Scheme of Instruction, Examination & Syllabus

(With effect from the academic year 2021-22)

M.E. I to IV Semester

of

Two Year Post Graduate Degree Programme

in

Civil Engineering

Specialization in Structural Engineering

DEPARTMENT OF CIVIL ENGINEERING

MATURI VENKATA SUBBA RAO (MVSR) ENGINEERING COLLEGE(Autonomous)
NADERGUL, HYDERABAD-501510
(Sponsored by Matrusri Education Society, Estd.1980)
Approved by AICTE & Affiliated to Osmania University, Estd.1981
ISO 9001:2015 Certified Institution, Accredited by NAAC
website: www.mvsrec.edu.in

2021

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SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Civil Engineering) I- Semester
Specialization in Structural Engineering

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Core	Program Core-I	3	1	-	4	30	70	3	4
2	Core	Program Core-II	3	-	-	3	30	70	3	3
3	Elective	Professional Elective-I	3	-	-	3	30	70	3	3
4	Elective	Professional Elective-II	3	-	-	3	30	70	3	3
5	MC or OE	Mandatory Course/ Open Elective	3	-	-	3	30	70	3	3
6	Audit	Audit Course-I	2	-	-	2	30	70	3	-
Practical/ Laboratory Courses										
7	Lab	Laboratory-I	-	-	2	2	50	-	3	1
8	P21PW804CE	Seminar	-	-	2	2	50	-	3	1
		TOTAL	**17**	**01**	**04**	**22**	**280**	**420**	**-**	**18**

PC: Program Core **PE:** Professional Elective **MC:** Mandatory Course **OE:** Open Elective
AD: Audit Course **HS:** Humanities and Social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE**: Semester End Examination

Note:

1. Each contact hour is a Clock Hour
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory

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SCHEME OF INSTRUCTION & EXAMINATION

M.E. (Civil Engineering) II- Semester

Specialization in Structural Engineering

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs /Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Core	Program Core-III	3	1	-	4	30	70	3	4
2	Core	Program Core-IV	3	1	-	4	30	70	3	4
3	Elective	Professional Elective-III	3	-	-	3	30	70	3	3
4	Elective	Professional Elective-IV	3	-	-	3	30	70	3	3
5	Audit	Audit Course-II	2	-	-	2	30	70	3	-
Practical/ Laboratory Courses										
6	Lab	Laboratory-II	-	-	2	2	50	-	3	1
7	Lab	Laboratory-III	-	-	2	2	50	-	3	1
8	P21PW805CE	Mini Project with Seminar	-	-	4	4	50	-	3	2
		TOTAL	**14**	**02**	**08**	**24**	**300**	**350**	**-**	**18**

PC: Program Core **PE:** Professional Elective **MC:** Mandatory Course **OE:** Open Elective
AD: Audit Course **HS:** Humanities and Social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE**: Semester End Examination

Note:

1. Each contact hour is a Clock Hour
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory

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SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Civil Engineering) III- Semester
Specialization in Structural Engineering

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs /Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Elective	Professional Elective-V	3	-	-	3	30	70	3	3
2	MC or OE	Mandatory Course/ Open Elective	3	-	-	3	30	70	3	3
3	P21PW806CE	Major Project Phase - I	-	-	20	20	100	-	3	10
		TOTAL	**06**	**-**	**20**	**26**	**160**	**140**		**16**

M.E. (Civil Engineering) IV- Semester
Specialization in Structural Engineering

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs /Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	P21PW807CE	Major Project Phase - II	-	-	32	32	-	200	3	16
		TOTAL	-	-	32	32	-	200		16

PC: Program Core **PE:** Professional Elective **MC:** Mandatory Course **OE:** Open Elective
AD: Audit Course **HS:** Humanities and Social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE**: Semester End Examination

Note:

1. Each contact hour is a Clock Hour
2. The students who are willing to register for MOOCs in the M.E. (SE) III – Semester instead of Professional Elective –V, should register for those of the courses, approved by the CBoS, MVSREC and respective college MOOCs Coordinator. Those students are strictly not permitted to appear for either CIE or SEE of professional Elective –V if they abstain from attending the semester class work. Further, students willing to appear for both MOOCs and Professional Elective –V, they should fulfill the minimum attendance criteria.

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List of subjects of Professional Core

S.No	Course Code	Course Title
1	P21PC001CE	Advanced Reinforced Concrete Design
2	P21PC002CE	Theory of Elasticity
3	P21PC003CE	FEM in Structural Engineering
4	P21PC004CE	Structural Dynamics

List of subjects of Professional Electives I to V

S.No	Course Code	Course Title
1	P21PE001CE	Theory of Plates
2	P21PE002CE	Advanced Structural Analysis
3	P21PE003CE	Theory of Structural Stability
4	P21PE004CE	Advanced Steel design
5	P21PE005CE	Structural Health Monitoring
6	P21PE006CE	Retrofitting and Rehabilitation of Structures
7	P21PE007CE	Earthquake Resistant Design of Structures
8	P21PE008CE	Bridge Engineering
9	P21PE009CE	Composite Construction
10	P21PE010CE	Advanced Concrete Technology
11	P21PE011CE	Design of High Rise Structures
12	P21PE012CE	Design of Prestressed Concrete Structures
13	P21PE013CE	Theory of Shells and Folded Plates
14	P21PE014CE	Structural Optimization
15	P21PE015CE	Fracture Mechanism in Concrete Structures

List of Mandatory Courses

S.No	Course Code	Course Title
1	P21MC001CS	Research Methodology & IPR

List of Open Electives

S.No	Course Code	Course Title
1	P21OE001CE**	Cost Management of Engineering Projects
2	P21OE002CS	Business Analytics
3	P21OE003EC	Embedded System Design
4	P21OE004EE	Waste to Energy
5	P21OE005ME	Industrial Safety

**Open Elective Subject is not offered to the students of Civil Engineering Department

List of subjects of Audit Course-I

S.No	Course Code	Course Title
1	P21AD001HS	English for Academic and Research Writing

Audit Course-II

S.No	Course Code	Course Title
1	P21AD005HS	Constitution of India and Fundamental Rights

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List of Laboratory Courses

S.No	Course Code	Course Title
1	P21PW801CE	Structural Design Lab
2	P21PW802CE	Advanced Concrete Lab
3	P21PW803CE	Virtual Smart Structures and Dynamics Lab

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Course Code	Course Title						Core/Elective
P21PC001CE	**Advanced Reinforced Concrete Design**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the analysis and design of beams curved in plan and deep beams.
- Analyze flexural and shear stresses in deep beams.
- Design and detail the deep beams.
- Analyze, design and detail the domes, water tanks, bunkers and silos.
- Analyze and design the raft, pile and machine foundations.

Course Outcomes

After completing this course, the student will be able to:

1. Design the beams curved in plan and deep beams.
2. Propose the deep beams and domes
3. Design and analyze various type water tanks.
4. Analyze and design the bunkers and silos.
5. Formulate the raft, pile and machine foundations.

UNIT-I

Beams Curved in Plan: Introduction - design principles – Terminologies, structural design of beams curved in plan of circular and rectangular type.

UNIT-II

Deep Beams: Introduction to deep beams, Flexural and Shear stresses in deep beams, IS Code provisions - design of deep beams.

UNIT-III

Domes: Introduction - Stresses and forces in domes - design of spherical and conical domes.

Water Tanks: Types, Codal specifications, Design of circular, rectangular and Intze type water tanks.

UNIT-IV

Bunkers and Silos: Introduction - Design principles and theories Code provisions - design of square and circular bunkers - design of cylindrical silos. IS specifications.

UNIT-V

Raft and Pile Foundations: Introduction, need for the design, Design principles - Structural design of raft and pile foundations including the design of pile caps.

Machine Foundations: Introduction, Types, Design Principles, Case studies, detailed designs.

Suggested Readings:

1. "Advanced Reinforced Concrete Design", by N. Krishna Raju, CBS Pub. 3rd Edition, 2016
2. "Reinforced Concrete", by H.J. Shah, Charotar Pub. Vol. II. 7th Edition, 2014
3. "R.C.C. Designs" by B.C. Punmia, Laxmi Pub, 2006

Course Code	Course Title						Core/Elective
P21PC002CE	**Theory of Elasticity**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- Understand the concepts of elasticity and equip them with the knowledge to independently handle the problems of elasticity.
- Understand flexibility and stiffness methods of structural analysis.
- Enhance the competency level and develop the self-confidence through quality assignments in theory of elasticity.
- Understand linear and nonlinear behavior of structural systems.
- Inculcate the habit of researching and practicing in the field of elasticity.

Course Outcomes

After completing this course, the student will be able to:

1. Solve the problems of 3-D elasticity and make a logical conclusion.
2. Determine principal stresses and principal strains.
3. Formulate the Airy's stress function in 2-D problems of elasticity and apply to cantilever, simply supported and fixed beams with simple loading.
4. Interpret the knowledge of equilibrium and compatibility equations and apply the Airy's stress functions in polar coordinates for stress distribution about an axis of symmetry.
5. Solve torsion problems for bars of various shapes. Apply Raleigh Ritz method and Finite difference method.

UNIT – I

Introduction: Definition and notation for forces and stresses, components of stress and strain, Generalized Hooke's law, Stress-strain relations in three directions, Plane stress and plane strain, Equations of equilibrium and compatibility in two and three dimensions, Stress components on an oblique plane, Transformation of stress components under change of co-ordinate system.

UNIT – II

Principal stresses and principal planes: Stress invariants, Mean and Deviator stress, Strain energy per unit volume, Distortion strain energy per unit volume, Octahedral shear stress, Strain of a line element. Principal strains, Strain invariants, Volume strain, Principle of superposition, reciprocal theorem.

UNIT – III

Two dimensional problems in Cartesian co-ordinates: Solution by polynomials, St. Venant's Principle, Uniqueness of solution, Stress components in terms of Airy's stress function. Applications to Cantilever, simply supported and fixed beams with simple loading.

UNIT – IV

Two dimensional problems in Polar co-ordinates: Stress-strain components, Equilibrium equations, Compatibility equations, Applications using Airy's strain functions in polar co-ordinates for stress distributions symmetric about an axis, Effect of hole on stress distribution in a plate in tension, Stress due to load at a point on a semi-infinite straight boundary, Stresses in a circular disc under diametrical loading.

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UNIT – V

Torsion: Torsion of various shapes of bars, Stress function method of solution applied to circular and elliptical bars, Torsion of rectangular bars, Solution of Torsional problems by energy method, use of soap films in solving torsion problems, Prandtl's membrane analogy. Solution of torsion of rectangular bars by (i) Raleigh Ritz method and (ii) Finite difference method.

Suggested Readings:

1. Theory of Elasticity, S. Timoshenko & N. Goodier, Mc Graw Hill, 3rd edition, 2017
2. Theory of Elasticity by T.G Sitharam, L. Govindaraju, Springer 2021
3. Theory of Elasticity, Sadhu Singh, Khanna publishers

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Course Code	Course Title						Core/Elective
P21PC003CE	**FEM in Structural Engineering**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	-	-	**30**	**70**	**4**

Course Objectives

The objectives of this course is to impart knowledge of

- Learn the rudiments of finite element analysis.
- Study the fundamentals of domain discretization, interpolation, application of boundary conditions, assembly of global matrices, and solution of the resulting algebraic systems.
- Explain the core concepts of variational and weighted residual methods in FEM.
- Derive the element stiffness matrix for 1-D, 2-D and 3-D problems.
- Formulate the simple structural problems in to finite elements.

Course Outcomes

After completing this course, the student will be able to:

1. Develop and analyze the FEA models for various engineeringproblems.
2. Apply the Rayleigh-Ritz Method and concept of shape functions to solve variational problems.
3. Interpret the idea of Iso-parametric elements to understand quadrilateral and 2nd order quadrilateral elements.
4. Apply the Galerkin's method of weighted residuals to structural engineering problems.
5. Identify the engineering problems where the concept of non-linear FEA can be used.

UNIT – I

Introduction to FEM: Types of Problems – Types of Materials – Elastic / Inelastic situations – Types of forces: Body forces / Surface Traction / Point loads – Deformable bodies – Types of Deformations – Homogeneous / Non homogeneous Problems – Equations of equilibrium for elastic 2-D / 3-D continua - Equilibrium equations for 2-D / 3-D boundary elements – Boundary conditions – Strain-displacement relation for 2-D / 3-D – Stress-strain relation for 2-D / 3-D – Plane stress / Plane strain problems.

Virtual Work Formulation: Application to problems of plane trusses with static indeterminacy not exceeding three.

Finite Difference Method with Central Differences: Solving ODE's and PDE's with central differences. Application to beam and plate bending problems of simple geometry

UNIT – II

Variational Formulation: Finite Element Formulation - Stationarity of Functional – Given the Functional or Differential equation – Number of elements limited to two.

Elements: Strain-displacement relation matrix / stiffness matrix / Minimum Potential Energy Approach /Rayleigh-Ritz Method / introduction to natural coordinates / stiffness matrix of second order bar element / Axial bar subjected to point loads, body forces and surface traction forces / Problems with kinematic indeterminacy not exceeding two.

Triangular Elements: Displacement models / criterion for convergence / geometric invariance / conforming and non-conforming elements - 3-node triangular elements (CST) / determination of strain- displacement matrix / area coordinates-shape functions / determination of element stiffness and load matrices, assembling global stiffness and load matrices / Problems with kinematic indeterminacy not exceeding three.

2nd Order triangular elements: Shape functions – degradation technique / strain-displacement matrix / Expression for stiffness matrix / Load matrices due to body forces and surface traction.

UNIT – III

Iso-parametric elements:

Quadrilateral elements: Construction of shape functions using natural coordinates/Strain-displacement matrices/Load matrices for body force and surface traction/ Expressions for stiffness matrix, load matrices for 4-noded quadrilateral elements/ Gauss Quadrature of numerical integration / Problems with rectangular elements, kinematic indeterminacy not exceeding three.

2nd Order Quadrilateral elements: - Determination of shape functions for 2nd order quadrilateral elements and for elements of with serendipity / Strain-displacement matrices / Load matrices for body force and surface traction.

UNIT – IV

Method of Weighted Residuals:

Galerkin's Method of Weighted Residuals – Application to problems of mathematics / structural engineering, number of trial functions not exceeding two.

Galerkin's Finite Element Method – Weak form of Trial Function - Application to problems of mathematics / structural engineering, number of elements limited to two.

Axi-symmetric Problems: Strain-displacement relationship/stress-strain relationship / determination of stiffness matrix for 3-noded ring element and load matrices for body force and surface traction/ Problems with kinematic indeterminacy not exceeding three for 3-noded ring elements only.

UNIT – V

Tetrahedron elements: Volume coordinates, Strain-displacement matrix, stiffness matrix, load matrices due to body force and surface traction/ introduction to Hexahedron (brick) elements.

Non-linear Finite element analysis: Introduction – problems with material non-linearity – problems with geometric non-linearity – problems with both material and geometric non-linearity.

Introduction to MSC Nastran: Illustration on different modules of Nastran / Structural engineering applications of the package/Creation of a simple 1-D model, 2-D model and a 3-D model/ analysis and post processing of the results.

Suggested Readings:

1. Cook, R. D.Concepts and Application of Finite Element Analysis, John Wiley and Sons, 2001
2. Zienkiewicz, O. C. and Taylor, R. L, The Finite Element Method, Vol.1, McGraw Hill Company Limited, London, 2006.
3. Reddy, J. N, An Introduction to the Finite Element Method, McGraw Hill, New York, 2006
4. Chandrupatla, T. R. and Belegundu, A. D, Introduction to Finite Elements in Engineering,Prentice Hall of India, New Delhi, 2001.
5. Seshu. P, Finite Element Analysis, Prentice Hall of India Private Limited, New Delhi, 2003.
6. David V. Hutton Fundamentals of Finite Element Analysis, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005
7. Bathe, K. J, Finite Element Procedures, Prentice Hall of India, New Delhi, 2006

Course Code	Course Title						Core/Elective
P21PC004CE	**Structural Dynamics**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- Study the various types as well as characteristics of loading and formulate the equations of motion.
- Learn the response of un-damped and damped SDOF and MDOF systems under various loadings.
- Employ the approximate and iterative methods to model continuous vibratory systems.
- Use the seismic codes in analysis and design of civil engineering structures.
- Understand the dynamic response by numerical methods.

Course Outcomes

After completing this course, the student will be able to:

1. Explain the fundamental theory of dynamic equation of motions and analysis methods for dynamic systems.
2. Formulate equations of motions for SDOF systems to solve problems of dynamics.
3. Develop the simple computer models for engineering structures using knowledge of structural dynamics for MDOF systems.
4. Interpret the dynamic response analysis results and understand the possible error sources. Apply the dynamic analysis results for design, analysis and research purposes.
5. Apply the structural dynamics theory to earthquake analysis, response, and design of structures.

UNIT – I

Introduction to Structural Dynamics: Objectives of dynamic analysis – Types of prescribed dynamic loading – Characteristics of a dynamic problem – Methods of discretization: Lumped mass Procedure / Consistent mass procedure/generalized displacements – Single Degree Freedom Systems – Formulation of Equation of Motion: D'Alembert's Principle / Method of Virtual Work / Hamilton's Principle – Influence of Gravity Forces and Ground Motion on equation of motion – Generalized SDOF systems: Rigid Body Assemblage/Distributed Flexibility.

UNIT – II

Single Degree of Freedom Systems: Response of Un-damped/Damped free vibrations of SDOF systems – Un-damped/Damped vibrations of SDOF systems subjected to Harmonic loading: Dynamic equilibrium / Accelero Meters / Displacement Meters / Resonant Response / Vibration Isolation – Un- damped / Damped vibrations of SDOF systems subjected Periodic loading – Response of SDOF systems subjected Impulse loads: Half-sine pulse/Rectangular pulse/Triangular Pulse/ Shock spectra / Approximate method of impulse load analysis – Un-damped / Damped vibrations of SDOF systems subjected General dynamic loading / Duhamel Integral - Un-damped / Damped vibrations of SDOF systems subjected arbitrary dynamic loading.

UNIT – III

Multi Degree Freedom Systems: Formulation of Equations of Motion / Evaluation of Lumped Mass Matrix and consistent mass matrix/ Evaluation of Stiffness Matrix.

Un-damped Free Vibrations: Analysis of Frequency matrix and mode shape matrices using detrimental equation/Flexibility Formulation/Orthogonality Conditions/ Normalizing Mode shapes/Analysis of Dynamic Response/Normal Coordinates/ Uncoupled Equations of Motion for un-damped systems/Conditions for damping orthogonality – Mode super position procedure for damped forced vibrations – Time History Analysis – Direct Integration Methods due to New Mark(average acceleration, linear acceleration), Wilson theta correction.

UNIT – IV

Practical Vibration Analysis: Stodola Method, Holtzer Method – Fundamental mode only, Reduction of degrees of freedom, basic concepts in matrix iteration.

Variational Formulation of Equations of Motion: Generalized coordinates, Lagrange's Equations of Motion, Application to simple un-damped and damped problems of 2-DOF systems.

UNIT – V

Distributed Parameter Systems: Partial Differential Equation of Motion – Beam Flexure (Elementary case) – Undamped free vibrations (Elementary case) – Analysis of dynamic response – normal coordinates.

Earthquake Resistant Design: Brief exposure to relevant IS Codes of Practice, Response Spectra method.

Suggested Readings:

1. Walter C. Hurty & Moshe F. Rubinstein, Dynamics of Structures, Prentice Hall India, 1964
2. Clough, Ray. W, and Penzien, Joseph Dynamics of Structures, McGraw Hill CompanyLimited, New Delhi, 1993
3. Mario Paz, Structural Dynamics, CBS Publishers, 2nd edition, 2004
4. Chopra, A. K, Dynamics of Structures, Prentice Hall India, 2020

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Course Code	Course Title						Core/Elective
P21PE001CE	**Theory of Plates**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
P21PC002CE	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the analysis of rectangular and circular plates subjected to various loading conditions with different boundary conditions.
- Understand fundamentals of buckling of plates.
- Know the concepts of small deflection theory of laterally loaded plates.
- Study the approximate methods of analysis of rectangular plates.
- Derive the governing differential equations for orthotropic plates and apply them to practical problems.

Course Outcomes

After completing this course, the student will be able to:

1. Analyze the rectangular and circular plates subjected to various loading conditions.
2. Solve the problems of buckling of plates with different edge conditions.
3. Formulate the problems of small deflection theory of laterally loaded plates with different edge conditions.
4. Interpret the various numerical and approximate methods for analysis of plate problems.
5. Apply the concepts of orthotropic plates to simply supported structures.

UNIT-I

Bending of Rectangular Plates: Pure and Cylindrical bending, differential equation, cylindrical bending of uniformly loaded rectangular plates with simply supported and built-in edges. Relations between slope and curvature of slightly bent plates, Moment-curvature relations in pure bending. Strain energy in pure bending.

Bending of circular plates: Symmetrical bending, differential equation of equilibrium, uniformly loaded plates at center and Circular plates with circular holes at the center.

UNIT-II

Buckling of Plates: Differential equation for bending of plate under the combined action of in-plane loading and lateral loading, Calculation of critical loads, buckling of simply supported rectangular plates uniformly compressed in one and two directions with different edge conditions

UNIT-III

Small deflections of laterally loaded plates: Differential equation of equilibrium, Boundary conditions, Solution of simply supported rectangular plates under various loading conditions viz. uniformly distributed load (full or partial), concentrated load by Navier's approach, Levy type solution for rectangular plates under U.D.L with all four edges simply supported or two opposite edges simply supported and other two fixed.

UNIT-IV

Approximate methods for Rectangular Plates: Finite difference method for simply supported or fixed rectangular plates carrying UDL (full or partial) or central point load, Strain energy approaches Rayleigh-Ritz method.

UNIT-V

Bending of Orthotropic Plates: Differential equation of the bent plate. Application of the theory to simply supported rectangular (i) laminates; (ii) RC slabs (iii) grids.

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Suggested Readings:

1. Theory of plates and shells, S. Timoshenko and W. Krienger, Mc Graw Hill, 2017
2. Theory of plates and shells, R.H. Wood, 2nd Edition.
3. Theory of plates and shells, Zienkiwicz, Mc Graw Hill Co.
4. Theory of Plates and Shells by Stephen P. Timoshenko, S. Woinowsky. Krieger, 2017

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Course Code	Course Title						Core/Elective
P21PE002CE	**Advanced Structural Analysis**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

- Understand the concepts of matrix methods of analysis and equip them with the knowledge to independently handle the problems of structural analysis.
- Enhance the competency level in analysis of continuous beam, portal frames, pin jointed structures by flexibility and stiffness matrix methods.
- Understand the formation of global stiffness matrix from local stiffness matrix and equation solving techniques using direct stiffness method.
- Gain an insight into the nonlinear analysis of structures.
- Learn the concepts of beams on elastic foundation.

Course Outcomes

After completing this course, the student will be able to:

1. Analyze the continuous beams, rigid jointed frames and pin jointed structures by stiffness method.
2. Analyze the continuous beams, rigid jointed frames and pin jointed structures by flexibility method.
3. Formulate the element and global stiffness matrices by direct stiffness method and learn equation solution techniques.
4. Identify and distinguish between the linear and nonlinear analyses.
5. Solve the problems pertaining to beams on elastic foundation.

UNIT-I

Introduction to Matrix Methods of Analysis: Static indeterminacy and kinematic indeterminacy, Coordinate systems, displacement and force transformation matrices, element and structure stiffness matrices, equivalent joint loads and fixed end forces.

Stiffness Method: Stiffness of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

UNIT-II

Flexibility Method: Flexibility of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

UNIT-III

Direct Stiffness Method: Assemblage of global stiffness matrix, Analysis of plane truss, continuous beams, plane frame and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

UNIT-IV

Introduction to Nonlinear Analysis: Geometric and material nonlinearity, P-Δ effect, Effects of axial force on flexural stiffness – buckling of ideal columns, buckling behaviour of real columns, flexural behaviour of beam columns, flexural stiffness measures for braced prismatic beam columns, effect of axial tension, flexural stiffness measures for unbraced prismatic beam columns. Slope-deflection method of analysis – slope deflection equations for prismatic beam-columns, fixed end moments in beam-columns.

Matrix method of Analysis – Stiffness matrix for prismatic beam column elements, estimation of critical elastic buckling loads, second order analysis.

UNIT-V

Beams on Elastic Foundations: Introduction-Modulus of foundation & Basic equation. Beams of infinite length under concentrated & uniformly distributed loads, Analysis of semi-infinite beams making use of functions for infinite beams.

Suggested Readings:

1. Advanced Structural Analysis by Ashok.K. Jain, NEM & CHAND Brothers, 2015
2. Devdas Menon, "Advanced Structural Analysis", Narosa Publishing House, 2009.
3. Asslam Kassimali, "Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.
4. Amin Ghali, Adam M Neville and Tom G Brown, "Structural Analysis: A Unified Classical and Matrix Approach", Sixth Edition, 2007, Chapman & Hall.
5. William Weaver, Jr & James M. Gere, Matrix Analysis of Framed Structures, CBS Publishers, 3rd Edition
6. N. Krishna Raju, D.R Gururaja "Advanced mechanics of Solids & Structures", Narosa publishing house, New Delhi, 2001
7. Advanced Mechanics of Materials, Seely and Smith, 2nd Edition

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Course Code	Course Title						Core/Elective
P21PE003CE	**Theory of Structural Stability**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the buckling of columns, analysis using equilibrium, energy and approximate methods.
- Know the stability analysis of beam-columns and frames with different loads.
- Analysis of torsional, flexural and lateral buckling of beams.
- Perform the buckling analysis of thin plates using different approaches.
- Study the inelastic buckling analysis of plates.

Course Outcomes

After completing this course, the student will be able to:

1. Elaborate the analysis of buckling of columns using appropriate method.
2. Analyze the practical problems of beam-columns and frames.
3. Analyze the beams for torsional, flexural and lateral buckling.
4. Solve buckling problems of thin plates.
5. Analyze the plates for inelastic buckling and understand the post-buckling behaviour of plates.

UNIT-I

Buckling of columns: States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkin's approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.

UNIT-II

Buckling of beam-columns and frames: Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples Analysis of rigid jointed frames with and without sway - Moment distribution - Slope deflection and stiffness method

UNIT-III

Torsional and lateral buckling: Torsional buckling - Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported beam and cantilever beam.

UNIT-IV

Buckling of plates: Governing differential equation - Buckling of thin plates, various edge conditions - Analysis by equilibrium and energy approach - Approximate and Numerical techniques

UNIT-V

Inelastic buckling: Double modulus theory - Tangent modulus theory – Shanley's model – Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behavior of plates

Suggested Readings:

1. Timoshenko, S., and Gere., Theory of Elastic Stability, McGraw Hill Book Company, 2017.
2. Chajes, A. Principles of Structures Stability Theory, Prentice Hall, 1974.
3. Ashwini Kumar, Stability Theory of Structures, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1995.
4. Iyenger.N.G.R., Structural stability of columns and plates, Affiliated East West Press,1986.
5. Gambhir, Stability Analysis and Design of Structures, Springer, New York, 2004

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Course Code	Course Title						Core/Elective
P21PE004CE	**Advanced Steel Design**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	-	-	-	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of and problem solving skills in

- Learn the fundamentals of design of steel tanks and grillage foundations.
- Solve the practical problems pertaining to steel tanks and grillage foundations.
- Study the concepts of analysis and design of various members of tubular structures.
- Gain knowledge of the design of bunkers and silos using appropriate method and solve the practical problems pertaining to it.
- Study the fundamentals of design of transmission line towers and solve the practical problems pertaining to it.

Course Outcomes

After completing this course, the student will be able to:

1. Design and detail the rectangular plated and pressed steel tanks.
2. Propose the grillage foundations for structures.
3. Design and detail the hollow rectangular, square and circular tubular members in a truss including its joints.
4. Formulate the rectangular and square bunkers and silos using appropriate method.
5. Propose the geometry and analyse and design the transmission towers subjected to various loads

UNIT-I

Steel Tanks: Introduction, Types, Loads, Permissible stresses, Detailed design of elevated rectangular and pressed steel tanks including columns.

UNIT-II

Grillage Foundations: Introduction, Necessity of grillage foundation, Various types, Grillage foundations for single and double columns.

Tubular Structures: Introduction, Permissible stresses, Design considerations, Design of tension members, compression members and flexural members, Design of tubular trusses including joints.

UNIT-III

Bunkers and Silos: Introduction, General design principles, Design theories for bunkers and silos, Detailed design of bunkers and silos.

UNIT-IV

Transmission Line Towers: Classification, Economical spacing, Design loads, IS codal provisions, Calculation of wind loads, Permissible stresses, Overall arrangement and design procedure, detailed design including foundations.

UNIT-V

Design of Light Gauge Steel Structures: Introduction, Forms of light-gauge sections, Behaviour of compression elements, Effective width for load and deflection calculation, Behaviour of unstiffened and stiffened elements, Design of compression members, Design of laterally supported beams and laterally unsupported beams, Connections.

Suggested Readings:

1. S.K. Duggal, Design of Steel Structures, Tata McGraw Hill, 2009.
2. B.C Punmia, Design of Steel Structures, Laxmi Publications, 2001.
3. Ram Chandra, Design of Steel Structures, Vol. I & II, Standard Book House, 2016
4. P. Dayaratnam, Design of Steel Structures, S Chand Publications, 2012.
5. I.C. Syal and S. Singh, Design of Steel Structures, Standard Book House, 2000

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Course Code	Course Title						Core/Elective
P21PE005CE	**Structural Health Monitoring**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

- Learn the fundamentals of structural health monitoring.
- Understand smart materials and smart structures.
- Study the various vibration-based techniques for structural health monitoring.
- Learn the structural health monitoring using fiber-optic and Piezoelectric sensors.
- Study the structural health monitoring using electrical resistance and electromagnetic techniques.

Course Outcomes

After completing this course, the student will be able to:

1. Perceive the fundamentals of maintenance and repair strategies.
2. Estimate the serviceability and durability aspects of concrete.
3. Select the materials and techniques used for repair of structures.
4. Propose the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building.
5. Find an appropriate health monitoring technique and demolition technique.

UNIT-I

Introduction to Structural Health Monitoring: Definition of structural health monitoring (SHM) – Objectives- Need –Steps involved in SHM-Motivation for SHM - SHM as a way of making materials and structures smart - SHM and biomimetics - Process and pre usage monitoring as a part of SHM - SHM as a part of system management - The most remarkable characters of SHM Birth of the SHM community.

UNIT-II

Vibration-Based Techniques for SHM: Basic vibration concepts for SHM -Local and global methods - Damage diagnosis as an inverse problem -Model-based damage assessment - General dynamic behavior - State- space description of mechanical systems - Neural network approach to SHM - The basic idea of neural networks - Detection of delamination in a CFRP plate with stiffeners.

UNIT-III

Fiber-Optic Sensors: Classification of fiber-optic sensors - Intensity-based sensors - Phase- modulated optical fiber sensors - or interferometers -Wavelength based sensors - or Fiber Bragg Gratings (FBG) - The fiber Bragg grating as a strain and temperature sensor - Orientation of the optical fiber optic with respect to the reinforcement fibers - Fiber Bragg gratings as damage sensors for composites -Measurement of strain and stress variations.

UNIT-IV

SHM with Piezoelectric Sensors: The use of embedded sensors as Acoustic Emission (AE) detectors - Available industrial AE systems- New concepts in acoustic emission - State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research –The full implementation of SHM of localized damage with guided waves in composite materials - Available industrial acousto ultrasonic systems with piezoelectric sensors.

UNIT-V

SHM Using Electrical Resistance: Composite damage - Electrical resistance of unloaded composite - Percolation concept - Anisotropic conduction properties in continuous fiber reinforced polymer - Influence of temperature - Composite strain and damage monitoring by electrical resistance -Randomly distributed fiber reinforced polymers - Damage localization.

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Low Frequency Electromagnetic Techniques: Theoretical considerations on electromagnetic theory, Maxwell's equations, Dipole radiation, Surface impedance, Diffraction by a circular aperture, Eddy currents, Polarization of dielectrics, Applications to the NDE/NDT domain, Dielectric materials, Conductive materials, Hybrid method, Signal processing, Time-frequency transforms, The continuous wavelet transform, The discrete wavelet transform, Multi resolution, Denoising, Application to the SHM domain, General principles, Magnetic method, Electric method, Hybrid method.

Suggested Readings:

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, Wiley-ISTE, 2006.
2. Douglas E Adams, Health Monitoring of Structural Materials and Components-Methods with Applications, John Wiley and Sons, 2007.
3. J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure, Vol-1, Taylor and Francis Group, London, U.K, 2006.
4. Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007.
5. M.V. Gandhi and B.D. Thompson, "Smart Materials and Structures," Springer, 1992.

Course Code	Course Title						Core/Elective
P21PE006CE	**Retrofitting and Rehabilitation of Structures**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- Learn the fundamentals of maintenance and repair strategies.
- Study the quality assurance, serviceability and durability of concrete.
- Know the various materials and techniques used for repair of structures.
- Educate the different repair, strengthening, rehabilitation and retrofitting techniques.
- Instruct the various health monitoring and demolition techniques.

Course Outcomes
After completing this course, the student will be able to:
1. Perceive the fundamentals of maintenance and repair strategies.
2. Estimate the serviceability and durability aspects of concrete.
3. Select the materials and techniques used for repair of structures.
4. Propose the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building.
5. Find an appropriate health monitoring and demolition techniques.

UNIT - I

Maintenance: Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration.

Repair Strategies: Causes of distress in concrete structures, Construction and design failures, Condition assessment and distress-diagnostic techniques, Assessment procedure for Inspection and evaluating a damaged structure.

UNIT - II

Serviceability and Durability of Concrete: Quality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

UNIT - III

Materials and Techniques for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Bacterial concrete, Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection

UNIT - IV

Repair, Rehabilitation and Retrofitting Techniques: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure, Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.

UNIT – V

Health Monitoring and Demolition Techniques: Long term health monitoring techniques, Engineered demolition techniques for dilapidated structures, Use of Sensors – Building Instrumentation.

Suggested Readings:

1. Concrete Technology by A.R. Santakumar, Oxford University press, 2018
2. Defects and Deterioration in Buildings, E F & N Spon, London, 2001
3. C Maierhofer, H-W Reinhardt, G Dobmann "Non-Destructive Evaluation of Reinforced Concrete Structures" , 2010
4. B.L. Gupta and Amit Gupta, Maintenance and Repair of Civil Structures, Standard Publications, 2018
5. Concrete Repair and Maintenance Illustrated, RS Means Company Inc W. H. Ranso, 1981

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Course Code	Course Title						Core/Elective
P21PE007CE	**Earthquake Resistant Design of Structures**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the causes of earthquake and effects of ground motion and modelling of structures.
- Study the response spectra and structural dynamics of MDOF systems.
- Discover the different analysis and design approaches like equivalent lateral force method and inelastic time history analysis.
- Be trained in the ductile detailing of reinforced concrete structures as per IS 4326 and IS 13920.
- Learn the seismic analysis of masonry buildings.

Course Outcomes

After completing this course, the student will be able to:

1. Apply the concepts of structural dynamics of MDOF systems for analysis of structures.
2. Model and analyze the structures to resist earthquake forces by different methods.
3. Design the various structural elements resisting earthquake forces as per IS Codes.
4. Analyze and design earthquake resistant multistory RCC buildings
5. Plan ductile detailing of reinforced concrete and masonry buildings as per codal provisions.

UNIT-I

Earthquake Ground Motion: Engineering seismology, Seismic zoning map of India, Strong motion studies in India, Strong motion characteristics, Evaluation of seismic design parameters.

Structural Dynamics: Initiation into structural dynamics, Dynamics of SDOF systems, Theory of seismic pickup, Numerical evaluation of dynamic response, Response spectra, Dynamics of MDOF systems.

UNIT-II

Concepts of Earthquake Resistant Design of RCC Structures: Basic elements of earthquake resistant design, Identification of seismic damages in RCC buildings, Effect of structural irregularities on performance of RCC buildings during earthquakes, earthquake resistant building architecture.

UNIT-III

Seismic Analysis and Modelling of RCC Structures: Code based procedure for determination of design lateral loads, Infill walls, Seismic analysis procedure as per IS 1893 code, Equivalent static force method, Response spectrum method, Time history analysis, Mathematical modelling of multi-storey RCC buildings.

UNIT-IV

Earthquake Resistant Design of RCC Structures: Ductility considerations, Earthquake resistant design of multi-storey RCC buildings and shear walls based on IS 13920 code, Capacity based design.

UNIT-V

Earthquake Resistant Design of Masonry Structures: Identification of damages and non-damages in masonry buildings, Elastic properties of structural masonry, Lateral load analysis of masonry buildings, Seismic analysis and design of one-storey and two-storey masonry buildings.

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Suggested Readings:

1. Bruce A Bolt, Earthquakes, W H Freeman and Company, New York, 2004.
2. C. A. Brebbia, Earthquake Resistant Engineering Structures, WIT Press, 2011.
3. Mohiuddin Ali Khan, Earthquake-Resistant Structures: Design, Build and Retrofit, Elsevier Science & Technology, 2013.
4. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall of India, 2009.
5. Paulay, T and Priestley, M.J.N., Seismic Design of Reinforced Concrete and Masonry buildings, John Wiley and Sons, 1992.
6. S K Duggal, Earthquake Resistant Design of Structures, Oxford University Press, 2013.

Course Code	Course Title						Core/Elective
P21PE008CE	**Bridge Engineering**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	-	-	-	**30**	**70**	**3**

Course Objectives

- Learn the hydraulic, geological and geo-technical aspects in bridge design.
- Classify types of bridges and materials used for different types of bridges.
- Identify advantages and disadvantages of composite bridges.
- Analyze, design and detail the bridge deck and box girder systems, steel and composite bridges.
- Analyze and design the sub-structures, bridge bearings and various long span bridges.

Course Outcomes

After completing the course, the students will able to

1. Perceive the fundamentals and codes of practice of bridgedesign.
2. Design the bridge deck and box girder systems using appropriate method.
3. Develop the steel truss and composite steel-concrete bridges.
4. Propose the sub-structure components such as pier, abutments, etc. and bridge bearings.
5. Design the various types of long span bridges, curved and skew bridges.

UNIT – I

Introduction:

Types of bridges, materials of construction, codes of practice (Railway and Highway Bridges), aesthetics, loading standards (IRC, RDSO, AASHTO), recent developments box girder bridges, historical bridges (in India and overseas). Planning and layout of bridges, hydraulic design, geological and geo-technical considerations; Design aids, computer software, expert systems.

UNIT – II

Concrete Bridges: Bridge deck and approach slabs, Slab design methods, design of bridge deck systems, slab-beam systems (Guyon-Massonet and Hendry Jaeger Methods), box girder systems, analysis and design. Detailing of box girder systems.

UNIT – III

Steel and Composite Bridges: Introduction to composite bridges, Advantages and disadvantages, Orthotropic decks, box girders, composite steel-concrete bridges, analysis and design, truss bridges.

UNIT – IV

Sub-Structure: Piers, columns and towers, analysis and design, shallow and deep foundations, caissons, abutments and retaining walls. **Bridge appurtenances:** Expansion joints, design of joints, types and functions of bearings, design of elastomeric bearings, railings, drainage system, lighting.

UNIT – V

Long span bridges: Design principles of continuous box girders, curved and skew bridges, cable stayed and suspension bridges, seismic resistant design, seismic isolation and damping devices. Construction techniques (cast in-situ, prefabricated, incremental launching, free cantilever construction), inspection, maintenance and rehabilitation, current design and construction practices.

Suggested Readings:

1. "Bridge Engineering Handbook", Wai-Fah Chen Lian Duan, CRC Press, USA, 2000.
2. "Design of Highway Bridges", Barker, P.M. and Puckett, J.A., John Wiley & Sons, New York, 2013.
3. "Theory and Design of Bridges", Xanthakos, P.P., John Wiley & Sons, New York, 1994.

Course Code	Course Title						Core/Elective
P21PE009CE	**Composite Construction**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

- Study the concepts of composite construction.
- Understand the elastic behavior of composite structures.
- Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.
- Apply the concepts for design of multi-storey composite buildings.
- Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.

Course Outcomes

After completing this course, the student will be able to:

1. Outline the fundamentals of composite construction, and analysis and designs of composite beams.
2. Analyze and design the composite floors and columns, composite trusses and understand connection details.
3. Analyze and design the multi-storey composite buildings.
4. Analyze and design composite trusses.
5. Analyze and design vertical cross bracings.

UNIT-I

Introduction of Composite Constructions: Benefits of composite construction, Introduction to IS, BS and Euro codal provisions.

Composite Beams: Elastic behaviour of composite beams, No and Full Interaction cases, Shear connectors, Ultimate load behaviour, Serviceability limits, Effective breadth of flange, Interaction between shear and moment, Basic design consideration and design of composite beams.

UNIT-II

Composite Floors: Structural elements, Profiled sheet decking, Bending resistance, Shear resistance, Serviceability criterion, Analysis for internal forces and moments, Design of composite floors.

UNIT-III

Composite Columns: Materials, Concrete filled circular tubular sections, Non-dimensional slenderness, Local buckling of steel sections, Effective elastic flexural stiffness, Resistance of members to axial compressions, Composite column design, Fire resistance.

UNIT-IV

Composite Trusses: Design of truss, Configuration, Truss members, Analysis and design of composite trusses and connection details.

UNIT-V

Design of Multi-Storey Composite Buildings: Design basis, load calculations, Design of composite slabs with profile decks, composite beam design, design for compression members, vertical cross bracings, design of foundation.

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Suggested Readings:

1. R. P. Johnson, Composite Structures of Steel and Concrete, Oxford Blackwell Scientific Publications, 2004
2. INSDAG Teaching Resources for Structural Steel Design, Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, 2001
3. INSDAG Handbook on Composite Construction – Multi-Storey Buildings, Institute for Steel Development and Growth Publishers, Calcutta.
4. INSDAG Design of Composite Truss for Building, Institute for Steel Development and Growth Publishers, Calcutta.
5. INSDAG Handbook on Composite Construction – Bridges and Flyovers, Institute for Steel Development and Growth Publishers, Calcutta.
6. IS:11384, Code of Practice for Composite Construction in Structural Steel and Concrete, Bureau of Indian Standards, New Delhi, 1985

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Course Code	Course Title						Core/Elective
P21PE010CE	**Advanced Concrete Technology**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	-	-	-	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- Learn the concept of cement and its properties, mechanical and thermal properties of aggregates.
- Study the properties and testing of concrete in fresh and hardened state.
- Learn the shrinkage and creep mechanisms, curing and durability of concrete.
- Design concrete mix by various methods as per different codes.
- Study the different types of admixtures, mix design, properties and applications of special concretes.

Course Outcomes

After completing this course, the student will be able to:

1. Explain hydration of cement and tests on properties of cement andaggregates.
2. Interpret the properties and testing of concrete in fresh and hardened state.
3. Explain the shrinkageand creep mechanisms, curing and durability of concrete.
4. Design concrete mixes by various methods.
5. Select with the types of admixtures, and applications of special concretes.

UNIT - I

Cement: Types of cement and their composition, hydration of cement and hydration product, structure of hydrated cement, heat of hydration, gel theories, review of tests on properties of cement.

Aggregate: Classification of aggregates, particle shape and texture, bond and strength of aggregate and its influence on strength of concrete, porosity, absorption and moisture content and their influence, soundness of aggregate, alkali aggregate reaction, sieve analysis and grading of aggregate, review of tests on properties of aggregate.

UNIT - II

Properties of Concrete: Mixing and batching, workability, factors affecting workability, measurements of workability, various tests and procedures, cohesion, segregation and bleeding, Strength of Concrete

Admixtures: Classification of admixtures: Accelerators, Set - retarders, plasticizers, Super plasticizers, Mineral additives, Bonding Admixtures, Water Repellent admixtures and other admixtures and additives, influence of various admixtures on properties of concrete, their applications.

UNIT - III

Shrinkage and Creep of Concrete: Types of shrinkage, mechanism of shrinkage, factors affecting shrinkage, creep mechanism, factors influencing creep, rheological model, effects of creep.

Curing of Concrete: Methods of curing, Maturity concept, Influence of temperature on strength of concrete, Steam Curing.

Durability of Concrete: Permeability of concrete, chemical attack of concrete, Tests on sulphate resistance, effect of frost, Concreting in cold weather, hot weather concreting, and air entrained concrete.

UNIT - IV

Mix Design of Concrete: Review of methods and philosophies, Basic considerations, factors in the choice of mix proportions and their influence, quality control, process of mix design, mix design of concrete, fly ash concrete, mix design of high strength concrete as per I.S code, mix design of self compacting concrete as per EFNARC guidelines.

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UNIT - V

Special Concretes: High performance concrete, light weight concrete, recycled aggregates concrete, Fiber reinforced concrete, Polymer Concrete, Sulphur- Concrete composites, Self compacting concrete, ultra high performance concrete.

Suggested Readings:

1. Neville. A.M, Properties of Concrete, English Language Book Society/Longman Publications, 2011
2. Mehta. P.K and Paulo. J.M.M, Concrete – Microstructure – Properties and Material, McGraw-Hill.2001
3. M.S Shetty, A.K. Jain, Concrete Technology Theory and Practice, S. Chand Technical, 2018
4. Krishna Raju. N., Design of Concrete Mix, CBS Publications, 2010

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Course Code	Course Title						Core/Elective
P21PE011CE	**Design of High Rise Structures**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	-	-	-	**30**	**70**	**3**

Course Objectives

- To study the functioning and behavior of high rise buildings.
- To understand the characteristics and effect of wind loads on buildings.
- To understand the effect of earthquake on buildings and to learn the techniques for earthquake resistance.
- To analyse tall buildings subjected to lateral loads.
- To understand the interaction between the various structural components of high rise structures.

Course Outcomes

After completing this course, the student will be able to:

1. Perceive the concepts of high rise building structures.
2. Analyze and design high rise structures subjected to wind loads.
3. Analyze and design high rise structures subjected to earthquake loads.
4. Contrast with the different structural systems used in high rise buildings.
5. Predict the behavior and response of slab column frames.

UNIT-I

Introduction: Design Principles for Lateral Load resistance, ductility considerations in earthquake resistant design of concrete buildings, construction methods, choice of materials, cladding systems and their design principles, types of foundations for tall buildings.

UNIT-II

Wind: Introduction to wind, characteristics of wind, impact on structures, wind pressure, internal and external wind, dynamic action of wind, aerodynamic forces, natural frequencies, wind tunnels, types of wind tunnel tests, Introduction to computational fluid dynamics, behaviour of tall buildings subjected to wind, National standards, maximum design loads for buildings and other structures. Calculation of wind loads, special winds, gust, wind speed data and importance. Wind resistant design.

UNIT-III

Earthquake: Introduction to earthquake, characteristic, impact of earthquake on ground, foundations and structural elements, response of elements attached to buildings, ground motion, quasi-static approach, dynamic analysis, performance criteria, Vibration Control – active control and passive control, liquefaction effects of earthquakes, Introduction to time history analysis and pushover analysis.

UNIT-IV

Structural Systems: Necessity of special structural systems for tall buildings, Structural Systems for Steel Buildings - Braced frames, Staggered Truss System, Eccentric Bracing System, Outrigger & Belt truss system, Tube Systems; Structural Systems for Concrete Buildings - shear walls, frame tube structures, bundled tube structures; Design of shear wall as per IS code.

UNIT-V

Special Topics: Second order effects of gravity loading, Creep and shrinkage in columns, Differential shortening of columns, Floor leveling problems, Panel zone effects, P-Delta analysis.

Suggested Readings:

1. Tall Building Structures: Analysis and Design, Smith, B. S. and Coull, A., John Wiley & Sons, 2011.
2. Reinforced Concrete Design of Tall Buildings, Taranath, B. S., CRC Press, 2010.
3. Tall Building Design: Steel, Concrete and Composite Systems, Taranath, B. S., CRC Press, 2017.
4. Wind Effect on Structures: Modern Structural Design for Wind, Simiu, E. and Yeo, D., Wiley Blackwell, 2019.
5. Handbook of Concrete Engineering, M. Fintel, Von Nostrand Reinhold Company, 2004.
6. Design of Earthquake Resistant Structures, Emilio Rosenblueth, Pentech Press Ltd., 1990.

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Course Code	Course Title						Core/Elective
P21PE012CE	**Design of Prestressed Concrete Structures**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	-	-	-	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- Learn the concept of pre-stressed concrete, methods and systems of pre-stressing, losses of pre-stress.
- Estimate the loss of pre-stress in pre-tensioned and post-tensioned members.
- Analyze and design the sections for flexure, torsion and shear using different methods.
- Learn the design of sections for bond and anchorage and deflections of pre-stressed concrete beams.
- Study the analysis and design of statically indeterminate beams.

Course Outcomes

After completing this course, the student will be able to:

1. Appraise the fundamentals of pre-stressed concrete, methods and systems of pre-stressing and losses of pre-stress.
2. Analyze and design the sections for Deflection, shear and Torsion.
3. Design End Blocks and analyse continuous beam.
4. Perceive the circular pre-stressing, design of PSC Pipes & columns.
5. Solve the problems pertaining to axial members, slabs and grid floors.

UNIT-I

Introduction: Basic concepts, materials, permissible stress – Advantages and types of prestressing, Systems and devices of pre-stressing and post-tensioning, Prestressing steel

Losses in pre-stress: Loss of pre-stress in pre-tensioned and post-tensioned members – Analysis of sectionsfor flexure

UNIT-II

Deflections: Importance of deflections, factors influencing deflections, codal provisions, short term and long term deflections.

Shear: Shear in principal stresses – cracked and un-cracked sections - codal provisions – Design of shear reinforcement.

Torsion: Torsion for cracked and un-cracked sections, codal provisions and design.

UNIT-III

End Blocks: Nature of stresses, Stress distribution – IS Code Method -codal provisions - Design.

Continuous beams: Advantages of Continuous members – Code provisions – Analysis of two span Continuous beams – concordant cable profiles.

UNIT-IV

Tension Members: Introduction, Ties, Circular pre-stressing – Design of PSC pipes.

Compression Members: Introduction – Design of PSC columns.

UNIT-V

Slabs: Introduction – Types – rectangular and flat slabs – Codal provisions – Design of PSC floor slabs - one way and two way slabs, and simple flat slabs. Grid Floors: Introduction.

Suggested Readings:

1. Prestressed Concrete by N. Krishna Raju, Tata Mc Graw Hill, 2006.
2. Prestressed Concrete by G.S. Pandit and S.P. Gupta, CBS Pub., 2019.
3. Design of Prestressed Concrete‖ by Arthur H. Nilson, John Wiley, 1991

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Course Code	Course Title						Core/Elective
P21PE013CE	**Theory of Shells and Folded Plates**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
P21PE001CE	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the analysis and design of cylindrical shells, short and long shells.
- Study the concepts of bending theory using D.K.J. equations and Schorer theory.
- Understand the beam theory and beam arch analysis.
- Gain knowledge of the analysis and design of different shells of double curvature andaxi-symmetrical shells by membrane theory.
- Analyze different types of folded plates using Simpson's and Whitney's methods.

Course Outcomes

After completing this course, the student will be able to:

1. Analyze the cylindrical shells and design the short and long shells.
2. Solve the problems of bending theory using appropriate equations.
3. Evaluate and design the different shells using beam theory and membrane theory.
4. Analyze the numerous types of folded plates using pertinent method.
5. Analyze plate deflections and rotations.

UNIT-I

Introduction: Definition and classification of shells.

Cylindrical Shells: Membrane Theory – Equilibrium equations for differential shell elements – Calculation of stresses and displacement due to dead loads and snow loads for circular cylindrical shell.

UNIT-II

Bending Theory: Necessity of bending theory (i) D.K.J theory Assumption – Equilibrium equations for a differential element - stress strain relations - Moment curvature relations – Derivation of D.K.J. Differential and characteristics equations – Roots of the Characteristic equation – Expression for defection. (ii) Schorer theory – assumptions – Equilibrium equations for a differential shell element – stress strain relations – Moment curvature relations – Derivation of Schorer differential and characteristic equation – Roots of the characteristic equation – Expression of defection.

UNIT-III

Beam Theory of cylindrical shells: Assumptions and range of their validity – Outline of the beam arch analysis – Advantages of beams theory over other theories.

UNIT-IV

Shells of Doubles Curvature: Membrane theory of shells of revolution- Equilibrium equations for a differential shell element – Calculation of stresses in a spherical dome due to uniform load over the surface and due to concentrated load around a skylight opening. Shells of translation equilibrium equations for a differential shell element. Pucher's stress function, derivation of a differential equation from equations of equilibrium using Pucher's stress function calculation of stresses in hyperbolic parabolids with straight edges under uniform load over the surface.

UNIT-V

Folded Plates: Assumptions – Structural behavior – Resolutions of ridge loads – Edge shears – Stress distribution – Plate deflections and rotations. Effect of joint moments – Analysis of V shaped folded plates using (i) Simpson and (ii) Whitney methods.

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Suggested Readings:

1. Theory of plates and shells, S. Timoshenko and W. Krienger, Mc Graw Hill.2017
2. Design and construction of concrete shell roofs, G.S. Ramaswamy, CBS Pub 2005
3. Thin Shells Theory and Problems, J. Ramchandran, Universities press, 2016

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Course Code	Course Title						Core/Elective
P21PE014CE	**Structural Optimization**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

- Learn the optimization techniques and linear optimization.
- Understand techniques of linear programming and its geometrical interpretations.
- Study the non-linear optimization and non-linear constrained optimization.
- Understand the dynamic programming, decision theory and simulations.
- Apply optimization techniques for simple structures.

Course Outcomes

After completing this course, the student will be able to:

1. Explain optimization techniques, linear optimization, algorithm, etc.
2. Interpret the linear Programming methods, network analysis and assignment problems.
3. Examine the non-linear optimization by different methods.
4. Propose the optimization techniques for simple structures.
5. Analyze and optimize structural slabs and grids.

UNIT – I

Introduction to optimization: Introduction, basic theory and elements of Optimization, Terminology and definitions, Basic principles and procedure of optimization, Engineering applications of Optimization.

Classical Methods of Optimization: Trial and error method, Monte-Carlo method, Lagrangian multiplier method, illustrative examples

Linear Programming: Introduction, terminology, formulation of LPP, graphical and algebraic methods of solving LPP, standard form and canonical form of linear programming, geometrical interpretation, illustrative examples.

UNIT – II

Linear Programming: Simplex methods, Artificial variable techniques, solution of simultaneous equations, Dual formulations - illustrative examples.

Network analysis: Modifications and improvements on CPM/PERT

Transportation and Assignment problem: Introduction, terminology, formulation and solution of mathematical models, illustrative examples.

UNIT – III

Non-Linear Programming: local and global optimum, problem formulation, Unconstrained and constrained methods of Optimization-Kuhn Tucker conditions, Lagrangian Multiplier methods, graphical method, Univariate search method, Steepest Descent Methods, quadratic programming problem, Wolfs modified simplex method, illustrative examples.

UNIT – IV

Dynamic programming: Introduction, terminology, need and characteristics of dynamic programming, formulation, solution of LPP, applications, illustrative examples

Decision theory: Introduction, types, decision trees.

Simulation: Introduction, advantages, limitations, types, applications.

UNIT – V

Structural Optimization: Optimum structural design of rectangular timber beam, reinforced concrete rectangular, T and L beams, concrete mix proportioning, reinforced concrete deep beams, planner trusses, Procedure of optimization for structural grid and slab.

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Suggested Readings:

1. Engineering Optimization‖, S.S. Rao, New Age Internationals, 2013.
2. Systems Analysis for Civil Engineers‖, Paul, J.O., john Wiley& Sons,1988
3. Fundamentals of Optimum Design in Engineering‖ S.S. Bhavikatti, New Age International Publishers, 2017
4. Operation Research‖, S. Kalavathy, Vikas Publishing house Pvt Ltd. Second edition, 2013

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Course Code	Course Title						Core/Elective
P21PE015CE	**Fracture Mechanism in Concrete Structures**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	-	-	-	**30**	**70**	**3**

Course Objectives

The objectives of the course are to impart knowledge of the:

- Identify and classify cracking of concrete structures based on fracture mechanics.
- Estimate growth of fracture from the stress at crack tip.
- Implement stress intensity factor for notched members.
- Apply fracture mechanics models to high strength concrete and FRC structures.
- Compute J-integral for various sections understanding the concepts of LEFM.

Course Outcomes

After the completion of the course, the student will be able to:

1. Estimate cracks in concrete structures based on fracture mechanics.
2. Distinguish type of failures in concretestructures.
3. Find stress intensity factors.
4. Develop different material models.
5. Develop numerical models.

UNIT - I

Introduction: Basic fracture mechanics, crack in a structure, mechanisms of fracture and crack.

UNIT - II

Growth, cleavage fracture, ductile fracture, fatigue cracking, environment assisted cracking, service failure analysis

UNIT - III

Stress at crack tip: Stress at crack tip, linear elastic fracture mechanics, Griffith's Criteria, Stress intensity factors, crack tip plastic zone, Erwin's plastic zone correction, R curves, compliance, J integral, concept of CTOD and CMD

UNIT - IV

Material Models: General concepts, crack models, band models, models based on continuum

UNIT - V

Damage Mechanics: Applications to high strength concrete, fibre reinforced concrete, crack concepts and numerical modeling.

Suggested Readings:

1. Fracture Mechanics, Suri, C.T. and Jin, Z. H., 1st Edition, Elsevier Academic Press, 2012.
2. Elementary Engineering Fracture Mechanics, Broek David, 3rd Edition, Springer, 2012.
3. Fracture Mechanics of Concrete Structures – Theory and Applications, Elfgreen, L., RILEM Report, Chapman and Hall, 2005
4. Fracture Mechanics – Applications to Concrete, Victor, Li C., Bazant Z. P., ACI SP118, ACI Detroit, 1989.

Course Code	Course Title						Core/Elective
P21OE001CE**	**Cost Management of Engineering Projects**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	-	-	-	**30**	**70**	**3**

Course Objectives

- To apply modern software packages to conduct analysis of real world data.
- Understand and interpret bar charts and Network diagram.
- To understand the technical underpinning of engineering economic analysis.
- The ability to apply the appropriate analytical techniques to a wide variety of real world problems and data sets.
- To summarize and present the analysis results in a clear and coherent manner.

Course Outcomes

After completing this course, the student will be able to:

1. Perceive the cost concepts in decision making
2. Evaluate Project Cost Control and bar charts and network diagram
3. Estimate cost planning and Marginal Costing
4. Analyze and interpret balanced score card.
5. Solve transportation problems.

UNIT-I

Introduction and Overview of the Strategic Cost Management Process: Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT-II

Project: Meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT-III

Cost Behavior and Profit Planning Marginal Costing: Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

UNIT-IV

Activity-Based Cost Management: Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

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UNIT-V

Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Text Books:

1. Cost Accounting – A Managerial Emphasis, Prentice Hall of India, New Delhi, 2008
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 2012
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting

Course Code	Course Title						Core/Elective
P21PW801CE	**Structural Design Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**2**	**50**	-	**1**

Course Outcomes

After completing this course, the student will be able to:

1. Design and detail all the structural components of frame buildings for seismic and wind force.
2. Design and detail complete multi-storey building.
3. Design beam-column joint of an RC frame building.
4. Design beam of an RC frame building.
5. Design column of an RC frame building.

Syllabus Content:

Seismic & Wind Analysis and Design:

1. Calculation of design seismic force by static and dynamic methods of IS 1893.
2. Calculation of lateral force distribution as per Torsion provisions of IS 1893.
3. Beam design of an RC frame building as per IS 13920.
4. Column design of an RC frame building as per IS 13920.
5. Beam-column joint design of an RC frame building as per IS 13920.
6. Complete manual seismic analysis, design and detailing of a simple G+3 storied building and its comparison with any structural analysis and design software.
7. Calculation of wind pressures and design forces on walls and roof of a rectangular building.
8. Calculation of design wind forces on a RC building using force coefficient method.
9. Calculation of design wind forces on a RC building using Gust Factor Approach.
10. Complete manual wind analysis and design of a simple G+3 storied structure using any structural analysis and design software and its comparison with any structural analysis and design software.

Note: All the experiments/assignments should be done manually by individual student and the analysis & design results should be compared using latest structural analysis and design software like STAAD PRO V8i and ETABS.

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Course Code	Course Title						Core/Elective
P21PW802CE	**Advanced Concrete Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**2**	**50**	-	**1**

Course Outcomes

After completing this course, the student will be able to:

1. Perceive the rheology of special Concrete- fly ash based Concrete- geo-polymer Concrete and Fibre Reinforced Concrete.
2. Design High strength concrete – Mix design
3. Test cube, cylinder strength and modulus of rupture of high strength
4. Test of NDT of concrete.
5. Develop correlation between Non-Destructive and Destructive Tests using Rebound Hammer and UPV instruments.

List of Experiments

1. To design the mix for High Strength Concrete.
2. To determine fresh properties of High Strength Concrete.
3. Study of stress-strain curve of high strength concrete, correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
4. Behaviour of beams under flexure and shear.
5. Mix proportion on FRC for compressive strength.
6. Cube compressive strength of fly-ash and geo polymer concrete.
7. Split tensile strength and modulus of rupture for fly-ash concrete/geo-polymer concrete.
8. To design mix for self compacting concrete and determine 7 days, 28 days and 56 days compressive strength.
9. Development of correlation between Non-Destructive and Destructive Tests using Rebound Hammer and UPV instruments
10. To design mix for Self Compacting Concrete

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Course Code	Course Title						Core/Elective
P21PW803SE	**Virtual Smart Structures and Dynamics Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
P21PC004CE	-	-	-	**2**	**50**	-	**1**

Course Outcomes

After the completion of the course, the student will be able to:

1. Perceive the behavior of structures subjected to dynamic loadings like wind, earthquake and blasting.
2. Explain the dynamic characteristics of structures instrumented with smart piezoelectric sensors.
3. Estimate shear lag effect and Rebar Corrosion
4. Analyze response spectrumcurve for given condition
5. Interpret displacements using Photogrammetry

List of Experiments:

Simulation based:

1. Free Vibration of S.D.O.F System
2. Forced Vibration of S.D.O.F System
3. Impulse Response of S.D.O.F System
4. Concept of Response Spectrum
5. Vibration of M.D.O.F System
6. Behaviour of Rigid Blocks
7. Torsional Response of Building
8. Continuous Systems
9. Vibration Control
10. Modes of Vibration of Simply Supported Beam Under Flexure
11. Modes of Vibration of Simply Supported Plate
12. Damage Detection and Qualitative Quantification Using Electro-Mechanical Impedance (EMI) Technique
13. Dynamics of Bandra Worli Sea Link Bridge
14. Piezoelectric Energy Harvesting and Structural Health Monitoring Using Thin Surface Bonded PZT Patches.
15. Shear Lag Effect in Electro-Mechanical Impedance (EMI) Technique
16. Rebar Corrosion Detection and Assessment Using Electro-Mechanical Impedance (EMI) Technique.
17. Vibration Characteristics of Aluminium Cantilever Beam Using Piezoelectric Sensors
18. Identification of High Frequency Axial Modes of Beam in "Free-Free" Condition Using Electro-Mechanical Impedance (EMI) Technique
19. Forced Excitation of Steel Beam Using Portable Shaker
20. Photogrammetry for Displacement Measurement

e-resources:

1. http://sd-iiith.vlabs.ac.in/Introduction.html (For Experiments 1 to 9)
2. http://vssd-iitd.vlabs.ac.in/home.html (For Experiments 10 to 20)
3. MATLAB Software

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Course Code	Course Title						Core/Elective
P21PW804CE	**Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**2**	**50**	-	**1**

Course Outcomes

After completing this course, the student will be able to:

1. Develop the habit of referring the journals for literature review.
2. Appraise the gist of the research paper.
3. Identify the potential for further scope.
4. Explain the work in an efficient manner.
5. Elaborate the documentation in standard format.

Guidelines:

- Each student shall present a seminar, generally comprising about three to four weeks of prior literature review and finally a presentation of their work for assessment.
- The seminar report shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference.
- At least two faculty members will be associated with the open seminar presentation to evaluate and award marks.

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Course Code	Course Title						Core/Elective
P21PW805CE	**Mini Project with Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**4**	**50**	-	**2**

Course Outcomes
After completing this course, the student will be able to:

1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Compose the results obtained
5. Elaborate the documentation in standard format

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present by students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter-disciplinary/ industry relevance.
- Students can select a mathematical modelling based/Experimental investigations or Numerical modelling.
- All the investigations should be clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference.
- Student should present open seminar to evaluate and award marks.

Departmental committee: Supervisor and a minimum of two faculty members

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

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Course Code	Course Title						Core/Elective
P21PW806CE	**Major Project Phase – I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**20**	**100**	-	**10**

Course Outcomes

At the end of this course, students will be able to

1. Propose to self-learning of various topics.
2. Survey the literature such as books, journals and contact resource persons for the selected topic of research.
3. Organize to write technical reports.
4. Develop oral and written communication skills to present.
5. Defend their work in front of technically qualified audience

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Open Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS, Head of the Department, Supervisor and Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson-BOS, HOD, Two Senior faculty members, Supervisor & Project coordinator)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the student regularly.

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Course Code	Course Title						Core/Elective
P21PW807CE	**Major Project Phase – II (Dissertation)**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**32**	-	**200**	**16**

Course Outcomes

At the end of this course, students will be able to

1. Organize different experimental techniques and will be able to use different software/ computational /analytical tools.
2. Design and develop an experimental set up/ equipment/test rig.
3. List various tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.
4. Illustrate work in a research environment or in an industrial environment.
5. Construct technical report writing and will be able to present and convince their topic of study to the engineering community.

Guidelines:

- It is a continuation of Major Project Phase – I started in semester -III.
- The student has to submit the report in prescribed format and also present open seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner, Chairperson BoS, Head of the Department and Supervisor from the Institute.
- The candidate has to be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BOS & Head of the Department	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application to society and Scope for future study
	20	Viva-Voce

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