**MAHATMA GANDHI MISSION UNIVERSITY**

**JAWAHARLAL NEHRU ENGINEERING COLLEGE**

**AURANGABAD**


# *DEPARTMENT OF CIVIL ENGINEERING*

**Curriculum for Master of Technology**
**In**
**STRUCTURAL ENGINEERING**

**With effective fromAcademic Year**

**2020-21**

## Vision of CivilEngineering Department

The department of Civil Engineering strives to produce qualified engineers, researchers and professionals to serve the society with sustainable development.

## Mission of Civil Engineering Department

- To provide quality education and prepare competitive graduates for successful career in Civil Engineering.
- To develop research opportunities that creates competent professionals who are trained in the design and development of environment friendly Civil Engineering system.

## Program Outcomes (POs)

**Engineering Graduates will be able to:**

**1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**2. Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriateconsideration for the public health and safety, and the cultural, societal, and environmentalconsiderations.

**4. Conduct investigations of complex problems:** Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and synthesis of theinformation to provide valid conclusions.

**5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modernengineering and IT tools including prediction and modelling to complex engineering activitieswith an understanding of the limitations.

**6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant tothe professional engineering practice.

**7. Environment and sustainability:** Understand the impact of the professional engineeringsolutions in societal and environmental contexts, and demonstrate the knowledge of, and needfor sustainable development.

**8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities andnorms of the engineering practice.

**9. Individual and team work:** Function effectively as an individual, and as a member or leaderin diverse teams, and in multidisciplinary settings.

**10. Communication:** Communicate effectively on complex engineering activities with theengineering community and with society at large, such as, being able to comprehend and writeeffective reports and design documentation, make effective presentations, and give and receiveclear instructions.

**11. Project management and finance:** Demonstrate knowledge and understanding of theengineering and management principles and apply these to one's own work, as a member andleader in a team, to manage projects and in multidisciplinary environments.

**12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage inindependent and life-long learning in the broadest context of technological change

**Definition of Credit**

| | |
|---|---|
| 1 Hr. Lecture (L) per week | 1 Credit |
| 1 Hr. Tutorial (T) per week | 1 Credit |
| 1 Hr. Practical (P) per week | 0.5 Credits |
| 2 Hrs. Practical (Lab) per week | 1 Credit |

**Course Code and Definition:**

# Course Standardization

## 20UME301D

## (Year-ProgramType-Department-Semester-Course Number-Course Type)

| | |
|---|---|
| 20 | First two digits are indicating the **year** of implementing the syllabus/course i.e. Year 2020 |
| U | Next one alphabet indicating **type of program**: U: UG Program, P: PG Program |
| ME | Next two alphabets indicating **name of department**:<br>ME: Mech CI:Civil CH: Chem CS: CSE ET: ECT IT: IT EE: Elect.<br>UC: University Course CC: College Course |
| 3 | Next one digit is indicating **semester** of course: 3: Third Semester |
| 01 | Next two digits are indicating **course number** starting from 01 to as many courses offered. |
| D | Last alphabet is indicating the **type of course** i.e.<br>D: Department Core H: Humanities E: Elective O: Open elective<br>L: Lab/Practicals P: Project S: Seminar I: Internship<br>M: MOOC N: New skill course C: Communication/Lang.<br>T: Thrust area course (Honors degree course) B: Basic course |

## Semester- I

| Course code* | Course Title | Teaching Scheme | | | Evaluation Scheme | | | | | | Minimum Passing | | | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Internal | | | External | | Total | Internal | | External | | Total | |
| (Mandatory) | | L | T | P | CA | MSE | TW | ESE | PR | | Internal Passing Cut Off | Internal Passing out Off | External Passing cut Off | External Passing out Off | | |
| **20PCI101D** | Theory of Elasticity and Plasticity | 3 | 1 | -- | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 4 |
| **20PCI102D** | Structural Dynamics | 3 | -- | -- | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 3 |
| **20PCI103D** | Advanced Structural Analysis | 3 | 1 | -- | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 4 |
| **20PCI104E** | Elective I | 3 | -- | -- | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 3 |
| **20PCI105E** | Elective II | 3 | -- | -- | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 3 |
| **20PCI106L** | Structural Dynamics Laboratory | -- | -- | 2 | | | 25 | | 25 | 50 | 10 | 25 | 10 | 25 | 20 | 1 |
| **20PCI107L** | Numerical Methods with MATLAB/Scilab | | | 2 | | | 25 | | 25 | 50 | 10 | 25 | 10 | 25 | 20 | 1 |
| | **TOTAL** | **15** | **2** | **4** | **100** | **100** | **50** | **300** | **50** | **600** | | | | | **240** | **19** |

**MSEPEC104: Elective I**

A. Advanced Numerical Methods for Structural Engineers

B. Mechanics of Composite Materials

C. Analysis and Design of Bridges

**MSEPEC105: Elective II**

A. Structural Stability

B. Design of Prestressed Concrete Structure

C. Earthquake Resistant Design of Reinforced Concrete Buildings

## Semester- II

| Course code* | Course Title | Teaching Scheme | | | Evaluation Scheme | | | | | | Minimum Passing | | | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Internal | | | External | | Total | Internal | | External | | Total | |
| (Mandatory) | | L | T | P | CA | MSE | TW | ESE | PR | | Internal Passing Cut Off | Internal Passing out Off | External Passing Cut Off | External Passing out Off | | |
| **20PCI201D** | Theory of Plates and Shells | 3 | 1 | | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 4 |
| **20PCI202D** | Finite Element Analysis | 3 | 1 | | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 4 |
| **20PCI203D** | Research Methodology | 3 | | | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 3 |
| **20PCI204E** | Elective III | 3 | | | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 3 |
| **20PCI205E** | Elective IV | 3 | | | 20 | 20 | | 60 | | 100 | 16 | 40 | 24 | 60 | 40 | 3 |
| **20PCI206L** | Structural Analysis and Design Laboratory | | | 2 | | | 25 | | 25 | 50 | 10 | 25 | 10 | 25 | 20 | 1 |
| **20PCI207L** | Advanced Concrete Technology Laboratory | | | 2 | | | 25 | | 25 | 50 | 10 | 25 | 10 | 25 | 20 | 1 |
| **20PCI208S** | Seminar | | 1 | | | | 25 | | | 25 | 10 | 25 | | | 10 | 1 |
| | **TOTAL** | **15** | **3** | **4** | **100** | **100** | **75** | **300** | **50** | **625** | | | | | **250** | **20** |

**MSEPEC-204: Elective III**

A. Design of High Rise Structures

B. Design of Blast Resistant Structures

C. Structural Audit

**MSEPEC-205: Elective IV**

A. Retrofitting of Structures

B. Advanced Design of Reinforced concrete structures

C. Advanced Design of Steel Structures

| Semester III | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course code*** | **Course Title** | **Teaching Scheme** | | | **Evaluation Scheme** | | | | | | **Minimum Passing** | | | | | **Credit** |
| | | | | | **Internal** | | | **External** | | Total | **Internal** | | **External** | | Total | |
| (Mandatory) | | L | T | P | CA | MSE | TW | ESE | PR | | Internal Passing Cut Off | Internal Passing out Off | External Passing Cut Off | External Passing out Off | | |
| 20PCI301P | Project Stage I | -- | -- | -- | -- | | 50 | | 50 | 100 | 20 | 50 | 20 | 50 | 40 | 10 |
| | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | | | **50** | | **50** | **100** | | | | | **40** | **10** |

| Semester IV | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course code*** | **Course Title** | **Teaching Scheme** | | | **Evaluation Scheme** | | | | | | **0 Minimum Passing** | | | | | **Credit** |
| | | | | | **Internal** | | | **External** | | Total | **Internal** | | **External** | | Total | |
| (Mandatory) | | L | T | P | CA | MSE | TW | ESE | PR | | Internal Passing Cut Off | Internal Passing out Off | External Passing Cut Off | External Passing out Off | | |
| 20PCI401P | Project Stage II | -- | -- | -- | | | 100 | | 100 | 200 | 40 | 100 | 40 | 100 | 80 | 20 |
| | | | | | | | | | | | | | | | | |
| | **TOTAL** | | | | | | **100** | | **100** | **200** | | | | | **80** | **20** |

**L**= Lecture, **T**=Tutorial, **P**= Practical, **CA**= Continuous Assessment, **MT**=Midterm, **ET**=End Term Exam, **PR**=Practical, **TW** =Term work

## 20PCI101D:Theory of Elasticity and Plasticity

| | | |
|---|---|---|
| **Course Code : 20PCI101D** | **Theory of Elasticity and Plasticity** | **Total credits: 4** |
| **Teaching Scheme** | | **Evaluation Scheme** |
| **Theory: 3Hrs/week** | | **CA: 20 Marks** |
| **Tutorial: 1Hr/week** | | **MT: 20 Marks** |
| | | **ET: 60 Marks** |

| | |
|---|---|
| **Course Objectives** | **Course objectives are to:**<br>1. Learn principles of analysis of Stress and Strain and predict the stress-strain behaviour of continuum.<br>***2.*** Study the stress and strain parameters and their inter relations of the continuum**.**<br>3. Study the torsion in prismatic &non circular sections.<br>4. Learn the concepts of plasticity& yield criteria of structures. |
| **Course Outcomes** | **On completion of this course, students are able to:**<br>1 Apply the principles of stress-strain behaviour of continuum<br>2 Develop analytical skills of solving 2 D & 3D problems using plane stress and plane strain conditions.<br>3. Analyse structural members subjected to torsion.<br>4. Illustrate the theory of plasticity theory & yield criteria. |
| **Pre-requisites** | **Engineering Mechanics, Strength of Materials** |
| **Course Type** | **Program Core Course** |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency | P.I | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 *:* Stresses and Strains** | | | | | | |
| Concept of Stress at a Point, Stress Tensor, State of Stress at a Point in Cartesian Coordinate System, Derivation of Stress Equilibrium Equations in Cartesian and Polar Coordinate System, | CO1 | 1, 2, 12 | **2** | 1.3, 2.4, 12.2 | 1.3.1, 2.4.1, 12.2.2 | Chalk and Board, Blended |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cauchy's Formula, Transformation of Stresses, Stress Invariants, State of Pure Shear, Principal Stresses, Maximum Shear Stresses, Octahedral Stresses, State of Pure Shear and Hydrostatic Stress, The State of Strain at a Point, Strain Displacement Relations, Strain Compatibility Condition, Volumetric Strain, Problems on Navier Lame's Equilibrium Equations | | | | | | Learning |
| **Unit 2 *:* Stress-Strain Relationship** | | | | | | |
| Generalized Hooke's Law, Hooke's Law for Isotropic, Orthotropic, Plane Stress, Plane Strain and Axi-Symmetric Problems, Relations between Elastic Constants, Problems in 2D and 3D Cartesian Coordinate System, Airy's Stress Function, Euler Bernoulli Hypothesis | CO2 | 1, 2, 12 | **2** | 1.3, 2.4, 12.2 | 1.3.1, 2.4.1, 12.2.2 | Chalk and Board, Blended Learning |
| **Unit 3 *:* Torsion in prismatic section** | | | | | | |
| Assumptions and Torsion Equation for General Prismatic Solid Bars, Torsion of Circular Sections. | CO3 | 1, 2, 12 | **2** | 1.3, 2.4, 12.2 | 1.3.1, 2.4.1, 12.2.2 | Chalk and Board, Blended Learning |
| **Unit 4 *:* Torsion in non-circular sections** | | | | | | |
| Warping of Non-Circular Sections and St. Venant's Theory, Prandtl's Stress Function Approach, Torsion of Elliptical Sections, Torsion of Rolled Sections and Shear Flow. | CO3 | 1, 2, 12 | **2** | 1.3, 2.4, 12.2 | 1.3.1, 2.4.1, 12.2.2 | Chalk and Board, Blended Learning |
| **Unit 5*:* Plasticity** | | | | | | |
| Basic Equations, Similarities and Differences when Compared with Elasticity, Idealized Material Behaviour, Yielding, Fracture, Yield Criteria, Saint Venant's Theory, Tresca Criteria, Von Mises and Various Empirical Stress-Strain Relationships. | CO4 | 1, 2, 12 | **2** | 1.3, 2.4, 12.2 | 1.3.1, 2.4.1, 12.2.2 | Chalk and Board, Blended Learning |
| **Unit 6*:* Yield Criteria & Yield Surface** | | | | | | |
| Theories of Plastic Flow, Mohr-Coulomb Yield Criteria, Pi-Plane, Post Yield Stress Strain Behaviour, Plastic Stress Strain Relations, Prandtl Reuss Equation, Lavy-Mises Relation, Strain Hardening. | CO4 | 1, 2, 12 | **2** | 1.3, 2.4, 12.2 | 1.3.1, 2.4.1, 12.2.2 | Chalk and Board, Blended Learning |

**Text Books *:***


- Timoshenko, S., History of strength of materials: with a brief account of the history of theory of elasticity and theory of structures,

Courier Corporation, 1953
- Timoshenko, S. P., & Goodier, J. N., Theory of Elasticity, McGraw-Hill, New York, 1971.
- Sadhu Singh, "Theory of Elasticity", Khanna Publishers
- Sadhu Singh, "Applied Stress Analysis", Khanna Publishers

**Reference Books *:***

1. Srinath L.S., Advanced Mechanics of Solids, 10th print, Tata McGraw Hill Publishing Company, New Delhi, 1994.
2. Verma P.D.S, "Theory of Elasticity", Vikas Publishing Pvt. Ltd
3. Chenn W.P and Hendry D.J, "Plasticity for Structural Engineers", Springer Verlag
4. Valliappan C, "Continuum Mechanics Fundamentals", Oxford IBH Publishing Co.Ltd.
5. Xi Lu, "Theory of Elasticity", John Wiley
6. Ugural, A. C., & Fenster, S. K. (2003). Advanced strength and applied elasticity. Pearson education.
7. Boresi, A. P., Chong, K., & Lee, J. D., Elasticity in engineering mechanics. John Wiley & Sons, 2010
8. Lubliner, J., Plasticity theory. Courier Corporation, 2008.
9. Hill, R., The mathematical theory of plasticity (Vol. 11). Oxford university press, 1998
11 Shames, I. H., Mechanics of deformable solids, 1964.
12 Chakrabarty, J., Theory of plasticity, Butterworth-Heinemann, 2012.

**E-Resources *:***

***1.*** NPTEL

## 20PCI102D: Structural Dynamics

| Course Code : 20PCI102D | Course Title | Total credits: 3 |
|---|---|---|
| Teaching Scheme | Structural Dynamics | *Evaluation Scheme |
| Theory : 3 Hrs./Week | | CA: 20 Marks. |
| | | MT: 20Marks. |
| | | ET: 60Marks. |

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| **Course Objectives** | Course objectives are to:<br>1. Recall the fundamentals of vibrations of SDOF system.<br>2. Study damped and undampedsystem.<br>3. Learn the analysis of free and forced vibration of SDOF &MDOF system. |
| **Course Outcomes** | At the completion of this course, the student should able to:<br>1. Applyprinciples of dynamics to SDOF system.<br>2. Analyse response of SDOF systems undergeneral dynamic loading.<br>3. Calculate response of structures under different excitations for MDOF system.<br>4.Analyse structures fornatural frequency and modalanalysis for linear system.<br>5. Evaluate dynamic response using variousclassical approaches. |
| **Pre-requisites** | Newton's Third Law of Motion |
| **Course Type** | 1 – Program Core Course |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency Level | PI | Teaching Methodology |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **Unit 1: Single Degree of Freedom (SDoF) Systems** | | | | | | |
| Simple Structures, SDoF System, Force - Displacement Relation, Damping Force, Equation of Motion, External Force, Mass Spring Damper System Equation of Motion: Earthquake Excitation, Combining Static & Dynamic Responses, Methods of Solution of the Differential Equation Free Vibration: Un-damped & Viscously Damped Free Vibration, Energy in Free Vibration, Coulomb Damped Free Vibration Response to Harmonic & Periodic Excitations, Viscously Damped Systems, Systems with Non Viscous Damping. | CO1 | 1,2 | 2 | 1.3, 2.1, 2.3 | 1.3.1, 2.1.2, 2.3.2 | Chalk and Board, PPT & Blended Learning |
| **Unit 2: Single Degree of Freedom System under General Loading** | | | | | | |
| Response to Unit Impulse, Arbitrary Time Varying Force, Response to Step and Ramp Forces, Response to Pulse Excitations, Rectangular Pulse, Half Sine Wave Pulse, Triangular Pulse, Response to Ground Motion, Numerical Evaluation of Dynamic Responses Time Stepping Methods, Interpolation Methods, Newmark's Beta Method. | CO2 | 1,2 | 2 | 1.3, 2.1, 2.3 | 1.3.1, 2.1.2, 2.3.2 | Chalk and Board, PPT & Blended Learning |
| **Unit 3: Generalised Single Degree of Freedom System** | | | | | | |
| Generalised SDF Systems, Rigid Body Assemblages, Systems with Distributed Mass & Elasticity, Lumped Mass System, Natural Vibration Frequency by Rayleigh's method, Shape Functions. | CO2 | 1,2 | 2 | 1.3, 2.1, 2.3 | 1.3.1, 2.1.2, 2.3.2 | Chalk and Board, PPT & Blended Learning |
| **Unit 4: Multiple Degree of Freedom( MDoF) System** | | | | | | |
| Simple Systems, Two Storey Shear Buildings, General Approach for Linear Systems, Static condensation, Symmetric and Asymmetric systems subjected to Ground Motion, Symmetric Systems subjected to Torsional Excitations, Multiple Support Excitations, Methods for Solving Equations of Motion. | CO3 | 1,2 | 2 | 1.3, 2.1, 2.3 | 1.3.1, 2.1.2, 2.3.2 | Chalk and Board, PPT & Blended Learning |
| **Unit 5: Dynamic Analysis and Response of LinearSystems** | | | | | | |
| Systems without Damping, Natural Vibration Frequencies and Modes, Modal & Spectral Matrices, Orthogonality of Modes, Normalisation of Modes, Modal Expansion of Displacements, Free Vibration Response of Damped and Undamped andClassically Damped Systems, Damping in Structures, | CO4 | 1,2 | 2 | 1.3, 2.1, 2.3 | 1.3.1, 2.1.2, 2.3.2 | Chalk and Board, PPT & Blended Learning |

| | | | | | | |
|---|---|---|---|---|---|---|
| Classical Damping Matrix, Non Classical Damping Matrix, Two DoF Systems, Modal Analysis, Modal Response Contributions. | | | | | | |
| **Unit 6: Numerical Evaluation of Dynamic Response** | | | | | | |
| Time Stepping Method, Analysis of Linear and Non Linear Systems, Systems with Distributed Mass and Elasticity, Undamped motions due to Applied Forces, Undamped motion due to Support Excitation, Natural Vibration Frequencies and Modes, Modal Analysis of Forced Dynamic Response, Rayleigh Ritz Method, Formulation using Conservation of Energy, Virtual Work, Finite Difference Method, Finite Element Method, Element Degree of Freedom and Interpolation Functions, Element Stiffness, Mass and Force Matrix, Comparison of FE Solution with Exact Solution. | CO1, CO5 | 1,2 | 2 | 1.3, 2.1, 2.3 | 1.3.1, 2.1.2, 2.3.2 | Chalk and Board, PPT & Blended Learning |

**Text Books :**

1. Clough, R.W. &Penzin, J., "Dynamics of Structures", McGraw Hill,1993.
2. Humar, J.L., "Dynamics of Structures", Prentice Hall,1990.
3. Chopra, A.K., "Dynamics of Structures", Prentice Hall, 3rd Edition, NY, 1970.

**Reference Books**:

1. Mario, Paz, "Structural Dynamics", CBS Publ. N-Delhi,1995.
2. Timoshenko, S., "Advanced Dynamics", McGraw Hill Book Co,NY, 1948.
3. Meirovitch, L., "Elements of Vibration Analysis", 2nd Edition, McGraw Hill International Edition, Singapore,1986.
4. Biggs, J.M., "Introduction of Structural Dynamics", McGraw Hill, NY,

**E-Resources**:

1. NPTEL

# 20PCI103D: Advanced Structural Analysis

| | | |
|---|---|---|
| **Course Code : MSEPCC103** | **Advanced Structural Analysis** | **Total credits: 4** |
| **Teaching Scheme** | | ***Evaluation Scheme** |
| **Theory : 3 Hrs/week** | | **CA:20 Marks** |
| **Tutorial: 1 Hr/week** | | **MT:20 Marks** |
| | | **ET:60 Marks** |

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|---|---|
| **Course Objectives** | Course objectives are to:<br>1. Study the advanced methods of Structural analysis.<br>2. Understand the effect of temperature on various structures.<br>3. Study the analysis by approximate method.<br>4. Learn the Non Linear Analysis. |
| **Course Outcomes** | At the completion of this course, the student should able to,<br>1. Evaluate forces and displacements for special structures using flexibility & stiffness matrix method.<br>2. Analysisof indeterminate structures with temperature changes<br>3. Analyse the frame by portal frame method<br>4. Illustratenonlinearanalysis of structures. |
| **Pre-requisites** | Solid Mechanics, Structural Mechanics I, Structural Mechanics II |
| **Course Type** | ***1* – Program Core Course** |

## Course Contents

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Unit 1 :Unit 1 : Introduction to matrix methods of analysis** | | | | | | |
| Introduction to matrix methods of analysis – static indeterminacy and kinematic indeterminacy – degree of freedom – coordinate system – structure idealization stiffness and flexibility matrices – suitability element stiffness equations – elements flexibility equations – mixed force – displacement equations – for truss element, beam element. | CO 1 | PO 1<br>PO 2 | PSO 2 | 1.1<br>1.2<br>2.1 | 1.1.1<br>1.2.1<br>2.1.2 | Chalk and Board, Blended learning |
| **Unit 2 *:* Direct & Generalized Flexibility Matrix Method** | | | | | | |
| Principles of Virtual work,Basic concepts of flexibility and stiffnessmatrix method.Analysis of Flexibility Matrix methods by Direct & Generalized methods to, continuous Beams, Pin Jointed Frames, Rigid Jointed Frames, etc. | CO 1 | PO 1<br>PO 2 | PSO 2 | 1.1<br>1.2<br>2.1 | 1.1.1<br>1.2.1<br>2.1.2 | Chalk and Board, Blended learning |
| **Unit 3*:* Direct & Generalized Stiffness Matrix Method** | | | | | | |
| Assembly of stiffness matrix from element stiffness matrix – direct & generalized stiffness matrix method<br>Element approach, Equivalent loads, Applications to beams, frames and trusses, direct stiffness method. | CO 1 | PO 1<br>PO 2 | PSO 2 | 1.1<br>1.2<br>2.1 | 1.1.1<br>1.2.1<br>2.1.2 | Chalk and Board, Blended learning |
| **Unit 4 *:* Effect of Temperature changes and lack of fit:** | | | | | | |
| Indeterminate trusses with lack offit in indeterminate structures. Temperature effects inIndeterminate trusses, effects ofYielding of supports in theIndeterminate trusses. | CO 2 | PO 1<br>PO 2 | PSO 2 | 1.1<br>1.2<br>2.1 | 1.1.1<br>1.2.1<br>2.1.2 | Chalk and Board, Blended learning |
| **Unit 5: Approximate Methods of Analysis**: | | | | | | |
| Assumptions, Approximate Methods of Analysis of Multi storied Multi bay 2 – D rigid jointed frames by Portal Method. | CO 3 | PO 1<br>PO 2 | PSO 2 | 1.1<br>1.2<br>2.1 | 1.1.1<br>1.2.1<br>2.1.2 | Chalk and Board, Problem based learning Assignment |
| **Unit 6*:* Non Linear Analysis of structures.** | | | | | | |
| Geometric & materialistic Non-Linearity, Stiffness Method analysis of Geometric & materialistic Non-Linearity. | CO 4 | PO 1<br>PO 2 | PSO 2 | 1.1<br>1.2 | 1.1.1<br>1.2.1 | Chalk and Board, |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | 2.1 | 2.1.2 | Blended learning |

**Text Books**:

1. C S Reddy, “Basic Structural Analysis”, Tata McGraw-Hill Education, 2001.
2. Vazirani. V.N. & Ratwani M.M., “Advanced Theory of Structures”, Khanna Publishers, 2008.
3. Timoshenko. S. P. & Gere. J. M., “Theory of Elastic Stability”, Tata McGraw-Hill Publishing Company Limited. 2nd Edition, 1985.Gere.
4. J. M. & Weaver. W., “Matrix Analysis of Framed Structures” CBS Publishers and Distributor, 2nd Edition, 2004.

**Reference Books:**

1. G. S. Pandit, S. P. Gupta, Structural Analysis – A Matrix Approach, Tata Mc Graw Hill Publications.
2. Graves Smith -Linear Analysis of Frame works.

**E-Resources**:

1. www.nptel.ac.in

## 20PCI104E-A: Advanced Numerical Methods for Structural Engineers

| Course Code : 20PCI104E-A | Advanced Numerical Methods for Structural Engineers | Total credits: 03 |
|---|---|---|
| **Teaching Scheme** | | ***Evaluation Scheme** |
| **Theory : 3.Hrs/week** | | **CA: 20 Marks.** |
| **Tutorial: 1Hr/week** | | **MT: 20 Marks.** |
| | | **ET: 60 Marks.** |

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|---|---|
| **Course Objectives** | Course objectives are to:<br>1. Revise basic knowledge of mathematics and numerical methods.<br>2. Apply various methods of interpolation and fitting to given data.<br>3. Understand various methods of numerical integration especially Gaussian Integration methods.<br>4. Apply basic methods to solve differential equations.<br>5. Understand the methods applicable to structural engineering.<br>6. Use computational software line MATLAB / Scilab to for coding Numerical Methods. |
| **Course Outcomes** | At the end of the course, the student would be able to:<br>1. Enlist mathematical fundamentals applicable for numerical methods<br>2. Apply different techniques to various problems.<br>3. Use numerical integration methods for solving classically unsolvable integrals.<br>4. Solve differential equations using numerical and matrix based techniques<br>5. Apply numerical techniques for solving emergent problems in Structural Engineering |
| **Pre-requisites** | *Engineering Mathematics I – III, Numerical methods (UG)* |

| Course Type | 2 – Professional Elective course | | | | | |
|---|---|---|---|---|---|---|
| **Course Contents** | | | | | | |
| **Unit No.** | **CO Mapping** | **PO Mapping** | **PSO Mapping** | **Competency** | **PI** | **Teaching Methodology** |
| **Unit 1 : Need and mathematical foundations** | | | | | | |
| Introduction to numerical methods – need, data types, variable types, number systems, implications of data types on memory. Representation of numbers – significant digits, mantissa and exponent. Computing bits – suitability of computing system in terms of bits; Errors in computing – calculation, percentage error, truncations and corresponding errors in number systems. Vector spaces – elementary concepts of linear independence, basis, inner and outer products – relevance with vector algebra. Basic introduction to MATLAB. | CO1 | 1,2,5 | 1,2 | 1.1, 2.3, 5.3 | 1.1.1, 1.1.2, 2.3.1, 5.3.1 | Chalk and duster, coding on MATLAB / Scilab |
| **Unit 2: Root finding and matrix operations** | | | | | | |
| Need for root finding – connections with elementary calculus. Root finding approaches – bracketing and non-bracketing methods; intermediate value theorem - fixed point iteration – bisection – secant - regula-falsi – Newton-Raphson method. Matrices – orders, fundamental operations, vector spaces of matrices, determinants and inverses, solutions of linear algebraic equations. Solutions of linear and non-linear systems of equations – Gaussian elimination, Gauss – Jordan and Gauss – Siedel methods – suitability of methods with reference to the problem. Gradient descent method. Memory implications. Solution mechanisms for large banded and sparse matrices. Rank of the matrix. Singular value decomposition; eigen values and eigen vectors. Application of methods using MATLAB. | CO2 | 1,2,5 | 1,2 | 1.1, 2.1, 2.4, 5.3 | 1.1.1, 1.1.2, 2.1.3, 2.4.1, 5.3.1 | Chalk and duster, coding on MATLAB / Scilab |
| **Unit 3: Interpolation and Curve Fitting** | | | | | | |
| Discrete Data, Lagrange's and Newton's interpolating polynomials, polynomial behaviour and limitations of polynomial interpolation. Spline Interpolation. Regression - concept of least squares and application to curve fitting – | CO2 | 1,2,5 | 1,2 | 1.1, 2.1, 2.4, 5.3 | 1.1.1, 1.1.2, 2.1.3, 2.4.1, | Chalk and duster, coding on MATLAB |

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|---|---|---|---|---|---|---|
| fitting straight lines, quadratic curves and general mathematical model of the nth degree polynomial regression – exponential regression. Application of methods using MATLAB. | | | | | 5.3.1 | / Scilab |
| **Unit 4: Numerical integration** | | | | | | |
| Need for numerical integration methods; elementary numerical methods – trapezoidal rule, 1/3rd rule, Newton-Cotes' formulae – applicability to single interval and multiple intervals, advanced numerical methods – Gaussian quadrature – Legendre, Laguerre, Hermite and Chebyshev – roots and coefficients. Romberg's method. Illustrations of accuracy and performance analysis of the numerical integration methods. Application of methods using MATLAB. | CO3 | 1,2,5 | 1,2 | 1.1, 2.1, 2.4, 5.3 | 1.1.1, 1.1.2, 2.1.3, 2.4.1, 5.3.1 | Chalk and duster, coding on MATLAB / Scilab |
| **Unit 5: Differential Equations** | | | | | | |
| Need for differential equations – order and degrees of differential equations; Initial and boundary value problems (IVP and BVP) – relation between conditions and the nature of the problem. Euler method, Runge-Kutta Method – 2nd and 4th order. Generalised Runge-Kutta method, Bulrich-Stoer method, Adams-Bashforth method, Romberg's method for improving accuracy. Central difference method for solving differential equations. Solving differential equations with algebraic polynomials. Newmark's beta method, Wilson theta method. Application of methods using MATLAB. | CO4 | 1,2,3,5 | 1,2,3 | 1.1, 1.4, 2.1, 2.4, 3.3, 5.3 | 1.1.1, 1.1.2, 1.4.1, 2.1.3, 2.4.1, 3.3.1, 5.3.1 | Chalk and duster, coding on MATLAB / Scilab |
| **Unit 6: Modern aspects in Numerical Methods for Structural Engineering** | | | | | | |
| Symmetric matrix Eigen value Problem, Inverse power and power methods, Fourier transformation and identification of frequencies from structural health sensor data, or vibration data. | CO5 | 1,2,3,5 | 1,2,3 | 1.1, 1.4, 2.1, 2.3, 2.4, 3.3, 5.3 | 1.1.1, 1.1.2, 1.4.1, 2.1.3, 2.3.1, 2.4.1, 3.4.1, 5.3.1 | Chalk and duster, coding on MATLAB / Scilab |
| ***Text books**:*<br>1. E. Kreyzsig, Advanced Engineering Mathematics, Wiley.<br>2. S. Chapra and R. Canale, Numerical Methods for Engineers, McGraw Hill. | | | | | | |

***Reference books:***


1. S. D. Conte and C. deBoor, Elementary Numerical Analysis: an algorithmic approach, McGraw Hill
2. L. Ridgway Scott., Numerical Analysis, Princeton University Press

# 20PCI104E-B: Mechanics of Composite Materials

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|---|---|---|
| **Course Code : 20PCI104E -B** | **(Elective 1) B: Mechanics of Composite Materials** | **Total credits: 3** |
| **Teaching Scheme** | | **Evaluation Scheme** |
| **Theory : 3 Hrs/week** | | **CA:20 Marks.** |
| | | **MT:20 Marks** |
| | | **ET: 60 Marks.** |

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| **Course Objectives** | **Course objectives are to:**<br>1. Impart knowledge of composite materials in the context of structural engineering application.<br>2. Impart a skill of analysing macro and micro mechanical behaviour of composites.<br>3. Studythe manufacturing of composites and its failure theories. |
| **Course Outcomes** | On successful completion of the course, the student will be able to:<br>1. Define and classify the composite materials.<br>2. Analyse the macro-mechanical behaviour of composites.<br>3. Illustrate the micro – mechanical behaviour of lamina.<br>4. Interpret the classical composite laminate theory.<br>5. Explain Higher order Shear deformation theories. |
| **Pre-requisites** | Basic knowledge on material properties, Matrix Method of Structural Analysis and Mechanics of Deformable Bodies |
| **Course Type** | **Professional Elective course** |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency | P.I | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1: Introduction to Composite materials** | | | | | | |
| Introduction to Composite materials, classifications and civil/structural engineering applications. Constituent materials of composites – Reinforcements and matrix. Rule of mixture. Selection of materials. Basics of fibre reinforced composite (Synthetic and natural FR Polymer composites). Advantages and Limitations of composites. | CO1 | 1, 2, 12 | 2 | 1.3, 2.2, 12.2 | 1.3.1, 2.2.2, 12.2.2 | Chalk and Board, Blended Learning |
| **Unit 2: Introduction to Macro-mechanical Behaviour of a Lamina** | | | | | | |
| Introduction, Stress-Strain Relations For Anisotropic Materials. Stiffness's, compliances, and engineering constants for orthotropic materials. Restrictions on engineering constants. | CO2 | 1, 2, 12 | 2 | 1.3, 2.2, 12.2 | 1.3.1, 2.2.2, 12.2.2 | Chalk and Board, Blended Learning |
| **Unit 3: Macro-mechanical Stress Analysis of a Lamina** | | | | | | |

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|---|---|---|---|---|---|---|
| Stress-strain relations for plane stress in an orthotropic material. Stress-strain relations for a lamina of arbitrary orientation. Invariant properties of an orthotropic lamina. Strengths of an orthotropic lamina, thermal and mechanical stress analysis. | CO2 | 1, 2, 12 | 2 | 1.3, 2.2, 12.2 | 1.3.1, 2.2.2, 12.2.2 | Chalk and Board, Blended Learning |
| **Unit 4:Micro-mechanical behaviour of a lamina** | | | | | | |
| Introduction, mechanics of materials approach to stiffness. Determination of E1. Determination of E2. Determination of v12. Determination of G12. Numerical problems. | CO3 | 1, 2, 12 | 2 | 1.3, 2.2, 12.2 | 1.3.1, 2.2.2, 12.2.2 | Chalk and Board, Blended Learning |
| **Unit 5:Classical composite lamination theory** | | | | | | |
| Classical composite laminate theory, cross and angle – play laminates, symmetric, anti-symmetric and general symmetric laminates. Mechanical coupling. Analysis of simple laminated structural elements ply-stress and strain. | CO4 | 1, 2, 12 | 2 | 1.3, 2.2, 12.2 | 1.3.1, 2.2.2, 12.2.2 | Chalk and Board, Blended Learning |
| **Unit 6:Introduction to higher order shear deformation theories** | | | | | | |
| Introduction to First order Shear Deformation theory, parabolic shear deformation theory | CO5 | 1, 2, 12 | 2 | 1.3, 2.2, 12.2 | 1.3.1, 2.2.2, 12.2.2 | Chalk and Board, Blended Learning |

**Text Books:**

1. **J N Reddy** " Mechanics of **composite** Materials", CRC Press, 2003
2. **J N Reddy** " Mechanics of laminated **composite** plates", CRC Press, 2005

**Reference Books:**


1. M. Mukhopadhya "Mechanics of Composite Materials and Structures", Universities Press, 2009
2. Robart M. Jones, "Mechanics of Composite Materials"- CRC Press, 2006
3. Bhagwan D Agarvalm, and Lawrence J Brutman, "Analysis and Performance of Fiber Composites"- John Willy and Sons.
4. Autar K. Kaw, "Mechanics of Composite Materias", Second edition, CRC Press, 2006.

# 20PCI104E-C: Analysis and Design of Bridges

| Course Code :20PCI104E-C | Analysis and Design of Bridges | Total credits: 3 |
|---|---|---|
| Teaching Scheme | | Evaluation Scheme |
| Theory : 3 Hrs/week | | CA:20Marks |
| | | MT:20 Marks |
| | | ET:60 Marks |

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| **Course Objectives** | The objective of this course is to<br>1. Understand the planning, behaviour and loading of bridges<br>2. Learn the analysis and design of bridges with its various components |
| **Course Outcomes** | After the completion of the course the students will be able to:<br>1. Illustrate preliminary concepts of various types of bridges.<br>2. Describe the behaviour of various types of bridges under different loadings.<br>3. Analyse structural behaviour of various types of bridges.<br>4. Design bridge components like deck slab, piers and foundation.<br>5. Explain different construction methods of bridges. |
| **Pre-requisites** | Design of RCC Structures |
| **Course Type** | Professional Elective course |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency | P.I | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 : Introduction to Bridge Engineering** | | | | | | |
| Definition and Basic Forms, Components of bridge, classification of bridge, short history of bridge development, General Arrangement of Various Types of Bridges, Site selection-Soil Exploration for site Importance of Hydraulic factors in Bridge Design. General arrangement drawing. | CO1 | PO 1, PO 2 | PSO 2 | 1.3, 2.2 | 1.3.1, 2.2.2 | Chalk and Board, Blended Learning |
| **Unit 2 : Loading on Bridges** | | | | | | |
| Loading Standards for Roads and Railway Bridges as per IRC Standards and IRS Standards, Different type of loads acting on bridge. Analysis by Pieguad's and Courbon's Theory. | CO2 | PO 1, PO 2 | PSO 2 | 1.3, 2.2, 2.4 | 1.3.1, 2.2.2, 2.4.1 | Chalk and Board, Blended Learning |

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|---|---|---|---|---|---|---|
| **Unit 3 : Structural Behaviour of Various Bridges** | | | | | | |
| Structural behaviour of Box Girder Bridges, Arch Bridges, Suspension Bridges, Skew Bridges and Cable Stayed Bridges under various loads. | CO3 | PO 1, PO 2 | PSO 2 | 1.3, 2.2, 2.4 | 1.3.1, 2.2.2, 2.4.1 | Chalk and Board, Blended Learning |
| **Unit 4** : **Design of Bridge Decks** | | | | | | |
| Load Distribution in Slab and Bridge, Behaviour, Analysis and Design RC Deck Slab, Longitudinal and Cross Girders, Design of Long Span Bridge | CO4 | PO 1, PO 2, PO 3 | PSO 2 | 1.3, 2.2, 2.4, 3.4 | 1.3.1, 2.2.2, 2.4.1, 3.4.1 | Chalk and Board, Blended Learning |
| **Unit 5**: **Design of Sub structure and Foundation** | | | | | | |
| Design of Bearings, Design of Sub Structure and Foundations, Piers and Abutments, Foundations | CO4 | PO 1, PO 2, PO 3 | PSO 2 | 1.3, 2.2, 2.4, 3.4 | 1.3.1, 2.2.2, 2.4.1, 3.4.1 | Chalk and Board, Blended Learning |
| **Unit 6**: : **Construction Methods** | | | | | | |
| Modern Methods of Construction of Different type of Bridges, Case Studies. | CO5 | PO 1, PO 2, PO 12 | PSO 2 | 1.3, 2.2, 12.2, 12.3 | 1.3.1, 2.2.2, 12.2.2 , 12.3.1 | Chalk and Board, Blended Learning |

**Text Books :**


1. Chen, W. F., &Duan, L. (Eds.). (2014). Bridge Engineering Handbook: Construction and Maintenance. CRC press.
2. Fintel, M. (Ed.). (1974). Handbook of concrete engineering (p. 801). New York: Van Nostrand Reinhold.
3. Branco, F. A., & De Brito, J. (2004). Handbook of concrete bridge management.
4. Smith, J. W. (1994). Theory and design of bridges: by Petros P. Xanthakos, Wiley Interscience, New York, 1994, ISBN 0-471-57097-4.
5. Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Reinforced Concrete Structures, Vol. II, Laxmi Publications.

**Reference Books** :


1. Dr. V. K. Raina, Concrete Bridge Practice: Analysis, Design and Economics, Shroff Publishers & Distributors Pvt Ltd.,
2. Jagadish & Jayaram, Design of Concrete Bridges, Tata McGraw Hill. • Victor, Design of Concrete Bridges, Tata McGraw Hill.
3. N. Krishnaraju, Prestressed Concrete Bridges, CBS Publishers & Distributors Pvt. Ltd.
4. Ponnuswamy S., Bridge Engineering, Tata McGraw Hill.
5. Dr. V. K. Raina., Concrete Bridge Practice: Construction, Maintenance & Rehabilitation, Shroff Publishers & Distrib. Pvt Ltd.
6. Dr. V. K. Raina, Field Manual for Highway & Bridge Engineers, Shroff Publishers & Distributors Pvt Ltd.
7. Dr. V. K. Raina, Handbook for Concrete Bridges, Shroff Publishers & Distributors Pvt Ltd.
8. Victor D. J., Essentials of Bridge Engineering, Oxford & IDH
9. David Lee, Bridge Bearing and Expansion Joints.
10. Indian Road Congress Codes IRC-6,18,21,112
11. Indian Railway Bridge Codes & Manuals.
12. Indian Standard Codes (latest Versions) IS 456-2000, IS 1893-2002, IS 1343-2012


**E-Resources :**

1. NPTEL

# 20PCI105E-A: Structural Stability

| Course Code : 20PCI105E-A | Course Title | Total credits: 3 |
|---|---|---|
| Teaching Scheme | Structural Stability | *Evaluation Scheme |
| Theory : 3 Hrs/week | | CA : 20 Marks |
| | | MT : 20 Marks. |
| | | ET: 60 Marks. |

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| **Course Objectives** | Course objectives are to:<br>***1.*** Study critical loads for straight columns for different loading and end conditions**.**<br>***2.*** Learn the critical loads for discrete and continuous systems.<br>***3.*** Study the buckling of thin walled bars and lateral buckling of beams.<br>***4.*** Study the buckling of rectangular plates. |
| **Course Outcomes** | On completion of course, Students are able to:<br>***1.*** Determine critical loads for straight columns for different loading and end conditions**.**<br>***2.*** Evaluate the critical loads for discrete and continuous systems.<br>***3.*** Analyse the buckling of thin walled bars and lateral buckling of beams.<br>***4.*** Analyse the buckling of rectangular plates**.** |
| **Pre-requisites** | |
| **Course Type** | **1 – Elective Course** |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency Level | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 : Buckling of Columns** | | | | | | |
| Critical loads with different end conditions and loading - Inelastic buckling | CO 1 | 1, 2, 3, 12 | PSO 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.6, 12.3.2 | Presentation, Videos, Animation along with Chalk and Talk |
| **Unit 2 : Energy Methods** | | | | | | |
| Prismatic and non-prismatic columns under discrete and distributed loadings - General Principles of elastic stability of | CO 1 | 1, 2, 3, 12 | PSO 2 | 1.3, 2.1, | 1.3.1, 2.1.2, | Presentation, Videos, |

| | | | | | | |
|---|---|---|---|---|---|---|
| framed structures | | | | 3.1, 12.3 | 3.1.6, 12.3.2 | Animation along with Chalk and Talk |
| **Unit 3 : Mathematical Modelling** | | | | | | |
| Critical loads & Eigen value problem for discrete systems - Critical loads & Eigen value problem for continuous systems - Orthogonality relation - converting continuous problem to a discrete problem. | CO 2 | 1, 2, 3, 12 | PSO 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.6, 12.3.2 | Presentation, Videos, Animation Chalk and Talk |
| **Unit 4 : Buckling of Thin Walled Members** | | | | | | |
| Buckling of Thin Walled Members of Open Cross Section - Torsion of thin-walled bars - Warping - Non-uniform torsion - Torsional buckling under axial loading - Combined bending and torsion buckling. Lateral Buckling. | CO 3 | 1, 2, 3, 12 | PSO 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.6, 12.3.2 | Presentation, Videos, Animation Chalk and Talk |
| **Unit 5 : Lateral Buckling of Beams** | | | | | | |
| Beams under pure bending - I Beams under transverse loading - Energy methods. | CO 3 | 1, 2, 3, 12 | PSO 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.6, 12.3.2 | Presentation, Videos, Animation Chalk and Talk |
| **Unit 6 : Buckling of Rectangular Plates** | | | | | | |
| Buckling of Rectangular Plates with various boundary conditions Buckling of shells - Introduction to buckling of axially compressed cylindrical Shells. | CO 4 | 1, 2, 3, 12 | PSO 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.6, 12.3.2 | Presentation, Videos, Animation Chalk and Talk |

**Text Books :**


- S. Timoshenko and J Gere, "Theory of Elastic Stability", 2nd Edition, McGraw Hill Education; 2017.
- Stephen H. Crandall, "Engineering Analysis - A Survey of Numerical Procedures", Krieger Publishing Co., 1986.
- Bleich," Buckling of Metal Structures", McGraw Hill Book Co., New York, 1952.


**Reference Books :**


- Alexander Chajes, "Principles of Structural Stability Theory", Prentice Hall Inc., 1974.

- N.G.R Iyengar, “Structural Stability of Columns and Plates”, Ellis Horwood Ltd, 1988.
- A.H. Chilver, “Thin Walled Structures”, Chatto and Windus Ltd., 1967.
- Coxhl, “The Buckling of Plates and Shells”, H.L. Pergaman press, 1963.


**E-Resources :**

- NPTEL Videos

## 20PCI105E -B: Design of Prestressed Concrete Structures

| Course Code : 20PCI105E -B | Course Title: Design of Prestressed Concrete Structures | Total credits: 3 |
|---|---|---|
| Teaching Scheme | | Evaluation Scheme |
| Theory : 3 Hrs/week | | CA:20 Marks |
| | | MT:20 Marks |
| | | ET:60 Marks |

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|---|---|
| **Course Objectives** | This course objectives are to<br>1. Learn the principle of prestressing along with different methods and systems.<br>2. Learn the analysis and design of composite and statically indeterminate structures.<br>3. Study the analysis and design of prestressed concrete members.<br>4. Learn basic remedies for defects in various prestressed concrete members. |
| **Course Outcomes** | After the completion of the course the Students will be able to<br>1. Describe the preliminary conceptrelated to prestressed concrete.<br>2. Analyse and design composite section and various slabs.<br>3. Design the simple and indeterminate structures like continuous beams, portal frames, slabs and bridge girder<br>4. Analyse the Prestressed concrete member for flexural, shear strength and deflection.<br>5. Describe the causes and remedies for various defects in Prestressed concrete structure |
| **Pre-requisites** | Basic understanding of Structural Analysis, Design of RCC structures |
| **Course Type** | 1 – Professional Elective course |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 :Introduction to Prestressed Concrete** | | | | | | |
| Basic Principle of Prestressing, Methods and Systems of Prestressing, Material Requirements, Analysis of Rectangular, Symmetrical and Unsymmetrical, Flanged Beams, Concept of Cable Profile, Pressure Line, Thrust Lines, etc. | CO 1 | 1,2 | 1, 2 | 1.3, 2.2 | 1.3.1<br>2.2.3 | Chalk, Board & PPT, Blended learning |
| | | | | | | |

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|---|---|---|---|---|---|---|
| **Unit 2 :Composite Section** | | | | | | |
| Analysis and Design of Composite Construction of Prestressed and in-situ Concrete Structures, Design of One way and Two way Slab, Grid Slab. | CO 2 | 1,2,3 | 1, 2 | 1.3, 2.2, 3.1 | 1.3.1, 2.2.3, 3.1.4 | Chalk, Board & PPT, Blended learning |
| | | | | | | |
| **Unit 3 :Statically Indeterminate Structures** | | | | | | |
| Advantages and disadvantages of continuous PSC beams, Primary and secondary moments, P and C lines, Linear transformation, concordant and non-concordant cable profiles, Analysis of continuous beams. | CO 3 | 1,2,3 | 1, 2 | 1.3, 2.2, 3.1 | 1.3.1, 2.2.3, 3.1.4 | Chalk, Board & PPT, Blended learning |
| | | | | | | |
| **Unit 4 :Analysis and Design of PSC Members** | | | | | | |
| Analysis of PSC section for Flexural Strength, Shear Strength and Deflection, Design of Prestressed Concrete section for Flexural Strength by Analytical procedure and Magnel's Graphical method, Shear Strength and Deflection, Design of Statically Indeterminate Beams and Single Story Portal Frame, Concordant Cable Profile. | CO 4 | 1,2,3,8 | 1, 2 | 1.3, 2.2, 3.1,8.2 | 1.3.1, 2.2.3, 3.1.4 ,8.2.1 | Chalk, Board & PPT, Blended learning |
| | | | | | | |
| **Unit 5 :Slabs and Bridge Girders** | | | | | | |
| Design of simply supported pre-tensioned and post tensioned slabs and beams. Design of bridge girders as per IRC | CO 3 | 1,2,3,8 | 1, 2 | 1.3, 2.2, 3.1,8.2 | 1.3.1, 2.2.3, 3.1.4 ,8.2.1 | Chalk, Board & PPT, Blended learning |
| | | | | | | |
| **Unit 6 :Causes and Remedies of Various Defects in PSC** | | | | | | |
| Causes of various Defects in Prestressed Concrete like Cracking, Buckling, Deflection, Deterioration, Corrosion of Prestressing Steel, Concrete Crushing at End Anchorages, Grouting of Post Tensioned Tendons, Congested Connections, Dimensional Tolerances etc. and Remedial Measures | CO 5 | 1,2 | 1, 2 | 1.3, 2.2 | 1.3.1, 2.2.3 | Chalk, Board & PPT, Blended learning |

**Text Books :**


- Krishna Raju N, "Prestressed Concrete" , 4th Edition Tata McGraw Hill, New Delhi, 2000.
- R.I. Gilbert and N.C. Mickleborough, "Design of Prestressed Concrete" Unwin Hyman,
- Pandit and Gupta, "Prestressed concrete", CBS, 2002.

**Reference Books** :

10. T. Y. Lin & Nedbhurns, Design of Prestressed Concrete Structures, John Wiley & Sons
11. S.Ramamruthm, Pretsressed Concrete, Dhanpat Rai and Sons.
12. Sinha and Roy, Fundamentals of Prestressed Concrete, S. Chand Ltd.
13. N. Rajagopalan, Prestressed Concrete, Narosa Publishing House.
14. James R. Libby, Modern Prestressed Concrete, CBS Publishers & Distributors Pvt. Ltd.

**E-Resources** :

1. NPTEL

## 20PCI105E -C: Earthquake Resistant Design of Reinforced Concrete Buildings

| Course Code : 20PCI105E-C | EARTHQUAKE RESISTANT DESIGN OF REINFORCED CONCRETE BUILDINGS | Total credits: 03 |
|---|---|---|
| Teaching Scheme | | Evaluation Scheme |
| Theory : 3Hrs/week | | CA: 20 Marks. |
| | | MT: 20Marks. |
| | | ET: 60Marks. |

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| **Course Objectives** | The course objectives are to :<br>1. Give fundamentals of earthquake engineering and seismic conditions of the country and world.<br>2. Impart the knowledge on the seismology and behaviour of buildings during earthquakes.<br>3. Learn the analysis and design the earthquake resistant structures. |
| **Course Outcomes** | After completion of course students will be able to:<br>1. Apply fundamentals of earthquake engineering and seismicity conditions to the structures.<br>2. Apply the basic principles for seismic design and construction of structures in accordance with the IS Code provisions.<br>3. Analysis and Design for earthquake resistant RCC and Masonry structure.<br>4. Describe the Seismic analysis of structural and Non-structural elements.<br>***5.*** Apply the knowledge of ductility considerations in Earthquake Resistant Design. |
| **Pre-requisites** | Structural Dynamics, Structural Mechanics |
| **Course Type** | Professional Elective course |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency level | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| **UNIT-I Engineering Seismology** | | | | | | |
| Earthquake phenomenon cause of earthquakes. Faults, Plate tectonics Seismic waves. Terms associated with earthquakes**: ma**gnitude/Intensity of an earthquake scales, energy released. Earthquake measuring instruments**:** Seism scope, Seismograph, Accelerograph Characteristics of strong | CO1 | 1,5,12 | 2,3 | 1.3, 5.2, 12.2, 12.3 | 1.3.1, 5.2.2, 12.2.2, 12.3.2 | Chalk and Board, Blended learning, PPT |

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|---|---|---|---|---|---|---|
| ground motions, Seismic zones of India. | | | | | | |
| **UNIT – II : Conceptual design** | | | | | | |
| **Introduction:** Functional planning, Continuous load path, Overall form, simplicity and symmetry, elongated shapes, stiffness and strength, Horizontal and Vertical members, Twisting of buildings. **Ductility:** Definition-ductility relationships, flexible buildings, framing systems, choice of construction materials, unconfined concrete, confined concrete, masonry, reinforcing steel. **Introduction to earthquake resistant design:** Seismic design requirements, regular and irregular configurations basic assumptions, design earthquake loads, basic load combinations, permissible stresses, seismic methods of analysis, factors in seismic analysis, equivalent lateral force method, dynamic analysis response spectrum method, Time history method. | CO2, CO5 | 1,2,3,5,8 ,12 | 2,3 | 1.3, 2.2, 3.2, 5.2, 8.2, 12.2 | 1.3.1, 2.2.3, 3.2.1 5.2.2, 8.2.1, 12.2.2 | Chalk and Board, Blended learning, PPT |
| **UNIT – III : Reinforced Concrete Buildings** | | | | | | |
| Principles of earthquake resistant design of RC members, Structural models for framed buildings, Seismic methods of analysis. **Seismic Deign methods:** IS code based methods for seismic design, Seismic evaluation and retrofitting, Vertical irregularities, Plan configuration problems, Lateral load resisting systems, Determination of design lateral forces Equivalent lateral force procedure, Lateral distribution of base shear. | CO3 | 1,2, 3,5, 8,12 | 2,3 | 1.3, 2.2, 3.2, 5.2, 8.2, 12.2 | 1.3.1, 2.2.3, 3.2.1 5.2.2, 8.2.1, 12.2.2 | Chalk and Board, Blended learning, PPT |
| **UNIT-IV: Masonry Buildings:** | | | | | | |
| Introduction to elastic properties of masonry assemblage, Categories of masonry buildings. Behaviour of unreinforced and reinforced masonry walls, Behaviour of walls, Box action and bands, Behaviour of infill walls, Improving seismic behaviour of masonry buildings. Load combinations and permissible stresses, Seismic design requirements, Lateral load analysis of masonry buildings. | CO3 | 1,2,3,8,1 2 | 2,3 | 1.3, 2.2, 3.2, 8.2, 12.2 | 1.3.1, 2.2.3, 3.2.1 8.2.1, 12.2.2 | Chalk and Board, Blended learning, PPT |

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|---|---|---|---|---|---|---|
| **UNIT – V : Structural Walls and Non-Structural Elements** | | | | | | |
| **Structural walls:** Strategies in the location of structural walls, sectional shapes, variations in elevation, cantilever walls without openings.<br>**Non-Structural Elements:** Failure mechanism of non-structures, Effects of non-structural elements on structural system, Analysis of non-structural elements, Prevention of non-structural damage, Isolation of non-structures. | CO4 | 1, 2, 8,12 | 2,3 | 1.3, 2.2, 8.2, 12.2 | 1.3.1, 2.2.3, 8.2.1, 12.2.2 | Chalk and Board, PBL, Blended learning, PPT |
| **UNIT VI–Ductility Considerations in Earthquake Resistant Design of RC Buildings** | | | | | | |
| **Introduction:** Impact of ductility, Requirements for ductility, Assessment of ductility, Factors affecting ductility, ductile detailing considerations as per IS 13920. Behaviour of beams, columns and joints in RC buildings during earthquakes. Vulnerability of open ground storey and short columns during earthquakes.<br><br>**Capacity Based Design:** Introduction to Capacity Design, Capacity Design for Beams and Columns Case studies. | CO5 | 1,2, 3, 8,12 | 2,3 | 1.3, 2.2, 3.2, 8.2, 12.2 | 1.3.1, 2.2.3, 3.2.1 8.2.1, 12.2.2 | Chalk and Board, Blended learning, PPT |

***Text Books :***

1. Earthquake Resistant Design of Structures By Pankaj Agarwal & Manish Shrikhande,PHI Publications
2. Manish Shrikhande&Pankaj Agrawal; Earthquake Resistant Design of Structures, PHI Publication, New Delhi
3. S. K. Duggal; Earthquake Resistance Design of Structures; Oxford University Press, New Delhi
4. A. K. Chopra; Dynamics of Structures, Pearson, New Delhi
5. Clough &Penzin; Dynamics of Structures
6. Park &Pauly; Behavior of R.C Structures
7. John M. Biggs; Introduction to Structural Dynamics
8. S S Rao; Mechanical Vibration; Pearson, New Delhi

***Reference Books :***

1. IITK – GSDMA EQ 26 – V- 3.0 Design Examples of a Six Storey Building

2. Seismic Design of Reinforced Concrete and Masonry Building – T. Paulay and M.J.N. Priestly, John Wiley & Sons
3. Masory and Timber structures including earthquake Resistant Design – AnandS.Arya, Nemchand& Bros
4. Earthquake –Resistant Design of Masonry Building –MihaTomazevic, Imperial College Press.
5. Earthquake Tips – Learning Earthquake Design and Construction C. V. R. Murty
6. IITK-bmtpc, Earthquake Tips "Learning Earthquake Design and Construction" by C.V.R.Murthy, Building Material and Technology Promotion Council

***Reference Codes*:**

1. IS: 1893 (Part-1) -2002 and 2016. "Criteria for Earthquake Resistant – Design of structures." B.I.S., New Delhi.
2. IS: 4326-1993, "Earthquake Resistant Design and Construction of Building", Code of Practice B.I.S., New Delhi.
3. IS: 13920- 2016, "Ductile detailing of concrete structures subjected to seismic force" – Guidelines, B.I.S., New Delhi.
4. IS: 13828 (1993), Guide lines for Improving Earthquake Resistance of low Strength Masonry Buildings
5. IS: 13827 (1993), Improving Earthquake Resistance of Earthen Buildings

***E-Resources :***

1. NPTEL

# 20PCI106L: Structural Dynamics Lab

| Course Code: 20PCI106L | Course Title | Total credits: 1 |
|---|---|---|
| Execution Scheme | Structural Dynamics Lab | Evaluation Scheme |
| Practical : 2 Hrs/week | | CA: 25 Marks. |
| | | PR/OR : 25 Marks. |

| Lab outcomes | Students are able to,<br>1. Conduct the dynamic analysisof different storiedbuildings.<br>2. Evaluatethe suitability of vibrationIsolation system.<br>3. Analyse the seismic effects on various structures. |
|---|---|

**Course Cont*ents***

| Sr | Name Of Practical | CO Mapping | PO Mapping | PSO Mapping | Competency Level | PI | Methodology |
|---|---|---|---|---|---|---|---|
| The students are expected to perform any five experiments out of list given below and submit report of same; | | | | | | | |
| 1. | Dynamics of a three-storied building frame subjected to harmonic base motion | LO1 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |
| 2. | Dynamics of a one-storied building frame with planar asymmetry subjected to harmonic base motion | LO1 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |
| 3. | Dynamics of a three-storied building frame subjected to periodic (Non harmonic) base motion | LO1 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |
| 4. | Vibration isolation of a secondary system. | LO2 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |
| 5. | Dynamics of a vibration absorber. | LO2 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **6.** | Dynamics of a four-storied building frame with and without an open ground floor. | LO1 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |
| **7.** | Dynamics of one-span and two span beams | LO3 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |
| **8.** | Earthquake induced waves in rectangular water tanks. | LO3 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |
| **9.** | Dynamics of free-standing rigid bodies under base motions. | LO3 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |
| **10** | Seismic wave amplification, liquefaction and soil-structure Interactions | LO3 | 1,2,4,5 | 2 | 1.3, 2.2, 4.1, 5.1 | 1.3.1, 2.2.3, 4.1.3, 5.1.2 | Practical |

# 20PCI107L: Numerical Methods with MATLAB/Scilab

| Course Code: 20PCI107L | Course Title | Total credits: 1 |
|---|---|---|
| Teaching Scheme | Numerical Methods with MATLAB / Scilab | Evaluation Scheme |
| Practical : 2 Hrs/week | | TW: 25 Marks |
| | | Pr:25 Marks |

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|---|---|
| **Lab outcomes** | The student will be able to:<br>1. Understand the essentials of computational programming, generating outputs like graphs and symbolic computation<br>2. Perceive all problems based on numerical methods as matrix based.<br>3. Write simple scripts, functions and handles for solving numerical methods based problems. |

***Course Contents***

| Sr | Name Of Practical | Type/ Methodology | LO Mapping | PO Mapping | PSO Mapping | Competency | PI |
|---|---|---|---|---|---|---|---|
| *1.* | Essentials of computing – MATLAB, data types, graph plotting, function handles, symbolic computing techniques | On the computer | LO1,3 | 1,2, 5 | 1,2 | 1.1, 2.4, 5.1 | 1.1.1, 2.4.1, 5.1.1 |
| *2.* | Root finding with MATLAB – bracketing methods, non-bracketing methods, plotting rate of convergence for root for different methods. | On the computer | LO1,3 | 1,2, 5 | 1,2 | 1.1, 2.4, 5.1 | 1.1.1, 2.4.1, 5.1.1 |
| *3.* | Solving systems of equations – linear and non-linear, MATLAB functions for solving these systems, Eigen values and Eigen vectors. | On the computer | LO1,2, 3 | 1,2, 5 | 1,2 | 1.1, 2.4, 5.1 | 1.1.1, 2.4.1, 5.1.1 |
| *4* | Numerical differentiation and integration – better precision of derivatives, application of Trapezoidal rule, Simpson's rules. | On the computer | LO1,2, 3 | 1,2, 5 | 1,2 | 1.1, 2.4, 5.1 | 1.1.1, 2.4.1, 5.1.1 |
| *5* | Solving differential equations with MATLAB – Solving IVP – Euler | On the computer | LO1, 2, 3 | 1, 2, 5 | 1, 2 | 1.1, 2.4, 5.1 | 1.1.1, 2.4.1, |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | method, Runge – Kutta method, Adams – Bashforth method, plotting with different step sizes. | | | | | | 5.1.1 |
| *6* | Solving differential equations with MATLAB – Solving BVP – Central difference method – formulation and plotting | On the computer | LO1,2, 3 | 1, 2, 5 | 1, 2 | 1.1, 2.4, 5.1 | 1.1.1, 2.4.1, 5.1.1 |
| *7* | Fast Fourier Transforms – processing vibration data, identifying frequencies and plotting. | On the computer | LO1,2,3 | 1, 2, 5 | 1, 2 | 1.1, 1.3, 2.3, 2.4, 3.1, 3.4, 4.1, 4.3, 5.1, | 1.1.1, 1.3.1, 2.3.2, 2.4.1, 3.1.5, 3.4.2, 4.1.3, 4.3.2, 5.1.1 |
| *8* | Optimization techniques in Engineering – optimization of a truss, genetic algorithm based optimization with linear and non-linear constraints, multi-objective optimization problems, neural network programming | On the computer | LO1,2, 3 | 1, 2, 5 | 1, 2 | 1.1, 1.3, 2.3, 2.4, 3.1, 3.4, 4.1, 4.3, 5.1 | 1.1.1, 1.3.1, 2.3.2, 2.4.1, 3.1.5, 3.4.2, 4.1.3, 4.3.2, 5.1.1 |

## 20PCI201D: Theory of Plates and Shells

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|---|---|---|
| **Course Code :**20PCI201D | **Theory of Plates and Shells** | **Total credits: 4** |
| **Teaching Scheme** | | **Evaluation Scheme** |
| **Theory : 3 Hrs/week** | | **CA:20 Marks.** |
| **Tutorial: 1Hr/week** | | **MT:20Marks.** |
| | | **ET: 60 Marks.** |

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|---|---|
| **Course Objectives** | **Course Objective is to:**<br>1. Learn different methods of analysis and design of plates and shells,<br>2. Study behaviour of plates and shells under different loadings.<br>3. Learn evaluation of performance of various structures. |
| **Course Outcomes** | **After completion of this course, students are able to:**<br>1. Describe theories associated with plates and shells.<br>2.Analyse rectangular and circular plates under different loadings.<br>3Analyse the shell structures subjected to different loadings. |
| **Pre-requisites** | Strength of Materials and Mechanics of Deformable Bodies |
| **Course Type** | **Program Core Course** |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency Level | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| ***Unit 1:*** **Introduction to Plate Theory** | | | | | | |
| Small Deflection Theory of Thin Plate, Assumptions in Analysis of Thin Plates, Slope Curvature Relations, Moment - Curvature Relations, Stress Resultants, Governing Differential Equations for Bending of Plates, Various Boundary Conditions. | CO1 | 1,2, | 2 | 1.3<br>2.2 | 1.3.1,<br>2.2.2,<br>2.2.3, | Chalk and Board, Blended learning. |
| ***Unit 2:*** **Navier's and Levy's Solution** | | | | | | |
| Navier's and Levy's Solution Rectangular Plates Subjected to Uniformly Distributed Load, Sinusoidal Load for Different Boundary Conditions. | CO2 | 1,2, | 2 | 1.3<br>2.2 | 1.3.1,<br>2.2.2,<br>2.2.3, | Chalk and Board, Blended learning. |
| ***Unit 3:*** **Circular Plates** | | | | | | |
| Analysis of Circular Plates under Axis-Symmetric Loading, Moment Curvature Relations, Governing Differential Equation in Polar Co-Ordinates, Simply Supported and Fixed Edges, Distributed Load, Ring Load, a Plate with Hole at Centre. | CO2 | 1,2, | 2 | 1.3<br>2.2 | 1.3.1,<br>2.2.2,<br>2.2.3, | Chalk and Board, Blended learning. |
| ***Unit 4:*** **Introduction to Shell Structures** | | | | | | |

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|---|---|---|---|---|---|---|
| Classification of Shells on basis of Geometry, Thin Shell Theory, Equation of Shell Surfaces, Stress Resultants, Stress Displacement Relations | CO3 | 1,2, | 2 | 1.3<br>2.2 | 1.3.1,<br>2.2.2,<br>2.2.3, | Chalk and Board, Blended learning. |
| ***Unit 5:*** **Membrane Analysis of Shell Structures** | | | | | | |
| Equation of Equilibrium for Synclastic Shells, Solution for Shells Subjected to Self-Weight and Live Load, Cylindrical Shells - Equation of Equilibrium, Problems on Pipes Carrying Fluid/Liquid Under Pressure, Just Filled & Partly Filled. | CO3 | 1,2, | 2 | 1.3<br>2.2 | 1.3.1,<br>2.2.2,<br>2.2.3, | Chalk and Board, Blended learning. |
| ***Unit 6:*** **Bending of Cylindrical Shells** | | | | | | |
| Bending of Cylindrical Shells Symmetrically Loaded Circular Cylindrical Shells, Beam Theory, Finsterwalder's Theory, D.K.J. Theory- Donnell's Equation, Characteristic Equation, Schorer's Theory | CO3 | 1,2, | 2 | 1.3<br>2.2 | 1.3.1,<br>2.2.2,<br>2.2.3, | Chalk and Board, Blended learning. |

**Text Books *:***


1. S. Timoshenko and W. Krieger, "Theory of Plates and Shells", Mc GrAw Hill.
2. Reddy, J. N., "Theory and Analysis of Elastic Plates and Shells", Taylor & Francis.


**Reference Books *:***


1. Ansel C. Ugural, Stresses in Plates and Shells, Mc Graw Hill.
2. G. S Ramaswamy, Design and Construction of Concrete Shell Roofs, CBS Publications.
3. Chandrashekhara K., Analysis of Concrete Shells, New Age International Edition.
4. Chandrashekhara K., Analysis of Plates, New Age International Edition.


**E-Resources :**

NPTEL Course Material

## 20PCI202D: Finite Element Analysis

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|---|---|---|
| **Course Code : 20PCI202D** | **Finite Element Analysis for Structural Engineers** | **Total credits: 4** |
| **Teaching Scheme** | | **Evaluation Scheme** |
| **Theory : 3 .Hrs/week** | | **CA: 20 Marks** |
| **Tutorial: 1Hr/week** | | **MT: 20 Marks** |
| | | **ET: 60 Marks** |

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| **Course Objectives** | Course objectives are to:<br>1. Explain various methods of solving ODE and PDEs<br>2. Explain various methods of interpolation used and apply them to understand shape functions.<br>3. Identify various shape functions and therefore characteristics of 1D, 2D and 3D elements<br>4. Apply shape functions for the iso-parametric analysis of various elements.<br>5. Apply FEA for linear and non-linear analysis. |
| **Course Outcomes** | *After the completion of the course, the student would be able to*<br>1. Convert existing physical problems to 1D, 2D or 3D elements as applicable using mathematical modelling<br>2. Apply appropriate interpolation techniques to approximate the field values on a given domain.<br>3. Use linear and non-linear techniques to solve finite element based problems. |
| **Pre-requisites** | **Numerical Methods for Structural Engineers** |
| **Course Type** | **1 – Program Core Course** |

***Course Contents***

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency Levels | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 : Foundations of the finite element analysis** | | | | | | |
| Mathematical modelling of engineering problems – governing equations – analytical, physical, computation method – numerical modelling; introduction to finite element analysis (FEA) – applications, merits and demerits; approaches in FEA – direct, variational, energy, weighted residual. Solving BVPs – collocation method, least squares method, Galerkin's method, Rayleigh-Ritz method. Implementation of solving BVPs with MATLAB/Scilab. | CO1 | PO1, PO2, PO5 | PSO2 | 1.1, 2.4, 5.1 | 1.1.2, 2.4.1, 5.1.1 | Chalk & Duster, Computational examples on MATLAB/Scilab |
| **Unit 2: Interpolation methods used in the FEA** | | | | | | |
| Lagrange's method of interpolation, matrix methods for processing interpolation functions of one, two and three independent spatial variables. One dimensional, two | CO2 | PO1, PO2, PO5 | PSO2 | 1.1, 2.1, 2.4, 5.1 | 1.1.2, 2.1.3, 2.4.1, | Chalk & Duster, Computational examples on |

| | | | | | | |
|---|---|---|---|---|---|---|
| dimensional – triangular and rectangular elements; three dimensional elements – tetrahedral and prismatic elements with linear, quadratic and cubic interpolation functions, Lagrangian forms for the interpolation functions – in natural and cartesian coordinates, iso-parametric and serendipity elements. Euler – Lagrange equations, Variational operator. | | | | | 5.1.1, 5.1.2 | MATLAB/Scilab |
| **Unit 3: One dimensional FEA** | | | | | | |
| Formulation for the linear spring element, combination of springs, element equations by minimization of potential energy, calculation of nodal forces, bar element – combination of bars - truss element – plane local and global equations for a bar in the X – Y plane, space truss; beam element – review of beam theory and corresponding differential equation – finite element formulation; two node isoparametric formulation; numerical examples; solution through MATLAB/Scilab. | CO1 CO2 CO3 | PO1, PO2, PO3, PO4, PO5 | PSO2 | 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, 2.3, 2.4, 3.1, 4.1, 5.1 | 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.2.3, 2.3.1, 2.3.2, 3.1.6, 4.1.4, 5.1.1, 5.1.2 | Chalk & Duster, Computational examples on MATLAB/Scilab |
| **Unit 4: Two dimensional FEA** | | | | | | |
| Review of theory of elasticity and implications on two dimensional stress analysis; 3D equations applied to 2D analysis; CST element – plane stress and strain analyses, axisymmetric analysis, isoparametric formulations for 4 node plane elements. FE solution of PDE by method of weighted residuals, formulation based on variational principle. Solutions of problems using MATLAB/Scilab | CO1, CO2, CO3 | PO1, PO2, PO3, PO4, PO5 | PSO2 | 1.1, 1.2, 1.3, 1.4, 2.1, 2.3, 2.4, 3.1, 4.1, 5.1 | 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.3.2, 2.4.1, 3.1.6, 4.1.4, 5.1.1, 5.1.2 | Chalk & Duster, Computational examples on MATLAB/Scilab |
| **Unit 5: Three dimensional FEA** | | | | | | |
| Axisymmetric solids – Fourier coefficients, isoparametric formulation - non-axisymmetric loading - traction on edge, eight node isoparametric element. Numerical problems. Solution of problems using MATLAB/Scilab. | CO1, CO2, CO3 | PO1, PO2, PO3, PO4, PO5 | PSO2 | 1.1, 1.3, 1.4, 2.1, 2.2, 2.3, 2.4, 3.1, 4.1, 5.1, | 1.1.2, 1.3.1, 1.4.1, 2.1.2, 2.2.3, 2.3.1, 2.4.1, 3.1.6, 4.1.4, 5.1.1, | Chalk & Duster, Computational examples on MATLAB/Scilab |

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|---|---|---|---|---|---|---|
| | | | | | 5.1.2 | |
| **Unit 6: Non-linear FEA** | | | | | | |
| Dynamics with FEA – governing equations – examples; non-linear analysis – FE formulation, solution of non-linear equations. FEA software for structural engineering. | CO1, CO2, CO3 | PO1, PO2, PO3, PO4, PO5 | PSO2 | 1.1, 1.3, 1.4, 2.1, 2.2, 2.3, 2.4, 3.1, 4.1, 5.1 | 1.1.2, 1.3.1, 1.4.1, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 3.1.6, 4.1.4, 5.1.1, | Chalk & Duster, Software demonstrations |

**Text books**:


1. Desai, Y. M., Eldho, T. I., and Shah, A. H., Finite Element Method with Applications in Engineering, Pearson.
2. Bathe, K. J., Finite Element Procedures, Pearson.
3. Desai, C. S., and Abel, J. F., Introduction to the Finite Element Method: A numerical method for Engineering Analysis, CBS Publishers.
4. Logan, D. L., A first course in the Finite Element Method, 5th ed, CENGAGE Learning.
5. Ferreira, A. J. M., MATLAB codes for Finite Element Analysis: solids and structures, Springer.


**Reference books**:


1. Bhatti, M. A., Fundamental Finite Element Analysis and Application: with Mathematica and MATLAB computations, Wiley.
2. Bhatti, M. A., Advanced Topics in Finite Element Analysis of Structures: with Mathematica and MATLAB computations, Wiley.
3. Surana, K. S., and Reddy, J. N., The Finite Element Method for Initial Value Problems: Mathematics and Computations, CRC Press, Taylor and Francis.
4. Surana, K. S., and Reddy, J. N., The Finite Element Method for Boundary Value Problems: Mathematics and Computations, CRC Press, Taylor and Francis.


**Internet resources:**

1. K. J. Bathe, MIT Finite Element Procedures for Solids and Structures, MIT OCW, Youtube.
2. K. J. Bathe, MIT Non-linear Finite Element Analysis, MIT OCW, Youtube.

# 20PCI203D: Research Methodology

| Course Code : 20PCI203D | Research Methodology | Total credits: 3 |
|---|---|---|
| Teaching Scheme | | *Evaluation Scheme |
| Theory : 3 Hrs/week | | CA: 10 x 2 |
| Tutorial: None | | Midsem: 20 x 1 |
| | | Endsem: 60 x 1 |

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| **Course Objectives** | Course objectives are to:<br>1. Enrich the student about the various parts of a research activity<br>2. Enable the student to identify methods of sampling, data analysis and hypothesis testing based on the characteristics of the data<br>3. Educate the student about the skills and techniques of research writing with special emphasis on research proposals, research papers, and thesis reports.<br>4. Prepare the student to handle datasets using statistical analysis and graphical representation schemes. |
| **Course Outcomes** | *After completion of the course, the student would be able to:*<br>1. Define and explain various aspects of research – data collection, hypothesis testing, writing<br>2. Explain sampling design and design of experiments<br>3. Apply the methods of data processing and analysis<br>4. Identify the statistical tools for testing of hypothesis<br>5. Evaluate research articles, identify research gaps and prepare summaries<br>6. Use word-processing software, bibliographic databases and spreadsheets for data analysis and research writing. |
| **Pre-requisites** | |
| **Course Type** | **2 – Professional Elective course** |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 : Aspects of research** | | | | | | |
| Definition – objectives – motivation – approaches; criteria of good research; research problem – literature review – defining the research problem – techniques involved in defining a problem. Research design – need, features of a good design, concepts related to design, basic principles of experimental design | CO1 | PO2, PO3, PO4 | PSO2 | 2.1, 2.4, 3.1, 4.1, 4.2 | 2.1.1, 2.4.4, 3.1.3, 4.1.1, 4.1.2, 4.2.1, 4.2.2, | Chalk and duster, Slides, Blended Learning |
| *Unit 2: Data collection* | | | | | | |

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|---|---|---|---|---|---|---|
| Sampling design – random samples and numbers, sampling distributions of means – steps in sampling design, characteristics of good sample design – selecting a random sample – complex random sampling designs. Data collection methods – primary data, observation methods; collection of secondary data; selection of a method for data collection – design of experiments – completely randomized, randomized block, factorial experiments, Yates technique. | CO2 | PO2, PO4 | PSO2 | 2.3, 4.1, 4.3 | 2.3.1, 4.1.2, 4.3.1 | Chalk and duster, Slides, Blended Learning |
| **Unit 3: Data processing and analysis** | | | | | | |
| Measures of central tendency – mean, median and mode; measures of dispersion – mean deviation, standard deviation, variance, covariance, correlation, partial correlation, regression – linear regression, quadratic regression, exponential regression. Concepts of probability – laws of probability, conditional probability, Bayes' theorem; Frequency distributions, probability distributions – uniform, binomial, Poisson, normal and gaussian distributions, cumulative probability distribution; Fitting theoretical distribution to sample frequency. Data plotting and correspondence to the type of the data. | CO3 | PO2, PO4, PO5 | PSO2 | 2.3, 4.1, 4.3 | 2.3.1, 2.3.2, 4.1.2, 4.3.2, 4.3.3, 5.1.1 | Chalk and duster, Slides, Blended Learning |
| **Unit 4: Hypothesis testing** | | | | | | |
| Definition – procedure – different tests – important parametric test. Confidence and significance, P – values, Type I and Type II errors, The $\chi 2$ test – uses, steps, alternative formula, Yate's correction. t-test, z – test, applicability conditions, F – distribution, Analysis of Variance (ANOVA) – one way and two way, analysis of variance table, interpretation; Latin – square design, ANOCOVA, Non-parametric hypothesis testing – Mann-Whitney U test, Kruskal-Wallis H test, Runs test for randomness, Spearman's Rank correlation. Multivariate analysis – important techniques and their relevance – factor analysis methods – R and Q type factor analysis. Analysis using statistical software | CO4 | PO2, PO4, PO5 | PSO2 | 2.1, 4.1, 4.3 | 2.1.3, 4.1.2, 4.3.4 | Chalk and duster, Slides, Blended Learning |
| **Unit 5: Research writing** | | | | | | |
| Types of research writing – review, research article, research report, research proposal. Parts of research writing | CO5 | PO2, PO3, PO4, PO7, | PSO2 | 2.2, 2.3, 3.1, 3.3, 3.4, 4.1, | 2.2.2, 2.2.3, 2.2.4, 2.3.2, | Chalk and duster, Slides, |

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|---|---|---|---|---|---|---|
| – abstract, introduction and background, literature review, research problems or questions, materials and methods, data analysis results and discussion, conclusions and future scope. Summarising literature – illustration through exercise by reading papers, finding and pointing out research gaps or emerging areas. | | PO10 | | 4.3, 5.3, 7.1, 10.1 | 3.1.3, 3.3.1, 3.4.1, 4.1.2, 4.3.1, 5.3.1, 7.1.1, 7.1.2, 10.1.1, 10.1.2, 10.1.3, 10.2.1 | Computer demonstration, Blended Learning |
| **Unit 6: Computer based tools for research** | | | | | | |
| Word processing tools – page layout, content formatting, page numbering, section breaks; word processing software; Bibliographic database management tools – JabRef, Zotero, EndNote, Mendeley; Data analysis tools – R, Spreadsheet software, Charts, Graphs, Regression plots, Notebooks | CO6 | PO2, PO4, PO5, PO10 | PSO2 | 2.1, 4.3, 5.1, 10.3 | 2.1.1, 4.3.3, 4.3.4, 5.1.1, 10.3.1, 10.3.2, | Chalk and duster, Slides, Computer demonstration, Blended Learning |

***Text Books :***


1. Kothari, C. R., Research Methodology,
2. Spiegel, M. R. and Stephens, L. J., Theory and Problems of Statistics, 4th ed., Schaum's Outline Series, McGraw **Hill.**


***Reference books:***


1. Montgomery, D. C., Probability and applied statistics for Engineers, Wiley.
2. Ross, S. M. Introduction to Probability and Statistics from Engineers and Scientists, Elsevier.
3. Holtom, D. and Fisher, E., Enjoy writing your science thesis – a step by step guide to planning and writing dissertations and theses for undergraduate and graduate science students, Imperial College Press.


***Web resources:***

1. NPTEL, Introduction to research, IIT Madras
2. Caspo Fugin, Research Methodology Lectures, YouTube**.**

## 20PCI204E -A: Design of High Rise Structures

| | | |
|---|---|---|
| **Course Code :20PCI204E -A** | **Design of High rise structures** | **Total credits:3** |
| **Teaching Scheme** | | **Evaluation Scheme** |
| **Theory :3 Hrs/week** | | **Mid Sem:20 Marks** |
| | | **CT: 20 Marks.** |
| | | **ET: 60 Marks.** |

| | |
|---|---|
| **Course Objectives** | Course objectives are to<br>1. Learn the design loads for tall structures.<br>2. Study the structural systems and its behaviour.<br>3. Study the analysis and design of tall structures. |
| **Course Outcomes** | Students will be able to<br>1. Calculate the design loads for tall structures.<br>2. Interpret the behavior and analyze special structures and their components.<br>3. Analyse and Design the tall structures as per Indian standard Codes. |
| **Pre-requisites** | Basic understanding of Design of RCC structures |
| **Course Type** | 1 – Professional Elective course |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 *:* Design Loads** | | | | | | |
| Design Criteria: Design philosophy, loading, sequential loading, Gravity loading: Dead and live load, methods of live load reduction, Impact, Gravity loading, | CO 1 | 1,2 | 2 | 1.3,2.1 | 1.3.1, 2.1.2 | Chalk, Board &blended learning |
| **Unit 2 *:* Wind and Earthquake loading** | | | | | | |
| Wind loading: static and dynamic approach, Analytical and wind tunnel experimentation method. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading, working stress design, Limit state design, Plastic design. | CO 1 | 1,2 | 2 | 1.3,2.1 | 1.3.1, 2.1.2 | Chalk, Board &blended learning |
| **Unit 3 *:* Structural Systems and its Behaviour** | | | | | | |

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|---|---|---|---|---|---|---|
| Behavior of Various Structural Systems: Factors affecting growth, Height and structural form; High rise behaviour, Rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, Futigger – braced and hybrid mega system. | CO 2 | 1,2 | 2 | 1.3,2.1 | 1.3.1, 2.1.2 | Chalk, Board &blended learning |
| **Unit 4 *:* Analysis and Design of Tall building** | | | | | | |
| Approximate Analysis, Detail Analysis and Reduction Techniques, Analysis of Member Forces, Drift, and Twist, Buckling<br>Analysis, P-Delta Analysis, Translational and Torsional Instability, Design for Differential Movements, Creep and Shrinkage, Structural Control and Energy Dissipation Devices. | CO 3 | 1,2 | 2 | 1.3,2.1, | 1.3.1, 2.1.2 | Chalk, Board &blended learning |
| **Unit 5*:*Chimneys** | | | | | | |
| Design Factors, Thermal Stresses, Components, Platform and Safety Ladders, Steel Stacks, Refractory Linings, Caps and Foundations. | CO 3 | 1,2 | 2 | 1.3,2.1, | 1.3.1, 2.1.2 | Chalk, Board &blended learning |
| **Unit 6 :Cooling Towers** | | | | | | |
| Types, Components, Analysis and Design. | CO 3 | 1,2 | 2 | 1.3,2.1, | 1.3.1, 2.1.2 | Chalk, Board & blended learning |

**Text Books :**

1. T.Y Lin &D.Stotes Burry, "Structural concepts and system for Architects and Engineers"- John
2. Lynn S.Beedle, "Advances in Tall Buildings"- CBS Publishers and Distributors.
3. Dr. Y.P. Gupta – Editor, "Proceedings National Seminar on High Rise Structures-

**Reference Books *:***

1. Taranath B.S, "Structural Analysis and Design of Tall Buildings"- McGraw Hill
2. Wilf gang Schuller, "High rise building structures"- John Wiley
3. Bryan Stafford Smith &Alexcoull, "Tall building structures Analysis and Design"- John Wiley

***E*-Resources *:***

https://www.youtube.com/watch?v=TuK672TtW0U

https://nptel.ac.in

## 20PCI204E -B: Design of Blast Resistant Structures

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|---|---|---|
| Course Code : 20PCI204E -B | **Design of Blast Resistant Structures** | Total credits: 3 |
| Teaching Scheme | | *Evaluation Scheme |
| Theory : 3 Hrs/week | | CA : 20 Marks |
| | | MT : 20 Marks |
| | | ET: 60 Marks |

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|---|---|
| **Course Objectives** | Course objectives are to:<br>3. Determine loads due to blast on structures.<br>4. Illustrate the response of structures aginst blast loads using Single Degree of Freedom analysis.<br>5. Learn the requirements of structures to resist blast loads. |
| **Course Outcomes** | **After completion of course students are able to:**<br>1. Determine blast loads on structures**.**<br>2. Analyse response of structures to blast loads using Single Degree of Freedom analysis.<br>3. Design structures to resist blast loading. |
| **Pre-requisites** | |
| **Course Type** | **1 – Elective Course** |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency Level | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 : Introduction** | | | | | | |
| Introduction to explosion effects: Air-blast, Fragmentation, Stand-off distance vs. Explosive charge mass, Chemical explosives Classification, initiation, TNT-equivalence, blast wave parameters calculation Types of industrial explosions and loads: TNO method, Baker-Strehlow Tang method, equivalent TNT method. | CO 1 | 1, 2, 12 | PSO 2 | 1.3, 2.1, 12.3 | 1.3.1, 2.1.2, 12.3.2 | Chalk and Talk, Blended Learning |
| **Unit 2:Structure Load Interaction** | | | | | | |
| Blast load-structure interaction Contact / Near contact, close-in and far-field loading, Front face loading, blast clearing, stagnation pressure, Side wall and roof loading, Back face loading, Net | CO 1 | 1, 2, 12 | PSO 2 | 1.3, 2.1, 12.3 | 1.3.1, 2.1.2, 12.3.2 | Chalk and Talk, Blended Learning |

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|---|---|---|---|---|---|---|
| loading on structure, Ground Shock Material Response to High strain Rate loading. | | | | | | |
| **Unit 3:Dynamic behaviour of materials after Impact** | | | | | | |
| Dynamic behaviour of materials, Stress wave propagation, Reflection and Transmission of Stress waves, X-T Diagrams, Plastic Stress waves, Charpy Impact Test, Instrumented Drop Test, Split-Hopkinson Bar Test, Taylor Impact Test, Flyer Plate Test, Johnson Cook Material Constitutive Model. | CO 2 | 1, 2, 12 | PSO 2 | 1.3, 2.1, 12.3 | 1.3.1, 2.1.2, 12.3.2 | Chalk and Talk, Blended Learning |
| **Unit 4: Response Analysis of various Systems** | | | | | | |
| Single-degree-of-freedom analysis of structures: D'Alambert's principle, dynamic equation of motion, free and forced vibration, harmonic forced vibration, forced vibration to generalized loading, Duhamel integral, response to triangular loading (blast load). Equivalent SDOF analysis of structural elements and nonlinear systems, pressure-impulse diagrams for elastic system and elasto-plastic systems. | CO 2 | 1, 2, 12 | PSO 2 | 1.3, 2.1, 12.3 | 1.3.1, 2.1.2, 12.3.2 | Chalk and Talk, Blended Learning |
| **Unit 5: Design of Blast Resistant Elements** | | | | | | |
| Design/analysis of reinforced concrete elements subjected to blast loading: Concrete and steel reinforcement behaviour under high strain rates (DIF), Response limits. Design and analysis of structural steel elements subjected to blast loading: Structural steel behaviour under high strain rates (DIF), Structural steel section properties, Resistance function, Response limits. Design for Progressive Collapse: Code provisions for structural stability, Alternate path method, Redundancy requirements. | CO 3 | 1, 2, 3, 12 | PSO 2 | 1.3, 2.1, 3.1 12.3 | 1.3.1, 2.1.2, 3.1.1 12.3.2 | Chalk and Talk, Blended Learning |
| **Unit 6:Blast Resistant Window& Frames** | | | | | | |
| Blast Resistant Window Design: Introduction to glass design standards for blast (DoD, GSA, VA), analysis and Design of windows, frames and Mullions. Anti-terrorism design: Design Philosophy, Master Planning, Threat and Vulnerability assessment, Design Strategies, Construction of Blast Resistant Structures, Evaluation and Retrofitting of existing structures. | **CO 3** | 1, 2, 12 | PSO 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.1, 12.3.2 | Chalk and Talk, Blended Learning |

**Text Books :**

- J.M.Biggs, Introduction to Structural Dynamics, McGrawHill, 1964
- G.F. Kinney & K.J.Graham, Explosive Shocks in Air, 2nd Ed., Springer Science + Business Media New York, 1985.
- P.D.Smith, J.G.Hetherington, Blast and Ballistic Loading of Structures, Butterwoth & Heinemann, Elsevier, 2003, ISBN 0-7506-2024-2.
- Design of Blast Resistant Buildings in Petrochemical Facilities, 2nd Ed., ASCE Publication, 2010.

**Reference Books :**

- IS 4991 (1968): Criteria for blast resistant design of structures for explosions above ground.
- UFC 3-340-02: Structures To Resist The Effects Of Accidental Explosions, December 2008 Change 2, 1 September 2014.
- NAVFAC, Blast Resistant Structures, DESIGN MANUAL 2.08, DECEMBER 1986.
- General Services Administration (GSA), Alternate Path Analysis & Design Guidelines for Progressive Collapse Resistance, 2013.
- UFC 4-010-01: Minimum Anti-Terrorism Standards for Buildings**.**

**E-Resources :**

NPTEL Videos

## 20PCI204E -C: Structural Audit

| Course Code :20PCI204E - C | Structural audits | Total credits: 3 |
|---|---|---|
| Teaching SchemeMCS | | *Evaluation Scheme |
| Theory :4Hrs/week | | CA…20 Mark |
| Tutorial: ---- | | Midsem: 20 Mark |
| | | Endsem:60 Mark |

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| **Course Objectives** | Course objectives are to,<br>1. Study the methods for design of Structural Audit.<br>2. Understand evaluation of various structural Problems.<br>3. LearnStructural Audit methods, various NDT methods.<br>4. Understand retrofitting of structures& fire safety measures. |
| **Course Outcomes** | On successful completion of the course students will be able to,<br>1. Evaluate strength of existing structures.<br>2. Evaluate the damaged structures and implement different retrofitting techniques.<br>3. Maintain the concrete structures in the working and safe condition.<br>4. Be able to take the decision of dismantling the structure, if it is deteriorated beyond the repairing. |
| ***Pre-requisites*** | Knowledge of Advance Concrete Technology, Design of Structural Steel ,Design of RCC Structure & IS Codes and specifications: IS 456 2000,IS 800 2007, IS 875& BIS rules. |
| ***Course Type*** | ***Program Elective Course*** |

***Course Contents***

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency Level | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 : Introduction to Structural Audit** | | | | | | |
| Introduction to Structural Audit, Objectives, Bye-laws, Importance, and Various Stages involved, Visual inspection: scope, coverage, limitations, Factors to be keenly observed. | CO1, C02. | PO1, 2, 3, 12 | PSO2 | 1.3<br>2.1,<br>3.1,<br>12.2 | 1.3.1<br>2.1.2<br>3.4.2<br>12.2.1 | Chalk and Board, Blended Learning |
| **Unit 2: Structural Health Monitoring** | | | | | | |
| Structural Health, factors affecting health of structures, effect of | CO1,CO2,CO3 | PO1, 2, | PSO2 | 1.3 | 1.3.1 | Chalk and |

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|---|---|---|---|---|---|---|
| leakage, age, creep, corrosion, fatigue on life of structure.<br>Structural health monitoring. Various measures, regular maintenance, structural safety in alteration. Quality control &assurance of materials of structure, durability of concrete, Factorsaffecting durability of concrete, Corrosion in structures, Testingand prevention of corrosion. | | 3, 12 | | 2.1,<br>3.1,<br>12.2 | 2.1.2<br>3.1.3<br>12.2.2 | Board,<br>Blended<br>Learning |
| **Unit 3: Investigation of Structure** | | | | | | |
| Structural Audit, Assessment of health of structure, study of structural drawings, nature of distress, visual observations,<br>Collapse and investigation, limitations on investigator, tools for investigation, Various NDT Methods for assessing strength ofdistressed materials, investigation management, review of assimilated information, interviews and statements, evaluation and reporting. | CO1,CO2,CO3 | PO1, 2,<br>3, 5, 12 | PSO2 | 1.3<br>2.1,<br>3.1<br>4.1<br>5.2<br>12.3 | 1.3.1<br>2.1.3<br>3.1.4<br>4.3.1,<br>5.2.1,<br>12.3.2 | Chalk and<br>Board,<br>Blended<br>Learning |
| **Unit 4: Retrofitting Techniques** | | | | | | |
| Retrofitting of Structures, parameters for assessment for restoration strategies, selection of construction chemicals during<br>restoration, Specification for important items of work in restoration, Structural detailing for restoration and various<br>Techniques of retrofitting. | CO1, CO2,<br>CO3, CO4. | PO1, 2,<br>3, 12 | PSO2 | 1.3<br>2.1,<br>3.1,<br>12.2 | 1.3.1<br>2.1.3<br>3.1.4<br>12.2.2 | Chalk and<br>Board,<br>Blended<br>Learning |
| ***Unit 5***: **Formwork** | | | | | | |
| Safety during construction, formwork and staging, Modular formwork, Structural aspects for formwork in buildings & bridges. | CO1, CO2,<br>CO3, CO4. | PO1, 2,<br>3, 12 | PSO2 | 1.3<br>2.1,<br>3.1<br>12.2 | 1.3.1<br>2.1.3<br>3.1.4<br>12.2.2 | Chalk and<br>Board,<br>Blended<br>Learning |
| **Unit 6: Safety Measures** | | | | | | |
| Fire safety. Demolition of Structure, study of structural system and structural drawings, outline of various demolition methods andtheir evaluation, partial and controlled demolition, role of safety measures, temporary support structures in demolition. Recycling of demolished materials. | CO1,CO2,CO3 | PO1, 2,<br>3, 5, 12 | PSO2 | 1.3<br>2.1,<br>3.1<br>5.2<br>12.3 | 1.3.1<br>2.1.3<br>3.1.4<br>5.2.1,<br>12.3.2 | Chalk and<br>Board,<br>Blended<br>Learning |

**Text Books:**

1. R N. Raikar: 'Durable Structures', R & D Centre, (SDCPL), Raikar Bhavan, Sector 17, Vashi, Navi Mumbai.
2. R.N. Raikar: 'Learning from Failures', R & D Centre, (SDCPL), Raikar Bhavan, Sector 17, Vashi, Navi Mumbai.

3. R.N. Raikar: 'Diagnosis and treatment of structures in Distress', R & D Centre, (SDCPL), Raikar Bhavan, Sector 17, Vashi, Mumbai.

**Reference Books:**

1. Jayakumar, J. Shah: 'A Book – A Handy Guide to Repairs, Rehabilitation and Waterproofing of RCC Building (Structures)', Third updated photo-copy set.
2. Austin. C. K : 'Formwork to Concrete', Chapman and Hall
3. Mr. Umesh Dhargalkar 'Structural Audit', Mumbai..
4. Jayakumar J. Shah: 'An Article – Repairs & Rehabilitation of RCC Buildings(Structures) – Materials and Techniques', Published in March 2002 issue of NewBuilding Materials and Construction World, New Delhi.
5. Jayakumar J. Shah: 'An Article – Repairs, Rehabilitation of Structurally Distressed RCCMembers of Buildings', Published in July 2000 issue of Construction World, ASAP Media,Mumbai.
6. J. J. Shah: 'Point of View – Repair, Rehabilitation and Waterproofing of structures-SomeView', Published in April 1998 issue of The Indian Concrete Journal, Mumbai.36
7. Mani, K and Srinivasan, P.: 'An Article: Corrosion Damage and its Evaluation by Testing' inAdvanced Testing and Evaluation of Structures and Components, Allied Publishers,Chennai, 2002 pp 14.01 – 14.33.
8. Popovics, S and Popovics, J.S: 'An Article: A Critique of the Ultrasonic Pulse VelocityMethod for Testing Concrete' in Non-destructive Testing of Concrete Elements andStructures', ASCE, New York, 1992, pp 94-103.
9. Thandavamoorthy T.S. et al: 'Health Assessment of Concrete Structures by Ultrasonic pulseVelocity Technique an experimental Investigation in Building Materials', RRL Bhopal,February 26-27, 2004, pp. 284-89.

***E-Resources :***

1. NPTEL Videos

## 20PCI205E -A: Retrofitting of Structures

| Course Code : 20PCI205E -A | Course Title | Total credits: 3 |
|---|---|---|
| Teaching Scheme | Retrofitting of Structures | *Evaluation Scheme |
| Theory : 3 Hrs/week | | CA: 20 Marks. |
| Tutorial: 0 Hr/week | | MT: 20 Marks. |
| | | ET: 60 Marks. |

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| **Course Objectives** | Course obectives are to:<br>***1.*** Learn to estimate the causes for distress and deterioration of structures.<br>***2.*** Understand the NDT for condition assessment of structures, identify damages in RC structures.<br>***3.*** Study repair material and retrofitting strategy suitable for distress.<br>***4.*** Learn the guidelines for repair management of deteriorated structures. |
| **Course Outcomes** | After completion of course students are able to:<br>***1.*** Estimate the causes for distress and deterioration of structures.<br>***2.*** Apply the NDT for condition assessment of structures, identify damages in RC structures.<br>***3.*** Select repair material and retrofitting strategy suitable for distress.<br>***4.*** Formulate guidelines for repair management of deteriorated structures |
| ***Pre-requisites*** | |
| ***Course Type*** | ***1 – Elective Course*** |

***Course Contents***

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency Level | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| ***Unit 1 :Introduction to Retrofitting*** | | | | | | |
| Introduction - present repair practices, distress identification and repair management - Causes of distress in concrete structures-Holistic Models for deterioration of concrete, Permeability of concrete, aggressive chemical agents, durability aspects – Condition Survey- objectives, different stages-Preliminary inspection, planning stage, visual inspection, field laboratory testing stage, | CO 1 | 1, 2, 3, 12 | 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.1, 12.3.2 | Chalk and Talk, Blended Learning |

| | | | | | | |
|---|---|---|---|---|---|---|
| consideration for repair strategy – Non-Destructive evaluation tests- Rebound hammer test-Ultrasonic pulse velocity tests, penetration resistance, pull out tests, core sampling and testing. | | | | | | |
| ***Unit 2 :*Chemical Tests** | | | | | | |
| Chemical tests-Carbonation tests and chloride content, Corrosion potential assessment- cover meter survey, half-cell potentiometer test, resistivity measurement – Case studies of RCC buildings subjected to distress-Identification and estimation of damage - Fire damage assessment, structural integrity and soundness assessment, interpretation and evaluation of results. | CO 1 | 1, 2, 3, 12 | 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.1, 12.3.2 | Chalk and Talk, Blended Learning |
| **Unit 3**:**Evaluation of reserve strength of existing structures** | | | | | | |
| Evaluation of reserve strength of existing structures, active and passive repairs, modeling of repaired composite structures - Selection of repair materials for concrete-Essential parameters for repair materials-Strength and durability aspects, cost and suitability aspects. | CO 2 | 1, 2, 3, 12 | 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.1, 12.3.2 | Chalk and Talk, Blended Learning |
| **Unit 4:Materials for Repair** | | | | | | |
| Materials for repair-Premixed cement concrete and mortars, polymer modified mortars and concrete, epoxy and epoxy systems, polyester resins, coatings - Rehabilitation and retrofitting methods-repair options, performance requirements of repair systems, important factors to be considered for selection of repair methods | CO 3 | PO1, 2, 3, 12 | 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.1, 12.3.2 | Chalk and Talk, Blended Learning |
| ***Unit 5:*Repair Methods** | | | | | | |
| Identifying a suitable repair option for certain damage in a structure - Repair stages, Repair methods- guniting, shortcreting, polymer concrete system, reinforcement replacement, strengthening concrete by surface impregnation, polymer and epoxy overlays. | CO 3 | 1, 2, 3, 12 | 2 | 1.3, 2.1, 3.1, 12.3 | 1.3.1, 2.1.2, 3.1.1, 12.3.2 | Chalk and Talk, Blended Learning |
| ***Unit 6:*Advance Repair Methods** | | | | | | |
| Repair methods- Resin/polymer modified slurry injection, | CO 4 | 1, 2, | 2 | 1.3, | 1.3.1, | Chalk and |

| | | | | | | |
|---|---|---|---|---|---|---|
| plate bonding technique, ferrocement jacketing, RCC jacketing, propping and supporting - Repair methods- fiber wrap technique, foundation rehabilitation methods, chemical and electrochemical method of repair. | | 3,12 | | 2.1, 3.1, 12.3 | 2.1.2, 3.1.1, 12.3.2 | Talk, Blended Learning |

**Text Books** *:*

- R.N. Raikar, "Learning from failures - Deficiencies in Design, Construction and Service" Rand Centre (SDCPL), Aikar Bhavan, Bombay, 1987.
- Santhakumar A.R., "Concrete Technology" Oxford University Press, New Delhi, 2007.

**Reference Books** *:*

- "CPWD Handbook on Repair and Rehabilitation of RCC buildings", Govt of India Press, New Delhi, 2014.
- ACI Handbook on Repair and Rehabilitation of RCC buildings.
- ICI Handbook on Repair and Rehabilitation of RCC buildings

**E-Resources** *:*

- *NPTEL Videos*

## 20PCI205E -B: Advanced Design of Reinforced Concrete Structures

| Course Code : **20PCI205E -B** | Course Title: **Advanced Design of Reinforced Concrete Structures** | **Total credits: 3** |
|---|---|---|
| **Teaching Scheme** | | ***Evaluation Scheme** |
| **Theory : 3 Hrs/week** | | **CA: 20 Marks.** |
| **Tutorial: 1 Hr/week** | | **MT: 20Marks.** |
| | | **ET: 60 Marks.** |

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|---|---|
| **Course Objectives** | Course objectives are to<br>1. Learn design of advanced structures such as retaining walls.<br>2. Study the design the different types of piles and flat slabs as per Indian Standard codes.<br>3. Study the basic design concepts of water tanks, silos and bunkers. |
| **Course Outcomes** | After the completion of the Course, students will able to<br>1. Design retaining wallsas per Indian standard codes.<br>2. Design flat slab, raft foundation, pile foundation, chimneys, bunker and silos using limit state method.<br>3. Design the water tank using working stress method.<br>4. Design the Pre Stressed Concrete Members<br>5. Explain yield line theory of slab |
| **Pre-requisites** | **Design of R.C.C. Structures** |
| **Course Type** | ***1* – Program Core Course** |
| ***Course Contents*** | |

**Course Contents**

| **Unit No.** | **CO Mapping** | **PO Mapping** | **PSO Mapping** | **Competency** | **PI** | **Teaching Methodology** |
|---|---|---|---|---|---|---|
| **Unit *1* : Design of Retaining Walls** | | | | | | |
| Types of Retaining walls, forces, Stability, Structural Behaviour on the cantilever retaining walls and Counter fort Retaining walls.Design of retaining walls by IS 456:2000 code. | CO 1 | 1,3 | 2 | 1.3<br>3.1 | 1.3.1<br>3.1.2 | Chalk and Board, Blended learning |
| **Unit 2 :Design of Foundations** | | | | | | |
| Design of flat slabs, Design of raft and pile foundations; | CO 2 | 1,3 | 2 | 1.3 | 1.3.1 | Chalk and |

| | | | | | | |
|---|---|---|---|---|---|---|
| Design concepts and IS code provisions | | | | 3.1 | 3.1.2 | Board, Blended learning |
| **Unit 3*:* Design Of Chimney, Bunker and Silos** | | | | | | |
| Introduction, Janssen's theory, Airy's theory.Design of chimneys, Design of bunkers and silos; Design concepts and IS code provisions. | CO 2 | 1,3 | 2 | 1.3<br>3.1 | 1.3.1<br>3.1.2 | Chalk and Board, Blended learning |
| **Unit 4 *:* Design of Water Tank**s | | | | | | |
| Elevated Service Reservoirs: Rectangular, Circular. Design of staging for wind and earthquake forces, container with flat top and domed bottom. | CO 3 | 1,3 | 2 | 1.3<br>3.1 | 1.3.1<br>3.1.2 | Chalk and Board, Blended learning |
| **Unit 5:Design of Pre Stressed Concrete Members** | | | | | | |
| Design of Pretension and Post tension Flexural members: Design of partially Pre stressed concrete members. Pre stressed Concrete Slabs: Introduction, Design of one way, two way and flat slabs. | CO 4 | 1,3 | 2 | 1.3<br>3.1 | 1.3.1<br>3.1.2 | Chalk and Board, Blended learning |
| **Unit 6:Yield Line Theory of Slabs** | | | | | | |
| Introduction, Properties, Methods of analysis, Analysis of One way and two way slab. | CO 5 | 1,2 | 2 | 1.3, 2.1 | 1.3.1,<br>2.1.2 | Chalk and Board, Blended learning |

***Text Books :***

1. Matrix Analysis of Frames structures by William Weaver J.R and James M. Gere, CBS publications.
2. Advanced Structural Analysis by Ashok. K. Jain, Nem Chand Brothers.
3. B.C. Punmia, Ashok K. Jain, Arun K. Jain **–** ***Reinforced Concrete Structures*** Vol. II, Laxmi Publications, New Delhi Gere. J. M. & Weaver. W.
4. N.C. Sinha, S.K. Roy **–** ***Fundamentals of Reinforced Concrete***, S. Chand & Co. Ltd, New Delhi.
5. Ashok K. Jain, "***Reinforced Concrete, Limit State Design***", Nemchand and Brothers,

***Reference Books :***

1. Purushothaman. P. ***"Reinforced Concrete Structural Elements",*** Behavior, Analysis and Design. Tata McGraw Hill.
2. Pillai.S.V and Menon.D, ***"Reinforced Concrete Design",*** Tata McGraw Hill Book Co.
3. Park. R & Paulay. T, ***"Reinfroced Concrete Structures"***, John Wiley and Sons.
4. M.L.Gambhir, "***Design of Reinforced Concrete Structures*****,** PHI Pvt. Ltd, New Delhi,
5. Matrix Structural Analysis by Madhu B. Kanchi, John Willey publishers
6. Indeterminate Structural Analysis by K.U. Muthuet al., I.K. International Publishing House Pvt. Ltd.
7. Matrix Methods of Structural Analysis by J.L. Meek, Mc-Graw hill
8. IS456, SP16, SP34.

# 20PCI205E -C: Advanced Design of Steel Structures

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| **Course Code :20PCI205E -C** | **Advanced Design of Steel Structures** | **Total credits: 3** |
| **Teaching Scheme** | | **Evaluation Scheme** |
| **Theory :3Hrs/week** | | **CA: 20 Marks.** |
| | | **MT: 20 Marks.** |
| | | **ET:60 Marks.** |

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| **Course Objectives** | Course objectives are to:<br>1. Introduce method for design of steel structures with loading standards as per code provisions.<br>2. Expose students to analysis of and design of various steel structures.<br>3. Expose students to industrial steel structure design problems.<br>4. Expose students to solve steel design problems using software. |
| **Course Outcomes** | After completion of the course students will be able to:<br>1. Analyse and design knee braced trusses with and without gantry.<br>2. Identify the structural behaviour of Gable portal frames and components of steel factory shed.<br>3. Design of light gauge steel sections for structural members.<br>4. Design the plate girder railway bridges.<br>5. Design pre-engineered building components. |
| **Pre-requisites** | Knowledge of Design of Structural Steel & IS Codes and specifications: IS 800 2007, IS 875. |
| **Course Type** | ***Program Elective Course*** |

**Course Contents**

| Unit No. | CO Mapping | PO Mapping | PSO Mapping | Competency Level | PI | Teaching Methodology |
|---|---|---|---|---|---|---|
| **Unit 1 :Introduction to braces and Gantry** | | | | | | |
| Analysis and design of knee braced trussed bent with hinged, fixed and partially fixed bases without gantry. Design of knee brace, roof column and its base. Various types of column configurations in case of knee braced trussed bent with gantry loads. Design of stepped columns and bases under various load combinations. | CO1 | 1,2,3 | 2 | 1.3<br>2.1,<br>3.1 | 1.3.1<br>2.1.3<br>3.1.4 | Chalk and Board, Blended learning, Site Visit. |

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| **Unit 2: Gable Portal frames and brackets** | | | | | | |
| Analysis and design of gable portal frame with and without gantry loads. Design of bracket supporting gantry loads. | CO1, CO2 | 1,2,3 | 2 | 1.3 2.1, 3.1 | 1.3.1 2.1.3 3.1.4 | Chalk and Board, Blended learning, Site Visit. |
| **Unit 3:Industrial sheds and purlins** | | | | | | |
| Open web frames for industrial shed, trussed purlins, analysis and design of two storeyed building with truss roofing. | CO2 | 1,2,3 | 2 | 1.3 2.1, 3.1 | 1.3.1 2.1.3 3.1.4 | Chalk and Board, Blended learning, Site Visit. |
| **Unit 4:Design of light gauged components** | | | | | | |
| Design in light gauge steel –forms of light-gauge sections, local buckling of thin elements, multiple stiffened compression elements, axially loaded column, laterally supported beams. | CO3 | 1,2,3 | 2 | 1.3 2.1, 3.1 | 1.3.1 2.1.3 3.1.4 | Chalk and Board, Blended learning, Site Visit. |
| **Unit 5**: **Plate girder bridge** | | | | | | |
| Plate Girder Bridges - Types of floor systems, design of deck type plate Girder bridges for broad gauge railway, horizontal truss bracings and end cross frames. | CO4 | 1,2,3 | 2 | 1.3 2.1, 3.1 | 1.3.1 2.1.3 3.1.4 | Chalk and Board, Blended learning, Site Visit. |
| **Unit 6:PEB structures** | | | | | | |
| Types of trusses, Economical spacing, Arrangements of Purlin, Loading Calculations on truss and Purlin, Design of Purlin. For PEB Structures up to 20 Mt. Span. | CO5 | 1,2,3 | 2 | 1.3 2.1, 3.1 | 1.3.1 2.1.3 3.1.4 | Chalk and Board, Blended learning, Site Visit. |

***Text Books :***


1. Ramchandra – Design of Steel Structures Vol – II, Standard Book House, Delhi
2. A.S. Arya and J.L. Ajmani – Design of Steel Structures, Nemchand & Bros., Roorkee
3 T.R. Jagadeesh, M.A. Jayaram - Design of Bridge Structures, Prentice-Hall of India
4. N. Krishna Raju - Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

**Reference Books*:***


1. Ramchandra – Design of Steel Structures Vol – II, Standard Book House, Delhi
2. A.S. Arya and J.L. Ajmani – Design of Steel Structures, Nemchand & Bros., Roorkee
3. Teaching Resource for Structural Steel Design – INSDAG Kolkatta
4. IS: 800 – 1984 Code of Practice for General Construction in Steel
5. IS: 875 – 1964 Code of Practice for Structural Safety of Building: Loading Standards (Revised)
6. IS: 4137 – 1967 Code of practice for Heavy Duty electric Overhead Traveling Crane
7. Steel Designers Manual – ELBS
8. John E. Lotheres – Advanced Design in Structural Steel, Prentice Hall
9. D. Johnson Victor - Essentials of Bridge Engineering Fifth Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
10. IS: 800 – 1984 Code of Practice for General Construction in Steel
11. IS: 875 – 1964 Code of Practice for Structural Safety of Building: Loading Standards (Revised)
12. IS: 1915 – 1961 Code of Practice for Steel Bridges 15. IS: 800 – 2007 Code of Practice for General Construction in Steel 16. Comprehensive Design of Steel Structures, B.C.Punmia, A.K.Jain ,Laxmi Publications(P)Ltd,


**E-Resources *:***

1. NPTEL Videos

## 20PCI206L: Structural Analysis Design Laboratory

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| **Course Code:20PCI206L** | **Structural Analysis and Design Laboratory** | **Total credits: 01** |
| **Execution Scheme** | | **Evaluation Scheme: *Practical*** |
| **Practical : 2Hrs/week** | | **TW:25Marks.** |
| | | **PR:25Marks.** |

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| **Lab outcomes** | After completion of lab sessions, students are able to:<br>1. *A*pply the basics of ETAB and prepare a model structure in ETAB<br>2.Apply different types of loading conditions andanalyze the structural engineering problems using advance method of analysis.<br>3.Design different types of Structure, like RCC, Steeland Compositeand preparein prescribedformat, which can be executed on site. |

**Lab Contents**

| Sr. No. | Name of Practical | LO mapping | PO Mapping | PSO Mapping | Competency | PI | Type/ Methodology |
|---|---|---|---|---|---|---|---|
| 1. | Introduction of ETAB - | LO1 | 1,2,5 | PSO2 | 1.1,2.1,5.1 | 1.1.1,2.1.2, 2.1.3,5.1.1, 5.1.2 | Practical session on PC(Software) |
| 2. | ETABS “Screen” and Basic commands | LO1 | 1,2,5 | PSO2 | 1.1, 2.1, 5.1 | 1.1.1,2.1.2, 2.1.3,5.1.1, 5.1.2 | Practical session on PC(Software) |
| 3. | Create the Structural Model | LO1 | 1,2,5 | PSO2 | 1.1, 2.1, 5.1 | 1.1.1,2.1.2, 2.1.3,5.1.1, 5.1.2 | Practical session on PC(Software) |

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| 4. | Load the Structural Model | LO2 | 1,2,5 | PSO2 | 1.1,2.1,5.1 | 1.1.1,2.1.2, 2.1.3,5.1.1, 5.1.2 | Practical session on PC(Software) |
| 5. | Analysis of Structural Model | LO2 | 1,2,5 | PSO2 | 1.13,2.1,5.1 | 1.1.1,2.1.2, 2.1.3,5.1.1, 5.1.2 | Practical session on PC(Software) |
| 6. | Analysis and Design of simply supported, cantilever and Continuous Beam | LO3 | 1,2,5 | PSO2 | 1.1,2.1,5.1 | 1.1.1,2.1.2, 2.1.3,5.1.1, 5.1.2 | Practical session on PC(Software) |
| 7. | Analysis and Design of Reinforced Cement Concrete Frame | LO3 | 1,2,5 | PSO2 | 1.1,2.1,5.1 | 1.1.1,2.1.2, 2.1.3,5.1.1, 5.1.2 | Practical session on PC(Software) |
| ***8***. | Analysis and Design of Reinforced Cement Concrete building (G+1). | LO3 | 1,2,5 | PSO2 | 1.1,2.1,5.1 | 1.1.1,2.1.2, 2.1.3,5.1.1, 5.1.2 | Practical session on PC(Software) |
| 9. | Analysis and Design of Reinforced Cement Concrete building (G+10). | LO3 | 1,2,5 | PSO2 | 1.1,2.1,5.1 | 1.1.1,2.1.2, 2.1.3,5.1.1, 5.1.2 | Practical session on PC(Software) |
| 10. | Analysis and Design the RCC (G+10) building for Earthquake Loading. | LO3 | 1,2,5 | PSO2 | 1.1, 2.1, 5.1 | 1.1.1, 2.1.2, 2.1.3, 5.1.1, 5.1.2 | Practical session on PC(Software) |

## 20PCI207L: Advanced Concrete Technology Lab

| Course Code: 20PCI207L MSEELC207 | Course Title : Advanced Concrete Technology | Total credits: 1 |
|---|---|---|
| Execution Scheme : Practicals | Name of the Lab : Concrete Technology | Evaluation Scheme : TW : 25 Marks |
| Practical :02Hrs/week | | PR/Oral: 25 Marks |

| **Lab outcomes** | After completion of the Course, Students are able to,<br>1. Determine the properties of various constituent material of concrete.<br>2. Evaluate strength parameters of fresh & hardened concrete.<br>3.Demonstrate the applications of Non-destructive tests. |
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**Course Contents**

| Sr | Name Of Practical | LO mapping | PO Mapping | PSO Mapping | Competency | PI | Type/ Methodology |
|---|---|---|---|---|---|---|---|
| The students are expected to perform any five experiments out of list given below and submit report of same; | | | | | | | |
| 1. | Comparison of Experimental Study of ACI & IS methods of Concrete Mix proportioning. | LO 1 | 1,2,3 & 4 | 2 | 1.3<br>2.2<br>3.1<br>4.3 | 1.3.1<br>2.2.2<br>3.1.4<br>4.3.1 | Explanation & Execute the experiments on different machines, Blended Learning |
| 2. | Determination of Modulus of elasticity of concrete. | LO 2 | 1,2& 4 | 2 | 1.3<br>2.2<br>4.3 | 1.3.1<br>2.2.2<br>4.3.1 | Explanation & Execute the experiments on different machines |
| 3. | Determination of Permeability of concrete. | LO 2 | 1,2& 4 | 2 | 1.3<br>2.2<br>4.3 | 1.3.1<br>2.2.2<br>4.3.1 | Explanation & Execute the experiments on different machines |
| 4. | Determination of Tensile strength | LO 2 | 1,2& 4 | 2 | 1.3 | 1.3.1 | Explanation |

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|---|---|---|---|---|---|---|---|
| | ofconventional & fibre reinforced concrete. | | | | 2.2<br>4.3 | 2.2.2<br>4.3.1 | &Execute the experiments on different machines |
| 5. | Determination of Flexural strength of conventional & fibre reinforced concrete. | LO 2 | 1,2& 4 | 2 | 1.3<br>2.2<br>4.3 | 1.3.1<br>2.2.2<br>4.3.1 | Explanation & Execute the experiments on different machines |
| 6. | Determination of Compressive strength of conventional & fibre reinforced concrete. | LO 2 | 1,2& 4 | 2 | 1.3<br>2.2<br>4.3 | 1.3.1<br>2.2.2<br>4.3.1 | Explanation & Execute the experiments on different machines |
| 7. | Non-destructive testing (NDT ) of concrete including rebound hammer and ultrasonic pulse method. | LO 3 | 1,2& 4 | 2 | 1.3<br>2.2<br>4.3 | 1.3.1<br>2.2.2<br>4.3.1 | Explanation & Execute the experiments on different machines, Blended Learning |

## 20PCI208S: Seminar

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| **Course Code: 20PCI208S** | **Seminar** | **Total credits: 1** |
| **Execution Scheme : Presentation** | | **Evaluation Scheme :**<br>**TW : 25 Marks** |
| **Practical :02Hrs/week** | | |

**Guidelines for Seminar/Presentation:**

1. An individual student shall present Seminar on one of the current topics chosen in consultation with the guide.
2. Students should carry out detailed literature survey.
3. The concepts must be clearly understood and presented by the student.
4. All modern methods of presentation should be used by the student.
5. A hard copy of the report should be submitted before delivering the seminar.
6. A copy of the report in soft form must be submitted to the Supervisor along with other details, if any.
7. Presentation should be done infront of Guide, Examiner and faculty members.

## 20PCI301P -Project Stage-I

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| **Course Code: 20PCI301P** | **Project Stage-I** | **Total credits: 10** |
| **Execution Scheme : presentation** | | **Evaluation Scheme : TW : 50Marks** |
| **Practical :02Hrs/week** | | **PR:50 Marks** |

The student shall submit a brief report on the selected topic of his/her thesis work and attend fora formal viva-voce examination before a committee comprising the Chairman, BOS, Head of theDepartment and the Guide.It is expected from the student to carry out exhaustive literature survey with consultation of his/her Supervisor. Student should present the Synopsis Submission Presentation (SSP)with literature survey report to justify about the research gap, innovativeness, applicability, relevance and significance of the work

## 20PCI401P -Project Stage-II

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| **Course Code: 20PCI401P** | **Project Stage-II** | **Total credits: 20** |
| **Execution Scheme : presentation** | | **Evaluation Scheme : TW : 100Mks** |
| **Practical :02Hrs/week** | | **PR:100** |

The student shall submit his/her thesis work and attend for a formal viva-voce examinationbefore a Committee comprising the Chairman, BOS, Head of the Department, the Guide and theExternal Examiner.It is desirable that student presents/publishes the research paper in peer reviewedconference/research journals. If student is not showing satisfactory performance, then he/she will be given grace period of 4weeks. After 4 weeks student will be again evaluated with grade penalty.