Scheme and Syllabus

for

Post Graduate Program (M. Tech.)

STRUCTURAL ENGINEERING

Department of Civil Engineering
Malaviya National Institute of Technology Jaipur
Jaipur, Rajasthan- 302017
August 2021

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Institute Vision:

To create a centre for imparting technical education of international standards and conduct research at the cutting edge of technology to meet the current and future challenges of technological development.

Institute Mission:

To create technical manpower for meeting the current and future demands of industry: To recognize education and research in close interaction with industry with emphasis on the development of leadership qualities in the young men and women entering the portals of the Institute with sensitivity to social development and eye for opportunities for growth in the international perspective.

DEPARTMENT OF CIVIL ENGINEERING

Vision:

To serve the nation by providing high quality engineering education that enables students to get a profession that can improve the civil infrastructure and social welfare.

Mission:

To create an environment conducive for excellent teaching, learning and research in order to produce leading entrepreneurs and innovators in the field of civil engineering for sustainable development.

Malaviya National Institute of Technology Jaipur
Department of Civil Engineering

Master of Technology -Structural Engineering

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO1 Prepare students to get employment, profession and/or to pursue Higher education and research in structural engineering discipline in particular and allied engineering disciplines in general.

PEO2 Possess technical competence in the fields of Renewable Energy & allied disciplines and will be successful for the execution of engineering solutions which are technically sound and environment friendly. (Core competence)

PEO3 To provide an academic ambience that allows to develop good scientific and technical skills in students to enable them to provide sustainable and cost-efficient innovative solutions to society. (Breadth)

PEO4 To inculcate in students professional and ethical attitude, teamwork skills, multidisciplinary approach, and an ability to engage in independent and life-long learning. (Learning Environment).

PROGRAM OUTCOMES (PO)

A student who has met the objectives of the program will possess:

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

PO2 An ability to write and present a substantial technical report/document like; analysis, design, rehabilitation etc. of structures.

PO3 Students should be able to demonstrate a degree of mastery over the area of structural engineering. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4 An ability to analyze and design of routine and complex structures by traditional methods and using modern engineering software/IT tools.

PO5 An ability to learn new innovative technologies in engineering materials to provide environmentally friendly and sustainable infrastructure development using locally available material

Malaviya National Institute of Technology Jaipur
Department of Civil Engineering

ACADEMIC CURRICULUM
Master of Technology - Structural Engineering

Semester I

S.No.	Course Code	Course Title	Course Category	Type	Credit	L	T	P
1.	21CET541	Advanced Structural Analysis	Program Core	Theory	4	4	0	0
2.	21CET542	Concrete Technology	Program Core	Theory	3	3	0	0
3.	21CET543	Design of Advanced Concrete Structures	Program Core	Theory	4	4	0	0
4.	21CEPxxx	Elective 1 (Lab Course)	Program Elective	Practical	1	0	0	2
5.	21CETxxx	Elective 2	Program Elective	Theory	3	3	0	0
6.	21CETxxx/ - - - - - -	Elective 3	Program Elective / Open Elective	Theory	3	3	0	0
Total Semester Credits					**18**			

Semester II

S.No.	Course Code	Course Title	Course Category	Type	Credit	L	T	P
1.	21CET544	Finite Element Method	Program Core	Theory	3	3	0	0
2.	21CET545	Plate and Shells	Program Core	Theory	3	3	0	0
3.	21CET546	Structural Dynamics	Program Core	Theory	3	3	0	0
4.	21CET2xxx	Elective 4	Program Elective	Theory	3	3	0	0
5.	21CETxxx	Elective 5	Program Elective	Theory	3	3	0	0
6.	21CETxxx/ - - - - - -	Elective 6	Program Elective / Open Elective	Theory	3	3	0	0
Total Semester Credits					**18**			

Semester III

S.No.	Course Code	Course Title	Course Category	Type	Credit	L	T	P
1.	21CES642	Seminar/Minor Research Project	Program Core	Seminar	4	0	0	8
2.	21CED641	Dissertation	Program Core	Dissertation	8	0	0	16
Total Semester Credits					**12**			

Semester IV

S.No.	Course Code	Course Title	Course Category	Type	Credit	L	T	P
1.	21CED643	Dissertation	Program Core	Dissertation	12	0	0	24
Total Semester Credits					**12**			
Total Program Credits					**60**			

List of Taught Courses

Sl. no.	Course code	Course title	Core/Elective	L-T-P
1	21CET541	Advanced Structural Analysis	Core	4-0-0
2	21CET542	Concrete Technology	Core	3-0-0
3	21CET543	Design of Advanced Concrete Structures	Core	4-0-0
4	21CET544	Finite Element Method	Program Core	3-0-0
5	21CET545	Plate and Shells	Program Core	3-0-0
6	21CET546	Structural Dynamics	Program Core	3-0-0
7	21CES642	Seminar/Minor Research Project	Program Core	0-0-8
8	21CED641	Dissertation	Program Core	0-0-16
9	21CED643	Dissertation	Program Core	0-0-24

SYLLABUS

FOR

CORE/ ELECTIVE COURSES

OF

M.TECH. (STRUCTURAL ENGINEERING)

PROGRAM

DEPARTMENT OF CIVIL ENGINEERING

MNIT JAIPUR, JAIPUR

AUGUST 2021

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET541

Course Name : Advanced Structural Analysis

Credits : 4 **L -** 4 **T -** 0 **P -** 0

Course Type : Core

Prerequisites : None

COURSE OUTCOMES

CO1: To acquire the knowledge about different types of indeterminate structures

CO2: To be able to analyse different types of indeterminate structures by traditional methods

CO3: To be able to analyse different types of indeterminate structures by advanced and computational methods.

CO4: To be able to write technical reports and present topics related to advanced structural analysis

Course Contents

Degree of Static and Kinematic indeterminacy, Released and restrained structure; Matrix method using system approach – flexibility and stiffness method for analysis of continuous beams, rigid – jointed plane frame and pin-jointed plane frame; Introduction to Direct Stiffness method; Formation of member stiffness matrix; Transformation of load vector and displacement vector Assembly of global stiffness matrix and load vectors; Boundary condition and solutions; Application to planer structures –beam and plane truss.

Recommended Readings

1. Text / Reference Book
   a. Pandit, G.S. and Gupta, S.P., "*Structural Analysis- A Matrix Approach (2/e)*", McGraw Hill Education.
   b. Weaver, W.Jr., and Gere, G.M., "*Matrix Analysis of Framed Structures (2/e)*", CBS Publishers.
   c. Menon, D., "*Advanced Structural Analysis*", Narosa Publishing House.
   d. Hibbeler, R.C., *"Structural Analysis (10/e)",* Pearson Education India.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET542

Course Name : Concrete Technology

Credits : 3 **L -** 3 **T -** 0 **P -** 0

Course Type : Core

Prerequisites : None

COURSE OUTCOMES

CO1: To understand concrete as structural material, its preparation and application for research as well as field usages

CO2: To design concrete mix of different grade and understanding various codes and guidelines

CO3: To be able to get the knowledge of short term and long-term properties, durability of concrete and factor influencing its properties

CO4: To acquire knowledge about destructive, non-destructive testing of concrete for performance assessment and report writing for the condition assessment of concrete and related members

Course Contents

Review of constituent materials and mix design, Admixtures, Properties of concrete in fresh state and hardened state, Special concrete: HPC, SPC etc., Durability of concretes subjected to extreme environment, Deterioration mechanisms, Assessment and Control of corrosion in concrete structures, In-situ assessment of concrete structures, Various NDT techniques and their applications, Repair of concrete structures.

Recommended Readings

1. Text / Reference Book
   a. Neville, A.M. and Brooks, J.J. "*Concrete Technology*", Pearson.
   b. Gambhir, M.L., "*Concrete Technology*", McGraw-Hill Education.
   c. Li, Z., "*Advanced Concrete Technology*", John Wiley & Sons.
   d. Bungey, J.H., Millard, S. and Grantham, M.G., "*Testing of concrete in structures (4/e)*", Taylor and Francis.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET543

Course Name : Design of Advanced Concrete Structures

Credits : 4 **L -** 4 **T -** 0 **P -** 0

Course Type : Core

Prerequisites : None

COURSE OUTCOMES

CO1: To understand the methods for seismic analysis and design of structures

CO2: To be able to understand and apply codal provisions with respect to ductile design of multistory buildings and other structures

CO3: To be able to understand and apply retrofitting techniques to masonry and RC structures

CO4: To be able to write technical reports and present topics related to seismic design and construction of structures

Course Contents

Basic philosophy of concrete materials, Concrete Mix Design; Basic philosophy of design of concrete structures; Design of single and multi-bay structures in concrete, Portal Frames, Bunkers and Silos; pressure vessels; chimneys; Folded Plates; Reinforcement detailing for members and joints detailing; Code provisions; Basic philosophy of foundation design, raft foundations, pile foundations and well foundations; Prestress of concrete structures, Analysis and design of determinate and indeterminate beams, Concordant Cables, Design of end blocks; Bunkers, Silos, chimneys, Folded Plates, raft, pile and well foundation, Prestress concrete.

Recommended Readings

1. Text / Reference Book
   a. Krishna Raju, N. "*Design of Reinforced Concrete Structures*", CBS Publishers and Distributors Pvt. Ltd.
   b. Krishna Raju, N. "*Advanced Reinforced Concrete Design*", CBS Publishers and Distributors Pvt. Ltd.
   c. Pillai, S.U. and Menon, D., "*Design of RCC Structures*", McGraw-Hill Education.
   d. Lin, T.Y. and Burns, N.H., "*Design of Prestressed Concrete Structures*", Wiley.
   e. Krishna Raju, N. "*Prestressed Concrete (6/e)*", McGraw-Hill Education

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET544

Course Name : Finite Element Method

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Core
Prerequisites : None

COURSE OUTCOMES

CO1: To obtain an understanding of the history & fundamental theory and solve mechanics of solids problem & apply direct stiffness, Rayleigh-Ritz, Galerkin, WR method to solve engineering problems and outline the requirements for convergence.

CO2: To develop the ability to generate mathematical models for the ordinary & partial differential equations on inter-discipline systems

CO3: To understand the application and use of the FE method for static, dynamic, Axisymmetric & heat transfer problems for 1D, 2D & 3D systems through Matlab®, ANSYS, ABAQUS, etc.

CO4: Analyze a physical problem, develop experimental & mathematical procedures for closely investigating the physical problem, and effectively perform and document findings.

CO5: To demonstrate the ability to evaluate and interpret FEM analysis results for design and evaluation purposes

Course Contents

History, Real and Field problems, Introduction about One, Two and Three-dimensional problems for structural engineering components, Error analysis, accuracy & precision.

Formulation for stiffness matrix using member approach for one dimensional truss, beam, portal frame and grid elements, transformation matrix. Two-dimensional elements with lateral and transverse loading. Three dimensional elements with lateral loading

Principle of minimum potential energy, formulation of stiffness matrix for one dimensional element truss and beam elements & Weightage Residual Method (WRM)

Theory of elasticity: Strain-displacement relations, compatibility conditions in terms of strain, plane stress and plane strain problems, stress-strain relations in 2D problem Displacement function for triangular (CST and LST) and rectangular elements. 3D problems Displacement function for Tetrahedron and Hexahedron (Brick) elements.

Novel solution to Structural Dynamic and buckling problems, Introduction to MATLAB®, using MATLAB® numerical solution for all above. One, Two & Three-dimensional element problems.

Recommended Readings

1. Text / Reference Book
   a. Reddy, J.N., "*An Introduction to the Finite Element Method*", Tata McGraw Hill Publshing Co. Ltd.
   b. Chandrupatla, T.R., and Belegundu, A.D., "*Introduction to Finite Elements in Engineering*", Prentice Hall of India Pvt. Ltd.
   c. Hughes, T.J.R., "*The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*", Dover Publications Inc.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET545

Course Name : Plate and Shells

Credits : 3 **L -** 3 **T -** 0 **P -** 0

Course Type : Core

Prerequisites : None

COURSE OUTCOMES

CO1: To Ability to know about Plate equation and behavior of thin plates in Cartesian, polar and skew coordinates.

CO2: Understand Isotropic and orthotropic plates, bending and twisting of plates; Numerical solutions.

CO3: Ability to learn Shell behavior, shell surfaces and characteristics, equilibrium equations in curvilinear coordinates, force displacement relations.

CO4: Ability to understand Membrane analysis of shells of revolution and cylindrical shells under different loads.

CO5: To be able to write technical reports and present topics related to Plates and Shells

Course Contents

Plate equation and behaviour of thin plates in Cartesian, polar and skew coordinates; Curvilinear coordinates and coordinate transformation; Isotropic and orthotropic plates, bending and twisting of plates; Numerical solutions. Shell behaviour, shell surfaces and characteristics, classifications of shells, equilibrium equations in curvilinear coordinates, force displacement relations; Membrane analysis of shells of revolution and cylindrical shells under different loads, shallow shells, membrane solution of elliptic paraboloids and hyperboloids, solutions of typical problems.

Recommended Readings

1. Text / Reference Book

a. Timoshenko, S.P. and Woinowsky-Kreiger, S., "*Theory of Plates and Shells*", McGraw-Hill Inc.
b. Ventsel, E. and Krauthammer, T., "*Thin Plates and Shells*", CRC Press
c. Krishna Raju, N., "*Advanced Reinforced Concrete Design*", CBS Publishers and Distributors Pvt. Ltd.
d. Varghese, P.C., "*Design of Reinforced Concrete Shells and Folded Plates*", PHI
e. Ugural, Ansel C., "*Plates and Shells: Theory and Analysis*", CRC Press.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET546

Course Name : Structural Dynamics

Credits : 3 **L -** 3 **T -** 0 **P -** 0

Course Type : Core

Prerequisites : None

COURSE OUTCOMES

CO1: To understand various type of degree of freedom systems in structures.

CO2: To understand orthogonal relationship of principle modes, Rayleigh's principle and its application

CO3: To gain the knowledge about application of structural dynamics to civil engineering problems

CO4: To be able to write technical reports and present topics related to structural dynamics

Course Contents

Single degree of freedom System: Equation of motion; Undamped and damped Free vibration; Undamped and damped forced vibration; Harmonic load; Evaluation of damping; Periodic load; General load; Response spectrum Analysis; Analysis of multi degree of freedom System; Generation of damping matrix, modal analysis; Continuous Systems; Numerical Evaluation of Dynamic Response; Introduction to seismic analysis.

Recommended Readings

1. Text / Reference Book
   a. Chopra, A.K., "*Dynamics of Structures, (5/e)*", Pearson
   b. Humar, J.L., "*Dynamics of Structures, (3/e)*", CRC Press
   c. Paz, M. and Kim, Y.H., "*Structural Dynamics, (6/e)*", Springer
   d. Shabana, A.A., "*Theory of Vibration: An Introduction, (3/e)*", Springer
   e. Jain, A.K., "*Dynamics of Structures With MATLAB® Applications*", Pearson
   f. Clough, R.W. and Penzien, J., "*Dynamics of Structures, (3/e)*", Computers & Structures, Inc
   g. Craig, Roy R. Jr. and Kurdila, A.J., "*Fundamental of Structural Dynamics, (2/e)*", John Wiley & Sons

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET819

Course Name : Advanced Solid Mechanics

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To understand various type of coordinate systems.
CO2: To understand the theory of elasticity and its application for solving civil engineering problems
CO3: To gain the knowledge about the theory of plasticity and yield ctiteria
CO4: To be able to write technical reports and present topics related to Advanced Solid Mechanics

Course Contents

Linear elasticity, Stress, strain, constitutive relations; Boundary conditions, Description of an Elasticity problem as a boundary value problem, Plane stress, strain, axis-symmetric problems, large displacements and large strains; Cartesian, cylindrical and spherical coordinates; Introduction to curvilinear coordinates; Thermal strains. Introduction to plasticity; Yield condition; Ideal elasto-plastic material.

Recommended Readings

1. Text / Reference Book
   a. Srinath, L. S., "*Advanced Mechanics of Solids*", McGraw-Hill
   b. Timoshenko, S. , "*Strength of Materials*", CBS Publisher
   c. Bruhns, O. T. , "*Advanced Mechanics of Solids*", Springer

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET820

Course Name : Advanced Foundation Engineering

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To be able to determine the information necessary for the successful design of a foundation for a given structure and stratigraphy.
CO2: To be able to decide the applicability and utility of a foundation type for a given structure and stratigraphy.
CO3: To be able to design (and check a given design of) a foundation for a given structure and stratigraphy

Course Contents

Soil exploration for foundation design; performance requirements of foundations; Shallow foundations - ultimate bearing capacity, safe bearing pressure, settlement, geotechnical design; uplift capacity; special footings and beam on elastic foundations; mat foundations; Pile types; pile axial load capacity based on static analysis methods, dynamic methods, and load tests; settlement of piles; piles subjected to lateral loads; pile groups; drilled piers; caisson foundations; foundation design for vibration control; foundations on expansive soils; foundations on rock and other geomaterial; micropiles.

Recommended Readings

1. Text / Reference Book
   a. Coduto, D., Kitch, W. and Yeung, M.R., "*Foundation Design Principles and Practices*", Pearson.
   b. Murthy, V.N.S., "*Advanced Foundation Engineering*", CBS Publishers.
   c. Bowles, Joseph E, "*Foundation Analysis and Design*", McGraw Hill.
   d. Reese, L.C. and Van Impe, W.F., "*Single Piles and Pile Groups under Lateral Loading*", CRC Press.
   e. Das, B.M., "*Shallow Foundations Bearing Capacity and Settlement*", CRC Press.
   f. FHWA, "*Micropile Design and Construction*", NHI-05-039

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET821

Course Name : Bridge Engineering

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To acquire the knowledge about different types of Bridges
CO2: To acquire the knowledge about selection of bridge site, estimation of economic span and effect of skew.
CO3: To be able to analyse and design different components of bridges.
CO4: To understand different methods for inspection, maintenance and rehabilitation of bridges
CO5: To be able to write technical reports and present topics related to bridge design

Course Contents

Types of Bridges, choice of bridge type, criteria for selection of bridge site, economic span, bridge loadings, slab bridges, effect of skew, load distribution theories for multi beam bridges, design of R.C. beam bridges, design of R.C. box culverts, introduction to PSC girder bridges, bridge bearings, inspection and maintenance procedures, rehabilitation of bridges.

Recommended Readings

1. Text / Reference Book
   a. Ponnuswamy, S., "*Bridge Engineering*", McGraw-Hill Education.
   b. Victor, D.J., "*Essentials of Bridge Engineering*", Oxford.
   c. Krishna Raju, N. "*Design of Bridges (5/e)*", Oxford & IBH Publishing.
   d. Jagadeesh, T.R. and Jayaram, M.A., "*Design of Bridge Structures*", PHI.
   e. Raina, V.K., "*Concrete Bridge Practice: Analysis, Design and Economics (4/e)*", Shroff Publishers and Distributors.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET822

Course Name : Computational Methods

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: For obtaining approximate representative numerical results of the physical problems & demonstrate an understanding of common computational methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems

CO2: To solve problems in the field of Applied & Theoretical Engineering as well as Science which requires computing of numerical results using computational methods tools to obtain approximate solutions to mathematical problems

CO3: To deal with various topics like finding roots of equations, solving systems of linear algebraic equations and derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations

CO4: To solve complex mathematical problems using only simple arithmetic operations. The approach involves the formulation of mathematical models of physical situations that can be solved with arithmetic operations & analyse and evaluate the accuracy of common methods

CO5: To implement computational methods in Matlab® & write efficient, well-documented Matlab® code and present numerical results in an informative way and to facilitate numerical computing

Course Contents

Solution of Equations and Eigenvalue Problems:

Taylor's series, Mclaurin series, Error analysis; roots of nonlinear equations, solutions of a large system of linear equations and Eigenvalue problem of a matrix; Pascal's triangle for one and two dimensions, divided differences; Newton's forward and backward difference formulas; Differentiation using interpolation formulae; Numerical integration by trapezoidal and Simpson's rules; Romberg's method; Two- and Three-point Gaussian quadrature formulae. Symbolic MATLAB® and complex numbers.

Interpolation and Approximation:

Solution of the equation; Fixed point iteration: x=g(x) method; Newton's method; Solution of linear system by Gaussian elimination and Gauss-Jordon method; Iterative method-Gauss Seidel method, Inverse of a matrix by Gauss Jordon method; Eigenvalue of a matrix by power method and by Jacobi method for symmetric matrix.

Numerical Differentiation and Integration: Advanced numerical linear algebra and related numerical methods; Direct and iterative methods for linear systems; Decompositions and SVD factorizations; stability and accuracy of numerical algorithms.

Linear / Non-Linear IVP AND BVP:
Laplace, Poisson, harmonic, bi-harmonic equations, Nonlinear ordinary differential equations, and partial differential equations; Nonlinear optimization, Novel technique for solving geometrical and material nonlinear problems, and wavelet analysis.

Recommended Readings

1. Text / Reference Book
   a. Kreyszig, E., "*Advanced Engineering Mathematics (10/e)*", Wiley publications.
   b. Hildebrand, F.B., "*Introduction to Numerical Analysis*", Dover publications.
   c. Chapra, S.C. and Canale, R.P., "*Numerical Methods for Engineers (7/e)*", McGraw-Hill.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET823

Course Name : Design of Composite Structures

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To understand the behaviour various type of composite structure systems.
CO2: To understand the design criteria for shear connection, buckling and shear lag.
CO3: To gain the knowledge about the elastic analysis of composite beams, rigid plastic analysis of simply supported beams, mechanical shear connectors.
CO4: To learn about transfer of longitudinal shear forces, stocky columns, slender columns, composite beams with service ducts

Course Contents

Types of composite construction, design criteria, material properties, partial shear connection, partial interaction, buckling, shear lag, elastic analysis of composite beams, rigid plastic analysis of simply supported beams, mechanical shear connectors, transfer of longitudinal shear forces, stocky columns, slender columns, composite beams with service ducts.

Recommended Readings

1. Text / Reference Book
   a. Oehlers, D. J. and Bradford, M. A., "*Elementary Behavior of Composite Steel and Concrete Structural Members*", Butterworth-Heinemann, Elsevier Science
   b. Johnson, R. P., "*Composite Structures of Steel and Concrete (3/e)*", Blackwell Publishing
   c. Narayanan, R., "*Steel-Concrete Composite Structures*", Elsevier Applied Science Publishers Ltd.
   d. Collings, D., "*Steel Concrete Composite Bridges*", Thomas Telford Ltd.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET824

Course Name : Earthquake Engineering

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To understand basic concepts of earthquake hazard and its effect on structures
CO2: To be able to model and analyze different structure under seismic action
CO3: To gain the knowledge about different codes of practices for design and retrofitting of structure.

Course Contents

Characterization of ground motion, Earthquake intensity and magnitude; Recording instruments and base line correction; Predominant period and amplification through soil; Earthquake spectra for elastic and inelastic systems; Idealization of structural systems; Lateral force evaluation by mode superposition and direct integration; Effect of foundation/soil on earthquake response; Analysis for torsion; Review of damages during past earthquakes and remedial measures; Reinforcement detailing for members and joints; Codal provisions.

Recommended Readings

1. Text / Reference Book
   a. Krishna, J., Chandrasekaran, A.R. and Chandra, B., "*Elements of Earthquake Engineering (2/e)*", Standard Publisher Distributers.
   b. Chopra, A.K., "*Dynamics of Structures*", Pearson.
   c. Agarwal, P. and Shrikhande, M., "*Earthquake Resistant Design of Structures*", PHI.
   d. Duggal, S.K., "*Earthquake Resistant Design of Structures*", Oxford.
   e. Kramer, S.L., "*Geotechnical Earthquake Engineering*", Pearson.
   f. Jain, A.K., "*Dynamics of Structures with Matlab® Applications*", Pearson.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET825

Course Name : Ground Improvement Techniques

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To learn the various aspects of ground improvement techniques and classical mechanical modification techniques
CO2: To gain knowledge and able to design various modification techniques by admixtures
CO3: To gain knowledge and able to design various hydraulic modification techniques
CO4: To be able to design reinforced soil structures
CO5: To learn about various Geosynthetics and their applications

Course Contents

Ground improvement potential, drainage methods, precompression and vertical drains, vibration methods, grouting and injection, mechanical cementing and chemical stabilization; granular piles, stone columns, diaphragm walls; Soil reinforcement, Geosynthetics and their application cost effective design of retaining walls with geosynthetics, Stability analysis of reinforced soil slopes, Design of Embankments for highways, Civil engineering applications of extruded polymer grids, Geomembranes with landfill closures, Thermal methods of ground improvement, Improving Rock stability and Quality.

Recommended Readings

1. Text / Reference Book
   a. Koerner, R.M. "*Construction and Geotechnical Methods in Foundation Engineering*", McGraw Hill
   b. Sivakumar Babu, G.L. "*An Introduction to Soil Reinforcement and Geosynthetics*", University Press
   c. Purushottam Raj, P., "*Ground Improvement Techniques(2/e)*", Laxmi Publications
   d. Patra, N.R., "*Ground Improvement Techniques*", Vikas Publishing House
   e. Rao, G.V. and Raju, G.V.S.S., "*Engineering with Geo-synthetics*", Tata McGraw Hill

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET826

Course Name : Prestressed Structures

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To gain knowledge about pre-stressing, processes and construction of pre-stressed structural components.
CO2: To learn the different method of analysis of pre-stressed structural components.
CO3: To be able to design pre-stressed components for different Civil Engineering Construction Projects.

Course Contents

Basic philosophy of prestressing, Various techniques of prestressing, Different systems of prestressing, Prestressing of concrete structures, Losses in prestress, Deflection of prestressed concrete members, Analysis and design of prestress beams, Camber, Deflection, Cable layouts, Stretching in stages, Ultimate strength in flexure and shear, Design of end blocks, Statically indeterminate structures, Concordant cables, Linear transformation, Analysis and design of continuous beams, Tension members, Circular prestressing-prestressed tanks and prestressed pipes, Compression members, Piles, Partial prestressing, Composite construction, Analysis of composite beams, Prestress slabs, Pre-cast prestressed elements like poles, Railway sleepers, Beams, Slabs and Wall panels etc. Planning and economical aspects of prestressed structures, Construction of prestressed concrete structures-techniques, Materials and management.

Recommended Readings

1. Text / Reference Book
   a. Lin, T.Y. and Burns, N.H., "*Design of Prestressed Concrete Structures*", Wiley.
   b. Krishna Raju, N., "*Prestressed Concrete (6/e)*", McGraw-Hill Education.
   c. Pandit, G.S. and Gupta, S.P., "*Prestressed Concrete*", CBS Publishers and Distributors Pvt. Ltd.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET827

Course Name : Soil Structure Interaction

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To understand various types and effect of SSI on structural response.
CO2: To apply the finite element approach in modelling and solution of static and dynamic SSI problems
CO3: To gain the knowledge about different codes of practices.

Course Contents

Fundamentals of Soil-Structure Interaction: Direct and substructure methods of analysis; Equation of motion for flexible and rigid base; Kinematic interaction, Inertial interaction and effect of embedment; Fixed base structure; Structures on soft ground; Modeling of unbounded media.
Modeling of Structure: Continuous models, discrete models and finite element models.
Modeling of Soil: Finite element model; Dynamic stiffness coefficients for different types of foundations – surface foundation, embedded foundation, shallow foundation and deep foundation.
Modeling of Boundaries: Elementary, local, consistent and transmitting boundaries.
Engineering Applications of Soil-Structure Interaction: Low-rise residential buildings, multistory buildings, bridges, dams, nuclear power plants, offshore structures, Soil-pile-structure interactions.

Recommended Readings

1. Text / Reference Book
   a. Wolf, J. P., "*Dynamic Soil-Structure Interaction*", Prentice Hall
   b. Wolf, J. P., "*Soil-Structure Interaction in the Time-Domain*", Prentice Hall
   c. Wolf, J. P. and Song, C., "*Finite Element Modelling of Unbounded Media*", John Wiley & Sons
   d. Chowdhury, I. and Dasgupta, S.P., "*Dynamics of Structure and Foundation - A Unified Approach : Fundamentals*", CRC Press
   e. Chowdhury, I. and Dasgupta, S.P., "*Dynamics of Structure and Foundation - A Unified Approach: Applications*", CRC Press
   f. Bull, J.W., "*Soil-Structure Interaction: Numerical Analysis and Modelling*", CRC Press
   g. Kolář, V. and Němec, I., "*Modelling of Soil-Structure Interaction*", Elsevier

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CEP828

Course Name : Structural Lab

Credits : 1 **L -** 0 **T -** 0 **P -** 2

Course Type : Elective

Prerequisites : None

COURSE OUTCOMES

CO1: To get the knowledge about different type of tests on raw materials of cement concrete and test on steel bars.

CO2: To get the knowledge of various types of concrete, their design mixes, mechanical and durability tests.

CO3: To be able to write technical reports and present topics related to various type of advanced concrete

Course Contents

Basic test for materials, Mix Design, Non-destructive and other relevant tests of concrete quality. Determination of various parameters for steel and concrete and other related parameters, durability related tests for concrete. Use of SEM and XRD

Recommended Readings

1. Text / Reference Book
   a. Neville, A.M. and Brooks, J.J., "*Concrete Technology*", Pearson.
   b. Gambhir, M.L., "*Concrete Technology*", McGraw-Hill Education.
   c. Li, Z., "*Advanced Concrete Technology*", John Wiley & Sons.
   d. Bungey, J.H., Millard, S. and Grantham, M.G., "*Testing of concrete in structures (4/e)*", Taylor and Francis.
   e. Malhotra, V.M. and Carino, N.J., "*Handbook on Non-destructive Testing of Concrete (2/e)*", CRC Press.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET829

Course Name : Structural Optimization

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To understand the structural optimization process based on optimality criteria
CO2: To compute the derivatives of response quantities with respect to design variables
CO3: To gain the knowledge about non-linear programming by different methods

Course Contents

Formulation of different types of structural optimization problems; Optimality criteria based structural optimization; Computation of derivatives of response quantities with respect to design variables; Classical optimization; Lagrange multiplier technique and Kuhn-Tucker conditions; Solution of NLP by direct methods, by series of unconstrained optimization problems and by series of linear programming problems.

Recommended Readings

1. Text / Reference Book
   a. Christensen, P.W. and Klarbring, A., "*An Introduction to Structural Optimization*", Springer.
   b. Spillers, W.R. and MacBain, K.M., "*Structural Optimization*", Springer.
   c. Rao, S.S., "*Engineering Optimization: Theory and Practice*", New Age International Publishers.
   d. Ravindran, A., Ragsdell, K.M. and Reklaitis, G.V., "*Engineering Optimization: Methods and Applications (2/e)*", John Wiley & Sons.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET830

Course Name : Sustainable Materials and Construction

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To understand sustainable development, sustainable materials, their development, and properties

CO2: To understand various sustainability assessment method for materials/designs and their comparison

CO3: To be able to get the knowledge of various guidelines/codes for alternate material/product utilization in construction to analyze the performance of materials, technology and system with respect to sustainability performance

CO4: To investigate local materials/wastes and to understand their sustainability performance and their applications in green infrastructure

Course Contents

Introduction to Sustainable development and sustainable Construction; Concept of sustainable products, materials and Infrastructure systems; reuse-recycle construction materials and technologies; Circularity concept in civil engineering, Construction and demolition waste utilization, Waste to resource in construction, Construction waste recovery techniques, sustainable material properties and characterization, Material resource efficiency, challenges and opportunities in use and construction, codes and policies Design for life cycle concept, whole system design concept, Low carbon and low embodied materials and systems, Life cycle costing in construction; Life cycle performance improvement techniques, Impact of repair and maintenance on life cycle, Service life concept; Climate change adaptive strategies for materials and construction, Construction techniques for sustainable material and system, Sustainability Index for construction materials and techniques, Introduction to green buildings and rating systems, green building materials and construction techniques.

Recommended Readings

1. Text / Reference Book
   a. Addis, B., "*Building with Reclaimed Components and Materials: A Design Handbook for Reuse and Recycling*", CRC Press.
   b. Sabnis, G.M., "*Green Building with Concrete: Sustainable Design and Construction*", CRC Press.
   c. Siddique, R., "*Waste Materials and By-Products in Concrete*", Springer.
   d. Winkler, G., "*Recycling Construction Demolition Waste*", McGraw-Hill Education

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CEP831

Course Name : Sustainable Materials and Construction Lab

Credits : 1 **L -** 0 **T -** 0 **P -** 2
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To develop understanding of properties of sustainable materials
CO2: To develop understanding of application of waste and its utilization in precast materials
CO3: To test and investigate the properties of precast materials
CO4: To test and investigate the sustainability properties of construction materials

Course Contents

Practical:

1. Physical Properties of Coarse Recycled Concrete Aggregates/ Alternative Materials
2. Physical Properties of Fine Recycled Concrete Aggregates/ Alternative Materials
3. Pozzolanic Action testing of Waste Materials as replacement of Cement
4. Physical and Mechanical testing of Solid Bricks/Blocks made with Alternate materials
5. Physical and Mechanical Testing of Hollow Blocks made with Alternate materials
6. Physical and Mechanical testing of Tiles/Pavers made with Alternate materials
7. Properties of Low Slump/Precast suitable/Innovative concrete
8. Sustainability Properties Assessment of Green Buildings/construction materials
9. Sustainability assessment based on durability and service life tests

Recommended Readings

1. Text / Reference Book
   a. Addis, B., "*Building with Reclaimed Components and Materials: A Design Handbook for Reuse and Recycling*", CRC Press.
   b. Sabnis, G.M., "*Green Building with Concrete: Sustainable Design and Construction*", CRC Press.
   c. Siddique, R., "*Waste Materials and By-Products in Concrete*", Springer.
   d. Winkler, G., "*Recycling Construction Demolition Waste*", McGraw-Hill Education

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Department/Centre : Department of Civil Engineering

Course Code : 21CET832

Course Name : Tall Buildings

Credits : 3 **L -** 3 **T -** 0 **P -** 0
Course Type : Elective
Prerequisites : None

COURSE OUTCOMES

CO1: To get the knowledge about different type of structural systems.
CO2: To be able to analyses tall building system through approximate and matrix oriented methods of design of all buildings including sub structure.
CO3: To be able to get the knowledge of various Indian standards like IS 875, 1893, 16700 latest versions.
CO4: To be able to analyze and design the tall building system by manual calculations as well as with the latest soft computing techniques.
CO5: To be able to write technical reports and present topics related to advanced RC structures

Course Contents

Structural systems and concepts. Frame, shear wall, Frame shear wall Interaction, coupled shear walls, Braced frames, Tubular Buildings, Diagrids, Exoskeleton. Approximate and Matrix methods of Analysis; Foundation superstructure interaction; Wind Effects on tall structures, Review of relevant Indian Standards; Earthquake effects and design for ductility; Review of relevant Indian standards; Case history of Tubular buildings, Diagrids and Exoskeleton buildings.

Recommended Readings

1. Text / Reference book-
   a. Fintel, M., "*Hand Book of Concrete Engineering*", Van Nostrand Reinhold
   b. Weaver, W.Jr. and Gere, J.M., "*Matrix Analysis of Framed Structures*", Springer.
   c. Taranath, B.S., "*Reinforced Cement Concrete Design of Tall Buildings*", CRC Press.
   d. Taranath, B.S., "*Tall Building Design: Steel, Concrete, and Composite Systems*", CRC Press.