, accidents, and safety requirements and recommend appropriate preventive and corrective measures.

CLO4: Plan and implement safety management practices, safety awareness programmes, and health provisions at construction sites.

CLO5: Evaluate construction quality and safety systems for effective project management, compliance, and sustainable engineering practices.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	2	1	1	2	1	2
CLO2	2	2	3	3	1	2
CLO3	2	2	2	3	1	3
CLO4	1	3	2	2	2	3
CLO5	2	2	3	3	2	3

Syllabus Contents:

Module 1: Introduction to quality; Importance of quality; Quality transition - quality control and inspection, quality assurance, total quality management;

Module 2: Evolution of quality management; Planning and control of quality during design of structures; Tools and techniques for quality management; Inspection of materials and machinery; Quality assurance in construction;

Module 3: Systems quality management; Quality standards/codes in design and construction; (ISO:9000); Total quality management (TQM) - principles, tools and techniques. Introduction to safety;

Module 4: Safety and health programs in construction industry; Planning for safety provisions; Analysis of construction hazards and accidents; Construction hazards and safety guidelines; Prevention techniques for construction accidents; Site management with regard to safety recommendations;

Module 5: Training for safety awareness and implementation; Construction safety and health manual.

Text Books

1. B. G. Dale, Managing quality, 4th ed., Blackwell Publishing, Oxford, 2003.
2. C. D. Reese and J. V. Eidson, Handbook of OSHA construction safety and health, 2nd ed., CRC Press, Boca Raton, 2006.
3. F. Harris, R. McCaffer and F. Edum-Fotwe, Modern construction management, 6th ed., Blackwell Publishing, Oxford, 2006.

References

1. K. Knutson, C. J. Schexnayder, C. M. Fiori and R. Mayo, Construction management fundamentals, 2nd ed., McGraw Hill, New York, 2008.
2. A. S. J. Holt, Principles of construction safety, Blackwell Publishing, Oxford, 2008.

Code	Course	L	T	P	C
CE560	Advanced RC Design	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1: Acquire knowledge of engineering design of different Member

CLO2: Ability to analyze the special /utility Structures: Bunker, Silo, Water Tank, Shell etc.

CLO3: Ability to understand the need of future studies

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	1	2	2	1	1
CLO2	3	2	3	3	1	2
CLO3	1	1	1	1	2	3

Syllabus Contents:

Module 1: Brief Introduction: Concrete as a construction material, Recapitulation of basic concepts WSM & LSM, Serviceability calculation, deflection and cracking; Moment Redistribution: Examples of single and multi-span beams

Module 2: Combined footing: Design of combined, strip and raft footing, pile cap

Module 3: Multistoried building: Design and detailing of multistoried building frames, Wind & earthquake load, Crack & deflection, earthquake resistance design & detailing

Module 4: Flat Slab: Design of flat slab and associated Column; Yield Line: Analysis and design by yield line theory

Module 5: Deep and curve Beam: Design of deep & curve beam

Module 6: Tension member: Brief introduction to tension members

Module 7: Water Tanks: Different types of tanks; Bunkers & silo: Analysis & Design of bunker & silo; Shell and folded plate: Design of shell and folded plate

Text Books

1. Adv. R. C. C Design Vol-II, by S.S. Bhavikatti, New Age International (P) Limited, New Delhi
2. Adv. R. C. C Design, by N.K. Raju, CBS Publishers & Distributor, New Delhi

References

1. IS 456: 2000, Indian Standard Plain and Reinforced Concrete – Code of Practice (4th Revision), BIS, New Delhi.
2. IS 3370 (I, II, IV): 2009 & 1965, Concrete structures for storage of Liquids- Code of practice (1st Revision), BIS, New Delhi.
3. IS 1893 (I): 2016, Criteria for earthquake resistance design of Structures-General provisions and building (6th Revision), BIS, New Delhi.
4. IS 13920: 2016, Ductile design & detailing of R. C. structures subjected to seismic forces- code of practice (1st Revision), BIS, New Delhi
5. ACI-318-19, Building Code Requirements for Structural Concrete and Commentary
6. EC-2: 1992, Design of concrete structures
7. AS-3600: 2018, Standards for Concrete Structures.
8. Reinforced Concrete Design, 2nd Edition, by S. Unnikrishna Pillai and Devdas Menon, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003

Code	Course	L	T	P	C
CE561	Advanced Design of Foundations	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Decide the suitability of soil strata for different projects.

CLO2. Design shallow foundations deciding the bearing capacity of soil.

CLO3. Analyze and design the pile foundation.

CLO4. Understand analysis methods for well foundation.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	3	3	1	2
CLO2	3	2	3	3	1	2
CLO3	3	2	3	3	1	2
CLO4	3	2	2	3	1	2

Syllabus Contents:

Module 1: Planning of Soil Exploration for Different Projects, Methods of Subsurface Exploration, Methods of Borings along with Various Penetration Tests.

Module 2: Shallow Foundations, Requirements for Satisfactory Performance of Foundations, Methods of Estimating Bearing Capacity, Settlements of Footings and Rafts, Proportioning of Foundations using Field Test Data, Pressure - Settlement Characteristics from Constitutive Laws.

Module 3: Pile Foundations, Methods of Estimating Load Transfer of Piles, Settlements of Pile Foundations, Pile Group Capacity and Settlement, Laterally Loaded Piles, Pile Load Tests, Analytical Estimation of Load- Settlement Behavior of Piles, Proportioning of Pile Foundations, Lateral and Uplift, Capacity of Piles.

Module 4: Well Foundation, IS and IRC Code Provisions, Elastic Theory and Ultimate Resistance Methods.

Module 5: Tunnels and Arching in Soils, Pressure Computations around Tunnels.

Module 6: Open Cuts, Sheet piling and Bracing Systems in Shallow and Deep Open Cuts in Different Soil Types. **Coffer Dams**, Various Types, Analysis and Design, Foundations under uplifting loads, Soil-structure interaction

Text Books

1. Design of foundation system, N.P. Kurian, Narosa Publishing House
2. Foundation Analysis and Design, J. E. Bowles, Tata McGraw Hill New York

References

1. Analysis and Design of Substructures, Sawmi Saran, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.

Code	Course	L	T	P	C
CE562	Design of Industrial Structures	3	0	0	3

Course Learning Outcomes: At the end of the course, the student will be able to:

CLO1. Design Steel Gantry Girders.

CLO2. Design Steel Portal, Gable Frames.

CLO3. Design Steel Bunkers and Silos.

CLO4. Design Chimneys and Water Tanks.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	1	3	3	1	2
CLO2	3	2	3	3	1	2
CLO3	3	2	3	3	1	2
CLO4	3	2	3	3	2	2

Syllabus Contents:

Module 1: Steel Gantry Girders – Introduction, loads acting on gantry girder, permissible stress, types of gantry girders and crane rails, crane data, maximum moments and shears, construction detail, design procedure.

Module 2: Portal Frames – Design of portal frame with hinge base, design of portal frame with fixed base - Gable Structures – Lightweight Structures

Module 3: Steel Bunkers and Silos – Design of square bunker – Jansen's and Airy's theories – IS Code provisions – Design of side plates – Stiffeners – Hooper – Longitudinal beams Design of cylindrical silo – Side plates – Ring girder – stiffeners.

Module 4: Chimneys – Introduction, dimensions of steel stacks, chimney lining, breech openings and access ladder, loading and load combinations, design considerations, stability consideration, design of base plate, design of foundation bolts, design of foundation.

Module 5: Water Tanks – Design of rectangular riveted steel water tank – Tee covers – Plates – Stays – Longitudinal and transverse beams – Design of staging – Base plates – Foundation and anchor bolts –

Module 6: Design of pressed steel water tank – Design of stays – Joints – Design of hemispherical bottom water tank – side plates – Bottom plates – joints – Ring girder – Design of staging and foundation.

Text Books

1. Design of Steel Structure, Punmia B. C., Jain Ashok Kr., Jain Arun Kr., 2nd Ed., Lakshmi Publishers, 1998.
2. Design of Steel Structures, Ram Chandra, 12th Ed., Standard Publishers, 2009.

References

1. Design of Steel Structures, Subramaniam.

Code	Course	L	T	P	C
CE563	Construction Methods and Equipment Management	3	0	0	3

Course Learning Outcomes: At the end of the course, the student will be able to:

CLO1. Understand the planning process, selection criteria, operation, and maintenance aspects of various construction equipment used in civil engineering projects.

CLO2. Analyze ownership and operating costs, equipment life, replacement procedures, and financing methods for construction equipment management.

CLO3. Apply engineering principles for selection, productivity estimation, optimization, and scheduling of construction equipment systems for earthmoving, concreting, lifting, and paving operations.

CLO4. Evaluate and optimize equipment-intensive construction operations using mathematical models, simulation techniques, and scheduling methods for effective project execution.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	2	2	2	3	1	1
CLO2	2	2	3	3	1	2
CLO3	2	2	3	3	1	2
CLO4	2	2	3	3	2	3

Syllabus Contents:

Module 1: Planning Process for Equipment and Methods; Cost of Owning and Operating Construction Equipment - Ownership cost, Depreciation, Operating cost, and Ownership and operating costs calculation methods;

Module 2: Equipment Life and Replacement Procedures - Physical, profit and economic life, Replacement analysis;

Module 3: Engineering Fundamentals of Moving Earth - Rolling resistance, Effect of grade on tractive effort, Effect of altitude on performance of IC engines; Earthmoving, Excavating, and Lifting Equipment Selection - Bulldozers, Front-end Loaders, Scrapers, Trucks, Excavators, Backhoes, Front shovels, Cranes, and Forklifts; Piles and Pile-Driving Equipment;

Module 4: Production of Crushed-stone Aggregate; Concreting Equipment; Asphalt Mix Production and Placement - Asphalt Plants, and Paving Equipment; Estimating and Optimizing Construction Equipment System Productivity - Peurifoy's method of

optimizing productivity, Phelps' Method, Optimizing hauling system based on loading facility;

Module 5: Estimation of Equipment Productivity - Mathematical models, Simulations; Scheduling Equipment-Intensive Horizontal Construction Projects - Linear scheduling method, Precedence diagramming method, Developing equipment resource packages;

Module 6: Scheduling Lifting Equipment for Vertical Construction; Equipment Financing Decision - Financing methods, Rental and lease contract considerations.

Text Books

1. D. G. Gransberg, C. M. Popescu and R. C. Ryan, Construction equipment management for engineers, estimators, and owners, Taylor & Francis, New York, 2006.
2. R. L. Peurifoy, C. J. Schexnayder, A. Shapira and R. Schmitt, Construction planning, equipment, and methods, 8th ed., McGraw Hill, New York, 2010.
3. D. A. Day and N. B. H. Benjamin, Construction equipment guide, 2nd ed., Wiley, New Jersey, 1991.

References

1. F. Harris, Modern construction and ground engineering equipment and methods, 2nd ed., Longman, London, 1994.
2. J. Singh, Heavy construction - planning, equipment and methods, 3rd ed., CRC Press, 2009

Code	Course	L	T	P	C
CE564	Machine Learning in Civil Engineering	3	0	0	3

Course Learning Outcomes: At the end of the course, students will be able to

CLO1: understand the basic of machine learning.

CLO2: understand the theory of machine learning based on knowledge of probability statistics and linear algebra.

CLO3: solve different engineering problems applying the machine learning methods.

CLO4: apply the different software of machine learning to solve civil engineering problems.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	2	1	1	1	1	1
CLO2	2	2	2	2	1	2
CLO3	2	2	3	3	2	2
CLO4	2	2	3	3	2	2

Syllabus Contents

Module 1: Introduction to Machine Learning: What is learning, What is machine learning, Machine learning activities, Basic types of data in machine learning.

Module 2: Basis of Probability and Statistics: Axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' theorem and independence, Random Variable, Few Distributions, Joint Distributions, Some Basic Statistics.

Module 3: Linear Algebra: Linear algebra and problem.

Module 4: Artificial Neural Network: Understanding biological neuron, artificial neuron, architectures of neural network, learning process of ANN. (8 hours)

Module 5: Bayesian Learning: Bayes theorem and concept learning. Naïve Bayes classifier. (2 hours)

Module 6: Machine Learning: Types of machine learning Approach: Supervised learning, Unsupervised learning and Reinforced learning, Applications of machine learning, usage of different software. (6 hours)

Module 7: Supervised Learning: (a) Supervised learning-classification- Basics of supervised learning classification, Decision tree, Support vector machine.

(b) Supervised learning -Regression- Simple regression, Other regression techniques.

Module 8: Applications of Machine Learning: Apply machine learning methods to solve Civil Engineering problems using Python, TensorFlow.

Text Books

1. Goulet, James-A, Probabilistic Machine Learning for Civil Engineers, MIT Press.
2. Mitchell Tom M. Machine Learning, McGraw-Hill Education.
3. Dutta, Saikat, Chandramouli, Subramanian, Das, Amit Kumar, Machine Learning, Pearson

References

1. Marsland Stephen, Machine Learning, CRC Press.
2. Ang, A. H.-S. and Tang, W. H. 1984. Probability Concepts in Engineering Planning and Design: Volume 2 Decision, Risk and Reliability, Wiley, New York.

Open Elective – I &II

Code	Course	L	T	P	C
CE540	Disaster Risk Reduction	2	0	0	2

Course Learning Outcomes: At the end of the course, students will be able to

CLO1: Risk Identification: Identify hazards, vulnerabilities, and risks at individual, institutional, and community levels.

CLO2: Framework Comprehension: Outline the legal and institutional frameworks of Disaster Risk Reduction (DRR) in India and globally.

CLO3: Practical Application: Demonstrate life-saving skills, emergency communication, disaster response, and risk mitigation techniques.

CLO4: Technological Utilization: Utilize and implement basic tools and technologies for risk assessment, preparedness, and resilience-building.

CLO5: Strategic Planning: Prepare disaster management plans and design community awareness activities or prototypes tailored to regional and local contexts.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	2	1	2	2	1	3
CLO2	2	1	1	2	2	3
CLO3	1	3	2	2	2	3
CLO4	2	2	3	3	1	2
CLO5	2	2	2	3	3	3

Syllabus Contents:

Module: 1 : Understanding Disaster Risk Reduction and Management- Basic concepts and terminology: Hazard, Vulnerability, Capacity, Exposure, Disaster, Risk, Disaster Management & Disaster Risk Reduction; Hazard profile of India: Regional profile; Disaster Management Cycle: Mitigation, preparedness, response, relief, recovery, rehabilitation; Policy and legal frameworks: DM Act 2005, DM Amendment Act 2025, National Policy, State-specific Acts; PM 10 Points agenda; International frameworks: Sendai Framework, Paris Agreement, SDGs.

Module: 2 Preparedness, Mitigation and Response Planning- Framework for Developing Disaster Management Plans; Hazard, Vulnerability, Capacity and Risk (HVCR) Assessment tools and techniques: Transect walk, Hazard mapping, Problem tree, Chapatti diagram etc.; Mitigation and Preparedness: Evacuation planning, mock drills, tabletop exercises; disaster-specific mitigation, Crowd Management techniques; Basics of Incident Response System (IRS); Role of emergency forces: NDRF, SDRF, police, fire services, armed forces, NCC, NSS; Planning for more vulnerable groups; Emerging technologies:

Drones, digital literacy, mobile apps (GIRI tool, SAFAR, Meghdoot, UMANG, Sachet, CWC Flood Alerts, IMD, BIS, IHIP), social media for DRR; Basics of safe construction and structural & nonstructural audit exercise (safety of home/ college buildings); Funding mechanisms for disasters in India; Emergency Communication Network.

Module: 3 - Life-Saving Skills- First Aid in disasters: Golden hour concept, CPR, wounds, choking, burns, fractures, animal bites (snake/dog/rabid), heat-related illnesses, triaging, stampede; Household and personal preparedness and protection: 72-hour emergency kit, safe food storage, water purification, ORS use, water sanitation and hygiene (WASH) and Infection Prevention Control (IPC) practices, Basic Sign Language; Search and Rescue methods; Fire safety and electrical/gas/LPG safety: Causes, prevention, fire extinguisher demonstration, indigenous methods (Natural first-aid remedies- aloe vera, turmeric, coconut oil, salt solution); traditional risk-reduction practices; Disaster-specific response: Floods, landslides, earthquakes, CBRN emergencies, pandemics, drowning, lightning, gas leakage, cyclone, heatwave, coldwave; Psychosocial support in DRR; Steps for implementing psychological first aid and its importance; Public health preparedness: Public health impacts of various disasters, Prevention of post-disaster water-borne and vector-borne diseases.

Module: 4 - Field Exposure and Community Engagement- Field visits: District Emergency Operations Centre, State Disaster Response Force/ National Disaster Response Force units, fire stations, State Emergency Operations Center, hazard-prone communities, heat-prone areas (flood-prone village, fire-vulnerable urban slum); Practical exposure: Mock drills, demonstrations and simulations (multi-hazard, evacuation, earthquake, flood); interaction with responders and officials (Aapda Mitras, National Cadet Corps/National Service Scheme/Nehru Yuva Kendra Sangathan, Red Cross); Community Engagement projects: Street plays (nukkad natak), awareness campaigns, DRR clubs (institute and community level clubs), Information, Education and Communication material (podcasts, videos, comics, photo essays, posters, Knowledge exchange webinars); Environmental hazards: Youth/community participation (tree plantation, soil conservation); Project/assignment: Preparation of institutional/household DM plan in local language; budget-friendly multi-disaster survival kit prototype; reflective field report, youth-led community engagement projects and creation of IEC/digital communication materials; Multidisciplinary integration: Links with local governments, HEIs, youth/adolescent networks; Activities for mitigating disaster risks: Increasing green cover, plantation and knowledge of human anatomy; Interaction with: State, district, gram panchayat level officials, DRR helpline numbers, and knowledge of physical resources required and available locally; interview /session with disaster survivors.

Note: *The approach of this course is to inculcate awareness of hazards and develop the capacity to respond to disasters with an aim for DRR. Hence, it is recommended to use the expertise of professionals during field visits and practical training. These professionals can be from the NDRF, SDRF, Indian Armed Forces, Firefighting department, medical and sports arenas and others who have first-hand experience and knowledge in such skills (a suggestive list is annexed).*

Text Books/Handbooks

1. Sphere Handbook for humanitarian response standards. Link: <https://spherestandards.org/handbook/>
2. Health emergency and disaster risk management framework (Health EDRM), WHO. Link: <https://www.who.int/publications/i/item/9789241516181>

Websites of Key Agencies

1. National Disaster Management Authority (NDMA): <https://ndma.gov.in>
India's apex body for policy and planning in disaster management.
2. National Institute of Disaster Management (NIDM): <https://nidm.gov.in>
Apex national level training and capacity-building institution for disaster risk reduction.
3. India Meteorological Department (IMD): <https://mausam.imd.gov.in>
Provides official weather forecasts, warnings and alerts.
4. Central Water Commission (CWC): <http://www.cwc.gov.in>
Responsible for flood forecasting and hydrological data.
5. Flood Forecasting Portal (FFWC): <https://ffs.india-water.gov.in/>
Real-time flood forecasting and inundation alerts for India.
6. Geological Survey of India (GSI): <https://www.gsi.gov.in>
Provides hazard maps and geological risk assessments.
7. India Disaster Resource Network (IDRN): <https://idrn.gov.in>
Inventory of emergency response resources across India.
8. Coalition for Disaster Resilient Infrastructure (CDRI): <https://cdri.world/>
Global initiative led by India for promoting resilient infrastructure.
9. Indian Space Research Organisation (ISRO): <https://www.isro.gov.in/>
Space agency of India; information regarding academic programmes and fellowships
10. Indian Institute of Remote Sensing: <https://www.iirs.gov.in/>
Research, educational programmes and resources related to remote sensing and geoinformatics
11. DRDO Avalanche Warning Bulletin: <https://drdo.gov.in/drdo/avalanche-warning-bulletin>
Snow and avalanche forecasts for high-altitude regions.
12. Building Materials and Technology Promotion Council (BMTPC): <https://www.bmtpc.org/>
Promoting sustainable, cost-effective, and disaster-resistant building materials and technologies
13. National Information Centre of Earthquake Engineering (NICEE) at IIT Kanpur: <https://www.nicee.org/EQTips.php> *Learning Seismic Design and Construction.*

Code	Course	L	T	P	C
CE541	English for Technical Writing	2	0	0	2

Course Learning Outcomes: At the end of this course, students will be able to

CLO1. Develop vocabulary skills using word formation, prefixes, suffixes, synonyms, antonyms, and abbreviations.

CLO2. Apply effective writing techniques for clear, coherent, and grammatically correct communication.

CLO3. Identify and correct common grammatical and writing errors in technical documents.

CLO4. Demonstrate structured writing skills using description, definition, classification, and examples.

CLO5. Improve professional communication skills through reading, writing, listening, speaking, and presentations.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	1	1	-	-	2	2
CLO2	1	1	1	1	3	2
CLO3	1	1	1	1	3	2
CLO4	1	1	1	1	3	2
CLO5	1	2	1	1	3	3

Syllabus Contents:

Module 1: Vocabulary Building- The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Synonyms, antonyms, and standard abbreviations.

Module 2: Basic Writing Skills -Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely.

Module 3: Identifying Common Errors in Writing - Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés.

Module 4: Nature and Style of Sensible Writing Describing, Defining, Classifying, providing examples or evidence, Writing introduction and conclusion.

Module 5: Writing Practices Comprehension, Précis Writing, Essay Writing.

Module 6: Oral Communication, Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentation.

Text Books

1. Effective Communication Skills, Kulbhushan Kumar, Khanna Book Publishing. 2022
2. Communication Skills in English, Anjana Tiwari, Khanna Book Publishing, 2022.
3. Practical English Usage. Michael Swan. OUP. 1995.
4. Remedial English Grammar. F.T. Wood. Macmillan.2007

References

1. On Writing Well. William Zinsser. Harper Resource Book. 2001
2. Study Writing. Liz Hamp-Lyons and Ben Heasley. Cambridge University Press. 2006.
3. Communication Skills. Sanjay Kumar and Pushpalata. Oxford University Press. 2011.
4. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

Code	Course	L	T	P	C
CE570	IKS in Civil Engineering	2	0	0	2

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Understand the evolution and contributions of Indian Knowledge Systems in Civil Engineering practices.

CLO2. Explain traditional Indian construction materials, building techniques, and architectural principles.

CLO3. Analyze ancient Indian water resource management, transportation systems, and town planning methods.

CLO4. Evaluate the sustainability aspects of indigenous construction practices and their relevance to modern engineering.

CLO5. Apply traditional Indian engineering concepts for sustainable and environmentally responsible infrastructure development.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	2	1	1	1	2
CLO2	3	2	2	2	1	1
CLO3	2	2	2	3	1	3
CLO4	2	1	1	2	1	3
CLO5	2	2	3	3	2	2

Syllabus Contents

Module 1: Introduction to Indian Knowledge System - Concept and scope of Indian Knowledge System (IKS), Historical development of science and technology in India, Contributions of ancient Indian civilization to engineering and architecture, Ancient Indian texts related to engineering and construction, Sustainability concepts in traditional Indian practices

Module 2: Ancient Indian Architecture and Construction Techniques- Principles of Vastu Shastra, Temple architecture: Nagara, Dravida, and Vesara styles, Ancient Indian monuments and their engineering significance, Traditional construction techniques and workmanship, Structural stability and durability of ancient structures, Case studies of Konark Sun Temple, Brihadeeswara Temple, Taj Mahal, and step wells

Module 3: Traditional Building Materials- Lime, surkhi, natural binders, and indigenous materials, Ancient brick-making and stone masonry techniques, Traditional flooring and

roofing systems, Bamboo, timber, and earthen construction methods, Eco-friendly and low-carbon construction materials, Preservation and restoration of heritage structures

Module 4: Water Resource Management in Ancient India - Traditional rainwater harvesting systems, Step wells, tanks, ponds, and canal systems, Irrigation techniques in ancient India, Hydraulic engineering in Harappan civilization, Traditional flood management and watershed systems, Case studies of ancient water conservation systems

Module 5: Ancient Indian Town Planning and Transportation -Town planning in Indus Valley Civilization, Road systems and drainage networks, Traditional transportation infrastructure, Urban planning concepts in ancient Indian cities, Smart and sustainable features of ancient settlements, Relevance of traditional planning in modern smart cities

Module 6: Sustainability and Modern Relevance of IKS - Sustainable development concepts in traditional Indian engineering, Climate-responsive architecture, Energy-efficient traditional buildings, Integration of IKS with modern Civil Engineering, Role of indigenous knowledge in disaster resilience, Future scope of IKS in infrastructure development

Text Books

1. Vastu-Sastra by Acharya Prasanna Kumar.
2. Indian Architecture by Percy Brown.
3. Traditional Water Management Systems of India by Anupam Mishra.

References

1. Building Science of Ancient India by D.N. Shukla.
2. Relevant publications from AICTE IKS Division.
3. Ancient Indian Technology by Dharampal.

Code	Course	L	T	P	C
CE571	Introduction to Remote Sensing and GIS	2	0	0	2

Course Learning Outcomes: At the end of the course, students will be able to

CLO1. Understand the basic principles, concepts, and applications of Remote Sensing and GIS.

CLO2. Interpret satellite imagery and analyse spatial data using Remote Sensing techniques.

CLO3. Apply GIS tools and techniques for spatial analysis and decision-making in civil engineering applications.

CLO4. Integrate Remote Sensing, GIS, and GPS technologies for infrastructure planning, environmental management, and resource assessment.

CLO-PLO Mapping:

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	3	1	2	1	1	1
CLO2	2	3	3	2	1	2
CLO3	2	3	3	3	2	2
CLO4	2	2	3	2	2	3

Syllabus Contents

Module 1: Fundamentals of Remote Sensing - Introduction to Remote Sensing: Definition, principles, and applications; Electromagnetic Spectrum and Electromagnetic Radiation; Energy interactions with atmosphere and earth surface; Spectral signatures of water, soil, and vegetation; Platforms and sensors: Ground-based, Airborne, Spaceborne systems
Types of Remote Sensing: Passive and active remote sensing, Optical and microwave remote sensing
Resolution concepts: Spatial resolution, Spectral resolution, Temporal resolution, Radiometric resolution

Module 2: Satellite Systems and Image Interpretation- Remote sensing satellites and missions: IRS, Landsat, Sentinel, Cartosat; Satellite image acquisition and data products; Visual image interpretation techniques; Elements of image interpretation: Tone, Texture, Pattern, Shape, Size, Association; Digital image processing: Image enhancement, Filtering, Classification; Applications of Remote Sensing in Civil Engineering: Land use and land cover mapping, Urban planning, Watershed management, Disaster monitoring

Module 3: Fundamentals of GIS- Introduction to Geographic Information System (GIS); Components of GIS: Hardware, Software, Data, Methods, People; Spatial and non-spatial data; GIS data models: Raster data model, Vector data model; Coordinate systems and map projections; Data input and editing techniques; Database management systems in GIS;

Spatial data analysis and querying

Module 4: GIS Applications and Integration with Remote Sensing- GIS overlay analysis- Buffering and network analysis; Terrain analysis and Digital Elevation Models (DEM); Integration of Remote Sensing and GIS; GPS and its applications; Applications in Civil Engineering: Transportation planning, Site suitability analysis, Water resources management, Environmental impact assessment, Infrastructure planning and management

Case studies related to Remote Sensing and GIS applications

Text Books

1. Lillesand, T. M., Kiefer, R. W., and Chipman, J. W., *Remote Sensing and Image Interpretation*, Wiley.
2. Kang-tsung Chang, *Introduction to Geographic Information Systems*, McGraw Hill.
3. Lo, C. P. and Yeung, A. K. W., *Concepts and Techniques of Geographic Information Systems*, Pearson.
4. Anji Reddy, M., *Remote Sensing and Geographical Information Systems*, BS Publications.

References

1. Burrough, P. A. and McDonnell, R. A., *Principles of Geographical Information Systems*, Oxford University Press.
2. Jensen, J. R., *Remote Sensing of the Environment*, Pearson.
3. Ian Heywood, Sarah Cornelius, and Steve Carver, *An Introduction to Geographical Information Systems*, Pearson.
4. Sabins, F. F., *Remote Sensing: Principles and Interpretation*, Waveland Press.
5. Longley, P. A. et al., *Geographical Information Systems and Science*, Wiley.