Course Title	**ADVANCED DESIGN OF STEEL STRUCTURES**	Semester	II
Course Code	MVJ20CSE21	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/Week	4	**Total**	100
Credits	4	**Exam Duration**	3Hrs

Course objective is to: This course will enable the students to

- Understand the background to the design provisions for hot-rolled and cold-formed steel structures, including the main differences between them
- Design different types of structures and to detail the structures
- Proficiency in applying the provisions for design of columns, beams, beam-columns
- Design structural sections for adequate fire resistance

Module-1	**L3, L4, L5**	**12Hrs**

Prerequisites: *Knowledge in the fundamentals of Design of Steel Structures*

Laterally Unrestrained Beams: Lateral Buckling of Beams, Factors affecting lateral stability, IS 800 code provisions, Design Approach. Lateral buckling strength of Cantilever beams, continuous beams, beams with continuous and discrete lateral restraints, Mono- symmetric and non- uniform beams – Design Examples. Concepts of -Shear Center, Warping, Uniform and Non-Uniform torsion.

Laboratory Sessions/ Experimental learning:

- Analysing the failure of restrained beam due to Lateral Torsional Buckling
- Analysing the failure of unrestrained beam due to Lateral Torsional Buckling

Applications:

- Construction of Laterally restrained Beams to act Against Lateral Torsional Buckling
- Better Load withstanding Capability Utilizing Beam by application of load at Shear Centre

Video link / Additional online information:

- https://nptel.ac.in/courses/105105162/

Module-2	**L3, L4, L5**	**12Hrs**

Prerequisites: *Knowledge in the fundamentals of Design of Steel Structures*

Beam- Columns in Frames: Behaviour of Short and Long Beam - Columns, Effects of Slenderness Ratio and Axial Force on Modes of Failure, Biaxial bending, Strength of Beam Columns, Sway and

Non-Sway Frames, Strength and Stability of rigid jointed frames, Effective Length of Columns-, Methods in IS 800 - Examples.

Laboratory Sessions/ Experimental learning:

- Experimental investigation of Long & Short column against axial force, and Biaxial Bending.
- Determining strength of Columns in Sway and Non-sway frames.
- Determining strength of Rigid Jointed Frames.

Applications:

- Developing Long Beam to act against biaxial bending.
- Obtaining the beam of Better strength in rigid jointed Frames.

Video link / Additional online information:

- https://nptel.ac.in/content/storage2/courses/105105104/pdf/m7l17.pdf
- https://nptel.ac.in/content/storage2/courses/105105104/pdf/m10l27.pdf

Module-3	**L3, L4, L5**	**12Hrs**

Prerequisites: *Knowledge in the fundamentals of Design of Steel Structures*

Steel Beams with Web Openings: Shape of the web openings, practical guide lines, and Force distribution and failure patterns, Analysis of beams with perforated thin and thick webs, Design of laterally restrained castellated beams for given sectional properties, Vierendeel girders (design for given analysis results)

Laboratory Sessions/ Experimental learning:

- Determining the failure pattern of the steel beams with web openings.
- Analysis of Beam with perforated thin and thick webs.

Applications:

- Developing the beams with web openings with better strength.
- Developing the better properties of castelled beams and Vierendeel girders.

Video link / Additional online information:

- http://www2.ku.edu/~iri/publications/sm23a.pdf

Module-4	**L3, L4, L5**	**12Hrs**

Prerequisites: *Knowledge in the fundamentals of Design of Steel Structures*

Cold formed steel sections: Techniques and properties, Advantages, Typical profiles, Stiffened and unstiffened elements, Local buckling effects, effective section properties, IS 801& 811 code provisions- numerical examples, beam design, column design. Cavity walls, walls with piers.

Laboratory Sessions/ Experimental learning:

- Determining the strength of Steel section in Stiffened and Unstiffened Condition
- Determining the Buckling Strength of Steel sections

Applications:

- Utilizing the Stiffened section as better strength criteria compared to unstiffened sections
- Cold Formed Steel sections have wide uses do to its better strength Properties

Video link / Additional online information:

- https://nptel.ac.in/courses/105106113/
- https://nptel.ac.in/content/storage2/courses/105106113/5_cold_form_steel/10_examples.pdf

Module-5	**L3, L4, L5**	**12Hrs**

Prerequisites: *Knowledge in the fundamentals of Design of Steel Structures*

Fire resistance: Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members, Methods of fire protection, Fire resistance ratings- Numerical Examples.

Laboratory Sessions/ Experimental learning:

- Determining the strength of Steel section against Fire Resistance.
- Testing different Methods of Fire Resistance.

Applications:

- Using Different Methods of Fire Resistance members to increase the strength.
- Utilizing the steel structures with better fire resistance properties can be obtained.

Video link / Additional online information:

- https://nptel.ac.in/content/storage2/courses/downloads_new/105102176/noc18_ce30_ Assignment4.pdf
- https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/105102176/lec9.pdf

Course outcomes: On completion of the course, students would be able to

CO1	Achieve knowledge of design and development of problem solving skills.
CO2	Understand the principles of Structural Design
CO3	Design and develop analytical skills.
CO4	Summarize the principles of Structural Design and detailing
CO5	Understands the structural performance.

Reference Books:	
1.	N. Subramanian, "Design of Steel Structures", Oxford,IBH, 5th Edition 2015.
2.	Duggal.S.K., Design of Steel structures. 3rd Edition 2017.
3.	Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co ltd., New Delhi 3. IS 1641, 1642,1643
4.	IS 800: 2007, IS 811
5.	INSDAG Teaching Resource Chapter 11 to 20

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	-	-	-	-	1	-	1
CO2	3	3	3	2	-	-	-	-	-	1	-	1
CO3	3	3	1	1	-	-	-	-	-	1	-	1
CO4	3	1	-	-	-	-	-	-	-	-	-	1
CO5	3	2	-	-	-	-	-	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	**FINITE ELEMENT METHOD OF ANALYSIS**	Semester	II
Course Code	MVJ20CSE22	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 0 :20	**SEE**	50
No. of Contact Hours/Week	4	**Total**	100
Credits	4	**Exam Duration**	3Hrs

Course objective is to: This course will enable the students to

- Make students to learn fundamental theory of the Finite Element Analysis
- Generate the governing Finite Element equations for systems
- Develop the strain-displacement matrix and stiffness matrix
- Restate the Application of Finite Element Method

Module-1	**L3**	**12 Hrs**

Basic concepts of elasticity – Discretization, Kinematic and Static variables for various types of structural problems – approximate method of structural analysis – Rayleigh – Ritz method – Finite difference method – Finite element method. Variation method and minimization of Energy approach of element formulation. Principles of finite element method – advantages & disadvantages – Finite element procedure. Finite elements used for one, two & three dimensional problems – Element aspect ratio – mesh refinement vs. higher order elements – Numbering of nodes to minimize band width.

Laboratory Sessions/ Experimental learning:

- Solve a beam using Rayleigh-Ritz method

Applications:

- Numerical analysis on structures (Beams, Columns and so on)

Video link / Additional online information :

- Rayleigh - Ritz method - https://nptel.ac.in/courses/105/108/105108141/

Module-2	**L3, L4, L5**	**12 Hrs**

Nodal displacement parameters – Convergence criterion – Compatibility requirements – Geometric invariance – Shape function – Polynomial form of displacement function. Generalized and Natural coordinates – Lagrangian interpolation function – shape functions for one, two & three dimensional elements.

Laboratory Sessions/ Experimental learning:

- Derive shape function using all the methods and differentiate the methods.

Applications:

- Numerical analysis of structures (Beams, Columns and so on).

Video link / Additional online information:

- Shape functions - http://www.nptelvideos.in/2012/12/finite-element-method.html

Module-3	**L4, L5**	**12 Hrs**

Isoparametric elements, Internal nodes and higher order elements, Serendipity and Lagrangian family of Finite Elements, Sub-parametric and Super- parametric elements, Condensation of internal nodes, Jacobean transformation Matrix. Development of strain-displacement matrix and stiffness matrix, consistent load vector, numerical integration

Laboratory Sessions/ Experimental learning:

- Do a case study on any two commercial softwares and identify the elements incorporated in it.

Applications:

- Numerical analysis on structures

Video link / Additional online information:

- Isoparametric elements - https://nptel.ac.in/courses/105/105/105105041

Module-4	**L3, L4, L5**	**12 Hrs**

Application of Finite Element Method for the analysis of one & two dimensional problems, Analysis of simple beams and plane trusses, Application to plane stress / strain / axisymmetric problems using CST & Quadrilateral Elements

Laboratory Sessions/ Experimental learning:

- Do a case study on application of FEM in 1D, 2D beams and trusses.

Applications:

- Numerical analysis on structures

Video link / Additional online information:

- Beams and Trusses - https://nptel.ac.in/courses/105/105/105105041

Module-5	**L3, L4, L5**	**12 Hrs**

Application of Finite Element Method for the analysis of two dimensional and three dimensional frame elements, Techniques for Non – linear Analysis.

Laboratory Sessions/ Experimental learning:

- Model making of Plates and Shells to study its characteristics using FEM

Applications:

- Behavior of Plates and Shells using Numerical Analysis

Video link / Additional online information:

- Plates and Shells - https://nptel.ac.in/courses/105/105/105105041

Course outcomes: On completion of the course, students would be able to

CO1	Achieve knowledge on Discretization and Finite Difference Method
CO2	Restate the principles Shape Fucntion
CO3	Formulate strain-displacement matrix and stiffness matrix
CO4	Describe the Applications of Finite Element Method in 1D and 2D
CO5	Explain the Applications of Finite Element Method in 3D

Reference Books:

1.	Krishnamoorthy C S, "Finite Element Analysis"- Tata McGraw Hill 2nd Edition 2015.
2.	Desai C and Abel J F, "Introduction to the Finite Element Method"- East West Press Pvt. Ltd., 1972
3.	Bathe K J, "Finite Element Procedures in Engineering Analysis"- Prentice Hall 3rd Edition 2015.
4.	Rajasekaran. S, "Finite Element Analysis in Engineering Design"-Wheeler Publishing, 4th Edition 2013.
5.	Cook R D, Malkan D S & Plesta M.E, "Concepts and Application of Finite Element Analysis" - 3rd Edition, John Wiley and Sons Inc., 1989
6.	Shames I H and Dym C J, "Energy and Finite Element Methods in Structural Mechanics"- McGraw Hill, New York, 1985

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	-	-	-	-	1	-	1
CO2	3	2	1	3	-	-	3	-	-	1	-	1
CO3	3	3	1	1	-	-	3	-	-	1	-	1
CO4	3	1	-	-	-	3		2	-	-	-	1
CO5	3	2	-	-	-	3		1	-	-	-	1

High-3, Medium-2, Low-1

Course Title	**EARTHQUAKE RESISTANCE STRUCTURES**	Semester	II
Course Code	MVJ20CSE23	**CIE**	50
Total No. of Contact Hours	60 L: T : P :: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/week	4	**Total**	100
Credits	4	**Exam. Duration**	3Hrs

Course objective is to:

- The objective of this course is to make students to learn principles of engineering seismology.
- To design the reinforced concrete buildings for earthquake resistance.
- To evaluate the seismic response of the structures

Module-1	**L3**	**12Hrs.**

Introduction: Introduction to engineering seismology, Geological and tectonic features of India, Origin and propagation of seismic waves, characteristics of earthquake and its quantification – Magnitude and Intensity scales, seismic instruments. Earthquake Hazards in India, Earthquake Risk Evaluation and Mitigation. Structural behaviour under gravity and seismic loads, Lateral load resisting structural systems, Requirements of efficient earthquake resistant structural system, damping devises, base isolation systems.

Applications:

- Epicentral location , seismic zonation

Video link:

- https://nptel.ac.in/courses/105102016/

Module-2	**L3, L4, L5**	**12Hrs.**

The Response history and strong motion characteristics. Response Spectrum – elastic and inelastic response spectra, tripartite (D-V-A) response spectrum, use of response spectrum in earthquake resistant design. Computation of seismic forces in multi-storied buildings – using procedures (Equivalent lateral force and dynamic analysis) as per IS 1893–2016.

Video link:

- https://nptel.ac.in/courses/105102016/

Module-3	**L4, L5**	**12Hrs.**

Structural Configuration for earthquake resistant design, Concept of plan irregularities and vertical irregularities, Soft storey, Torsion in buildings. Design provisions for these in IS-1893. Effect of infill masonry walls on frames, modelling concepts of infill masonry walls. Behaviour of masonry buildings during earthquakes, failure patterns, strength of masonry in shear and flexure, Slenderness concept of masonry walls, concepts for earthquake resistant masonry buildings – codal provisions. Video link: • https://nptel.ac.in/courses/105102016/		
Module-4	**L4, L5**	**12Hrs.**
Design of Reinforced concrete buildings for earthquake resistance-Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS 1893–2016. Structural behavior, design and ductile detailing of shear walls. Video link: • https://nptel.ac.in/courses/105102016/		
Module-5	**L3, L5**	**12Hrs.**
Seismic response control concepts – Seismic demand, seismic capacity, Overview of linear and nonlinear procedures of seismic analysis, Static Push over analysis. Performance Based Seismic Engineering methodology, Seismic evaluation and retrofitting of structures. Video link: • https://nptel.ac.in/courses/105102016/		

Course outcomes:	
CO1	Understand the principles of engineering seismology
CO2	Apply the concept of Earthquake Resistant Design & concept of lateral load distribution on buildings.
CO3	To analyse earthquake characteristics and associated effects on structures, including linear responses
CO4	Understand the concepts of earthquake resistance of reinforced concrete buildings.
CO5	Understand the concepts of Seismic response control.

Reference Books:	
1.	Dynamics of Structures – Theory and Application to Earthquake Engineering- 2nd ed. – Anil K. Chopra, Pearson Education, 7th Edition 2018.
2.	Earthquake Resistant Design of Building Structures, Vinod Hosur, WILEY (india), 3rd Edition 2016.
3.	Earthquake Resistant Design of Structures, Duggal, Oxford University Press, 5th Edition 2017.
4	Earthquake resistant design of structures - Pankaj Agarwal, Manish Shrikande - PHI India , 4th Edition 2016.
5	Seismic Design of Reinforced Concrete and Masonry Buildings, T Paulay and M J N Priestley, John Wiley and Sons
6	Codal Provisions IS 1893–2016, IS 4928–1993, IS 13827–1992, IS: 13920–1997, IS: 13935–1993.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	-	-	-	-	-	1	-	1
CO2	3	3	1	2	3	-	-	-	-	1	-	1
CO3	3	3	2	1	-	3	3	2	-	1	-	1
CO4	3	1	-	-	-	3	3	2	1	2	-	1
CO5	3	2	-	3	-	3	1	1	3	1	-	1

High-3, Medium-2, Low-1

Course Title	**DESIGN OF CONCRETE BRIDGES**	Semester	II
Course Code	MVJ20CSE24	**CIE**	50
Total No. of Contact Hours	60 L: T: P:: 40 : 10 : 10	**SEE**	50
No. of Contact Hours/Week	4	**Total**	100
Credits	4	**Exam Duration**	3Hrs

Course objective is to: This course will enable the students to

- Make students to learn principles of bridge design
- Illustrate the various loads to be considered in bridge design.
- Design different types of bridge structures and to detail them using Limit State method of design.
- Evaluate performance of the Bridge structure.
- Design and understand bridge substructures.

Module-1	**L3**	**12 Hrs**

Introduction: Historical Developments, Site Selection for Bridges, Classification of Bridges, Forces on Bridges. Bridge substructures: Abutments, piers and wing walls. Economic span length-Types of loading-Dead load live load-Impact Effect-Centrifugal force-wind loads-Lateral loads-Longitudinal forces-Seismic loads Frictional resistance of expansion bearings-Secondary Stresses-Temperature Effect-Erection Forces and effects-Width of roadway and footway-General Design Requirements.

Experimental learning:

- To compare the codal provisions of limit state and working stress method.

Applications:

- Knowledge of loads is important in the design of any bridge structure.

Video link:

- https://www.youtube.com/watch?v=RB2k5hSYO3U&list=PL3MO67NH2XxJxMvfgAgdohx5-ksPZruA8

Module-2	**L3, L5**	**12 Hrs**

Box Culvert and Slab Culvert: Different Loading Cases IRC Class AA Tracked, Wheeled and Class A Loading, working out the worst combination of loading, Moment Distribution, Calculation of BM & SF, Structural Design of Slab Culvert, with Reinforcement Details. Specification for culverts as per

MORTH Specifications for Road and Bridge Works, IRC Publication.

Experimental learning:

- Analyse and design slab and box culvert using StaadPro/Csi bridges

Applications:

- In designing slab and box culverts as per codes.

Video link:

- https://www.youtube.com/watch?v=RX-WImcb73Y

Module-3	**L3, L5**	**12 Hrs**

Analysis and design of T-beam bridge:

Proportioning of components, analysis of slab using IRC Class AA tracked vehicle, structural design of slab, analysis of cross girder for dead load & IRC Class AA tracked vehicle, structural design of cross girder, analysis of main girder using Courbon's method, calculation of dead load BM and SF, calculation of live load B M & S F, Structural design of main girder. Guidelines per MORTH Specifications for Road and Bridge Works, IRC Publication

Experimental learning:

- Analyse and design T Beam bridge using StaadPro / Csi bridges

Applications:

- In designing T beam bridges as per codes.

Video link:

- https://www.youtube.com/watch?v=TDuvNevZwp0&list=PL8gfIRC-iTgkn-LsZf9VQoJtLd4FRhkpz&index=17

Module-4	**L3, L5**	**12 Hrs**

PSC Bridges: Introduction to Pre and Post Tensioning, Proportioning of Components, Analysis and Structural Design of Slab, Analysis of Main Girder using COURBON's Method for IRC Class AA tracked vehicle, Calculation of pre-stressing force, cable profile and calculation of stresses, Design of End block and detailing of main girder, Guidelines per MORTH Specifications for Road and Bridge Works, IRC Publication

Experimental learning:

- Analyse and design PSC bridge using StaadPro/Csi bridges

Applications:

- In designing PSC slab and PSC T beam bridges as per codes.

Video link:

- https://www.youtube.com/watch?v=e6h8wzM7pBU

Module-5	**L3, L5**	**12 Hrs**

Substructures and Balanced Cantilever Bridge:

Substructures - Design of Piers and abutments, Introduction to Bridge bearings, Hinges and Expansion joints. Specification for bearings as per MORTH Specifications for Road and Bridge Works, IRC Publication.

Balanced Cantilever Bridge: Introduction and proportioning of components, Design of simply supported portion and design of cantilever portion, design of articulation

Experimental learning:

- Study the feasibility of different types of bridge bearings.

Applications:

- For designing the substructure of any bridge structure.

Video link:

- https://www.youtube.com/watch?v=7nTdkPV_AAE

Course outcomes: On completion of the course, students would be able to

CO1	Describe historical growth, various forces acting on bridges and select ideal site for bridge.
CO2	Analyse and design box and slab culverts using limit state method of design.
CO3	Analyse and design T-beam bridges using limit state method of design.
CO4	Analyse and design psc slab bridge and T-beam bridge using limit state method of design.
CO5	Design piers and abutments and describe the proportioning of components of a Balanced Cantilever bridge.

Reference Books:

1.	Johnson Victor. D, "Essentials of Bridge Engineering", Oxford Publishing Company, 6th Edition, 2019.
2.	N Krishna Raju, "Design of Bridges, Oxford and IBH publishing company, 5th edition, 2019.
3.	T R Jagadeesh and M A Jayaram, "Design of bridge structures", Prentice Hall of India, 2nd Edition, 2009.
4.	Design of Concrete Bridges by M.G. Aswani, V.N. Vazirani and M.M. Ratwani, 8th Edition, 2014.
5.	IS: 456 – 2000 "Indian Standard Plain and Reinforced Concrete Code of Practice"- (Fourth

	Revision) BIS New Delhi.
6.	IS :1343 – 2012, “Indian Standard Prestressed Concrete Code of Practice”- BIS New Delhi.
7.	IRC:112-2019, “Code of Practice for Concrete Road Bridges”.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	1	1	-	-	2	1	1	1
CO2	3	3	2	2	3	2	1	1	1	1	-	1
CO3	3	3	2	2	3	2	1	1	1	1	-	1
CO4	3	3	2	2	3	2	1	1	1	1	-	1
CO5	3	3	2	2	3	2	1	1	1	1	-	1

High-3, Medium-2, Low-1

Course Title	**DESIGN OF PRECAST & COMPOSITE STRUCTURES**	Semester	II
Course Code	MVJ20CSE251	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/Week	3	**Total**	100
Credits	3	**Exam Duration**	3Hrs

Course objective is to: This course will enable the students to

- Learn principles of precast materials preparation
- Implement the Design of Precast Concepts.
- Evaluate different methods of Analysis of precast materials.

Module-1	**L3, L4**	**12 Hrs**

Concepts, components, Structural Systems and Design of precast concrete floors: Need and types of precast construction, Modular coordination, Precast elements-Floor, Beams, Columns and walls. Structural Systems and connections.

Design of precast Concrete Floors: Theoretical and Design Examples of Hollow core slabs. Precast Concrete Planks, floor with composite toppings with and without props.

Laboratory Sessions/ Experimental learning:

- Experiments on the Seismic Performance of Hollow-Core Floor Systems in Precast Concrete Buildings.

Applications:

- Understanding the scope of the subject.
- Understanding the design and Construction of Composite Slab.

Video link / Additional online information:

- https://www.youtube.com/watch?v=Jr43y9WYxkI

Module-2	**L3, L4**	**12 Hrs**

Design of precast reinforced and prestressed Concrete beams: Theoretical and Design Examples of ITB –Full section precast, Semi Precast, propped and un propped conditions. Design of RC Nibs.

Laboratory Sessions/ Experimental learning:

- Testing of precast beams for behaviour of concrete

Applications:

- Understanding the design and construction of precast reinforced and prestressed concrete beams.

Video link / Additional online information:

- https://www.youtube.com/watch?v=pjwrXLWhISE

Module-3	**L3**	**12 Hrs**

Design of precast concrete columns and walls: Design of braced and unbraced columns with corbels subjected to pattern and full loading. Design of Corbels. Design of RC walls subjected to Vertical, Horizontal loads and moments, Design of vertical ties and horizontal joints.

Laboratory Sessions/ Experimental learning:

- Experimental testing of precast concrete panel connections.

Applications:

- Knowledge about the design and Construction of precast concrete columns and walls

Module-4	**L3**	**12 Hrs**

Design of Precast Connections and Structural Integrity: Beam bearing, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties.

Laboratory Sessions/ Experimental learning:

- Experimental Investigation on Precast Wall Connections

Applications:

- Obtaining the structure with better connection to withstand loads.

Video link / Additional online information (related to module if any):

- https://www.youtube.com/watch?v=uiQzx1YFOBs

Module-5	**L4**	**12 Hrs**

Design of Steel Concrete Composite Floors and Beams Composite Floors: Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, Design Example Composite Beams: Elastic Behavior, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams.

Laboratory Sessions/ Experimental learning:

- Experimental Investigation on Steel Concrete Composite Floor Slab – Field visit

Applications:

- Knowledge about composite material and construction
- Design of steel concrete composite floors and beams can be done.
- Behavior of precast composite structures against loads.

Video link / Additional online information:

- https://nptel.ac.in/courses/105/108/105108124/

Course outcomes: On completion of the course, students would be able to

CO1	Achieve knowledge of design and development of problem solving skills.
CO2	Understand the principles of precast elements.
CO3	Design and develop analytical skills.
CO4	Summarize on precast concrete connection details
CO5	Understand the concepts of prestressed elements.

Reference Books:

1.	Structural Precast Concrete Handbook, CIDB, Singapore, 7th Edition 2017.
2.	INSDAG Teaching Resource Chapter 21 to 24: www.steel-insdag.org
3.	IS 15916 (2011): Building Design and Erection Using Prefabricated Concrete -Code of Practice [CED 51: Planning, Housing and pre-fabricated construction]
4.	IS 1343-2012, IS 456-2000, IS 800-20075.
5.	IS 11384 (1985):Code of Practice for Composite Construction in Structural Steel and Concrete [CED 38: Special Structures]

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	-	-	-	-	-	1	-	1
CO2	3	1	2	3	-	-	-	-	-	1	-	1
CO3	3	3	3	3	-	3	3	2	-	1	-	1
CO4	3	1	-	-	-	3	3	2	-	-	-	1
CO5	3	2	-	-	-	3	1	1	-	-	-	1

High-3, Medium-2, Low-1

Course Title	**DESIGN OF SUBSTRUCTURES**	Semester	II
Course Code	MVJ20CSE252	**CIE**	50
Total No. of Contact Hours	60 L: T: P:: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/week	3	**Total**	100
Credits	3	**Exam. Duration**	3

Course objective is to: This course will enable the students to

- Learn principles of subsoil exploration
- Design the sub structures
- Evaluate the soil shear strength parameters
- Design of deep foundation
- Design of well foundation

Module-1	**L4**	**12Hrs.**

Pre requisites: *Geotechnical Engineering*

Introduction, Site investigation, In-situ testing of soils, Subsoil exploration, Classification of foundations systems. General requirement of foundations, Selection of foundations, Computations of Loads, Design concepts.

Laboratory Sessions/ Experimental learning:

- Basic testing of soil

Applications:

- Practical procedure for extraction of soil sample and laboratory testing

Video link / Additional online information:

- https://nptel.ac.in/courses/105105168/
- https://www.youtube.com/watch?v=f1K-918AxrY

Module-2	**L3,L5**	**12Hrs.**

Concept of soil shear strength parameters, Settlement analysis of footings, Shallow foundations in clay, Shallow foundation in sand & C-Φ soils, Footings on layered soils and sloping ground, Design for Eccentric or Moment Loads.

Laboratory Sessions/ Experimental learning:

- Model making different types of rafts

Applications:

- Design of raft foundation

Video link / Additional online information:

- https://nptel.ac.in/courses/105104162/

Module-3	L3,L4	12Hrs.

Types of rafts, bearing capacity & settlements of raft foundation, Rigid methods, Flexible methods, soil structure interaction, different methods of modeling the soil. Combined footings (rectangular & trapezoidal), strap footings & wall footings, Raft – super structure interaction effects & general concepts of structural design, Basement slabs, Machine foundation.

Laboratory Sessions/ Experimental learning:

- Model making different types of caissons

Applications:

- Calculation of bearing capacity of raft foundation

Video link / Additional online information:

- https://www.youtube.com/watch?v=xytmHFEuUQM

Module-4	L3,L4	12Hrs.

Deep Foundations: Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different types of piles in different soil conditions, Laterally loaded piles, tension piles & batter piles, Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles, Proportioning and design concepts of piles.

Laboratory Sessions/ Experimental learning:

- Testing on load distribution between piles in Deep Foundations

Applications:

- Design of deep foundation

Video link / Additional online information:

- https://www.youtube.com/watch?v=SZefeLiaiIE

Module-5	L3,L4	12Hrs.

Types of caissons, Analysis of well foundations, Design principles, Well construction and sinking. Foundations for tower structures: Introduction, Forces on tower foundations, Selection of foundation type, Stability and design considerations, Ring foundations – general concepts

Laboratory Sessions/ Experimental learning:

- Preparing checklist for selection of type of foundation

Applications:

- Design concepts of well foundation

Video link / Additional online information:

- https://www.youtube.com/watch?v=2T9s5i21yCs

Course outcomes: On completion of the course, students would be able to	
CO1	Achieve Knowledge of design and development of problem solving skills.
CO2	Understand the principles of subsoil exploration
CO3	Design and develop analytical skills.
CO4	Identify and evaluate the soil shear strength parameters.
CO5	Understand the concepts of Settlement analysis.

Reference Books:	
1.	J.E. Bowles – "Foundation Analysis and Design"- McGraw-Hill Int. Editions, Fifth Ed., 2nd Edition 1996.
2.	Nainan P Kurian – "Design of Foundation Systems"- Narosa Publishing House, 1st Edition 1992.
3.	Swami Saran – "Analysis & Design of Substructures"- Oxford & IBH Pub. Co. Pvt. Ltd., 2nd Edition 1998.
4.	W.C. Teng – "Foundation Design"- Prentice Hall of India Pvt. Ltd., 3rd Edition 1983.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	1	1	-	1
CO2	2	2	-	1	-	-	-	-	1	1	-	1
CO3	2	2	-	1	-	-	-	-	1	1	-	1
CO4	2	2	1	2	1	-	-	-	1	1	-	1
CO5	2	2	1	2	1	-	-	-	1	1	-	1

High-3, Medium-2, Low-1

Course Title	**SUSTAINABILITY CONCEPTS IN ENGINEERING**	Semester	II
Course Code	MVJ20CSE253	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 00 : 20	**SEE**	50
No. of Contact Hours/week	3	**Total**	100
Credits	3	**Exam. Duration**	3 Hrs

Course objective is to:

- Learn about the principles, indicators and general concept of sustainability.
- Apprehend the local, regional and global impacts of unsustainable designs, products and processes.
- Apply the sustainability concepts in engineering
- Know built environment frameworks and their use
- Understand how building and design is judged and valued by clients and stakeholders and how to implement sustainability.

Module-1	**L3**	**12 Hrs.**

Introduction: Sustainability - Introduction, Need and concept of sustainability, Social-environmental and economic sustainability concepts. Sustainable development, Nexus between Technology and Sustainable development, Challenges for Sustainable Development. Multilateral environmental agreements and Protocols - Clean Development Mechanism (CDM), Environmental legislations in India - Water Act, Air Act.

Applications:

- Knowledge of the scope of the subject.
- Knowledge about dynamics of sustainable systems.

Video link / Additional online information:

- https://nptel.ac.in/courses/127/105/127105018/
- https://nptel.ac.in/courses/107/103/107103081/

Module-2	**L3**	**14 Hrs.**

Global Environmental Issue: Air Pollution, Effects of Air Pollution; Water pollution- sources, Sustainable wastewater treatment, Solid waste – sources, impacts of solid waste, Zero waste concept. Resource degradation, Climate change, Regional and Local Environmental Issues. Carbon credits and carbon trading, carbon foot print Carbon sequestration – Carbon capture and storage (CCS).

Environmental management standards, ISO 14000 series, Life Cycle Analysis (LCA) - Scope and Goal, Bio-mimicking.

Laboratory Sessions/ Experimental learning:

- Pollution assessment tests for different areas and give remedies to control it.

Applications:

- Understanding the various environmental pollutions, its effects and how to overcome the global environmental issues.
- Getting an idea to improve urban infrastructure.

Video link / Additional online information:

- https://nptel.ac.in/courses/127/105/127105018/
- https://nptel.ac.in/courses/107/103/107103081/

Module-3	**L3**	**12Hrs.**

Sustainable Design:

Basic concepts of sustainable habitat, Green buildings, green materials for building construction, material selection for sustainable design, green building certification- GRIHA & IGBC Certification for buildings, Energy efficient building design- Passive solar design technique, Thermal storage, Cooling strategies, high performance insulation. Sustainable cities, Sustainable transport.

Laboratory Sessions/ Experimental learning:

- Conduct any sustainability event in the campus (ex: Technical talk, Documentary/film etc)

Applications:

- Knowledge about Sustainable design and green construction.
- Understanding the design of energy efficient building.

Video link / Additional online information:

- https://nptel.ac.in/courses/127/105/127105018/
- https://nptel.ac.in/courses/107/103/107103081/

Module-4	**L3 & L4**	**10Hrs.**

Clean Technology and Energy:

Energy sources: Basic concepts-Conventional and non-conventional, solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans, Geothermal energy. Rainwater harvesting.

Laboratory Sessions/ Experimental learning:

- Industrial visit of any of the energy sources and make a report on it.

Applications:

- Understanding the various application of different energy sources

Video link / Additional online information:

- https://nptel.ac.in/courses/127/105/127105018/
- https://nptel.ac.in/courses/107/103/107103081/

Module-5	**L3**	**12 Hrs.**

Green Engineering:

Green Engineering concepts, Sustainable Urbanization, industrialization and poverty reduction; Social and technological change, Industrial Processes: Material selection, Pollution Prevention, Industrial Ecology, Industrial symbiosis.

Laboratory Sessions/ Experimental learning:

- Develop a sustainability project for a green campus

Applications:

- Understanding the concept of green engineering and how it is applicable for the sustainability in society.

Video link / Additional online information:

- https://nptel.ac.in/courses/127/105/127105018/
- https://nptel.ac.in/courses/107/103/107103081/

Course outcomes: On completion of the course, students would be able to

CO1	Learn the sustainability concepts, understand the role and responsibility of engineers in sustainable development
CO2	Quantify sustainability, and resource availability, Rationalize the sustainability based on scientific merits
CO3	Understand and apply sustainability concepts in construction practices, designs, product developments and processes across various engineering disciplines
CO4	Application of engineering knowledge in utilization of natural resources for the production materials.
CO5	Make a decision in applying green engineering concepts and become a lifelong advocate of sustainability in society

Reference Books:	
1.	Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2.	Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage Learning
3.	Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4.	Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication,1998
5.	Sustainable Engineering Practice: An Introduction, Committee on Sustainability, American Society of Civil Engineers
6.	Daniel A. Vallero and Chris Brasier, " Sustainable Design: The Science of Sustainability and Green Engineering", Wiley-Blackwell

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	3	1	1	-	1	-	-	1
CO2	3	-	-	-	1	1	-	-	2	1	1	-
CO3	1	2	3	1	-	1	-	-	-	-	-	1
CO4	3	1	1	1	2	-	-	-	1	-	-	-
CO5	1	1	1	-	-	1	-	-	3	-	-	1

High-3, Medium-2, Low-1

Course Title	**STABILITY OF STRUCTURES**	Semester	II
Course Code	MVJ20CSE254	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/Week	3	**Total**	100
Credits	3	**Exam Duration**	3Hrs

Course objective is to: This course will enable the students to

- The objective of this course is to make students to learn principles of stability of structures.
- To analyse the structural elements for stability. To evaluate the use of strain energy in plate bending and stability.

Module-1	**L3**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials and Structural Analysis*

Beam – column – Differential equation. Beam column subjected to lateral concentrated load, several concentrated loads, Continuous lateral load. Application of trigonometric series, Euler's formulation using fourth order differential equation for pined – pined, fixed – fixed, fixed – free and fixed – pinned column, Imperfection factor.

Laboratory Sessions/ Experimental learning:

- Developing differential equation for the beam subjected to several concentrated load
- Deflection of Beam under Different supports.

Applications:

- Short term deflection of existing beams
- Prediction on Column Deflection

Video link / Additional online information:

- https://nptel.ac.in/courses/105104160/-

Module-2	**L3**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials and Structural Analysis*

Buckling of frames and continuous beams. Elastic Energy method: Approximate calculation of critical loads for a cantilever. Exact critical load for hinged – hinged column using energy approach. Buckling of bar on elastic foundation. Buckling of cantilever column under distributed loads. Determination of critical loads by successive approximation. Bars with varying cross section. Effect of shear force on critical load. Column subjected to non – conservative follower and pulsating forces.

Laboratory Sessions/ Experimental learning:

- Determining the Buckling characteristics of Cantilever due to critical load.

Applications:

- Critical buckling load can be estimated by this method.
- The strength of the beam can be improved by determining the shear force at different cross section.

Video link / Additional online information:

- https://nptel.ac.in/courses/105101085/downloads/lec-25.pdf

Module-3	**L3, L4**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials and Structural Analysis*

Stability analysis by finite element approach – deviation of shape function for a two nodded Bernoulli – Euler beam element (lateral and translation of) – element stiffness and element geometric stiffness matrices – assembled stiffness and geometric stiffness matrices for a discretised column with different boundary condition – calculation of critical loads for a discretised (two elements) column (both ends built in). Buckling of pin jointed frames (maximum of two active DOF) – symmetrical single bay portal frame, Stability analyis of truss.

Laboratory Sessions/ Experimental learning:

- Determining the critical loads for a column using FEM method.
- Determining the Buckling of pin jointed frames using FEM method.

Applications:

- The finite element method represents a powerful alternative approach for stability analysis which is accurate.
- Critical load can be easily determined by FEM method for discretized structure.

Video link / Additional online information:

- https://nptel.ac.in/courses/105105041/

Module-4	**L3**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials and Structural Analysis*

Lateral buckling of beams – differential equation – pure bending – cantilever beam with tip load – simply supported beam of I section subjected to central concentrated load. Pure Torsion of thin – walled bars of open cross section. Non – uniform Torsion of thin – walled bars of open cross section.

Laboratory Sessions/ Experimental learning:

- Determining the loads carrying capacity in I section due to central concentrated load.
- Determining the loads carrying capacity in cantilever beam with tip load

Applications:

- By the approach of equation load acting on the cantilever beam can be determined easily.
- The load value on I-Section can be determined with the help of equations.

Video link / Additional online information:

- https://nptel.ac.in/content/storage2/courses/105106112/6_beams/6_examples.pdf

Module-5	**L3**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials and Structural Analysis*

Expression for strain energy in plate bending with in plate forces (linear and non – linear). Buckling of simply supported rectangular plate – uniaxial load and biaxial load. Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge condition along the other two sides.

Laboratory Sessions/ Experimental learning:

- Experimental verification on beam under buckling through uniaxial and biaxial loading.
- Determining the Buckling of uniformly compressed rectangular plate simply supported along two opposite sides.

Applications:

- Buckling of the simply supported beam under uniaxial and biaxial loading condition.

Video link / Additional online information:

- https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112106065/lec8.pdf

Course outcomes: On completion of the course, students would be able to

CO1	Achieve knowledge of design and development of problem solving skills.
CO2	Understand the principles of strength and stability
CO3	Design and develop analytical skills.
CO4	Appraise the Stability analysis by finite element approach.
CO5	Understand the concepts of Lateral buckling of beams

Reference Books:

1.	Stephen P.Timoshenko, James M Gere, "Theory of Elastic Stability"-2nd Edition, McGraw – Hill, New Delhi, 8th Edition 2013.

2.	T Robert D Cook et.al, "Concepts and Applications of Finite Element Analysis"-3rd Edition, John Wiley and Sons, New York, 7th Edition 2014.
3.	S.Rajashekar, "Computations and Structural Mechanics"-Prentice – Hall, India, 6th Edition 2018.
4.	Ray W Clough and J Penzien, "Dynamics of Structures" - 2nd Edition, McGraw Hill, New Delhi, 5th Edition 2017.
5.	H.Zeiglar, "Principles of Structural Stability"-Blaisdall Publications, 4th Edition 2014.
6.	Chajes A, Principles of Elastic Stability, Prentice Hall, New Jersey", 1974.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	3	3	-	-	1	-	1
CO2	3	3	3	2	-	2	3	3	1	1	-	1
CO3	2	3	3	1	2	1	1	1	-	2	3	1
CO4	2	2	2	0	1	-	3	2	3	1	3	1
CO5	3	1	1	-	-	2	3	-	-	1	-	1

High-3, Medium-2, Low-1

Course Title	**ADVANCED STRUCTURAL ANALYSIS**	Semester	II
Course Code	MVJ20CSE261	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/Week	3	**Total**	100
Credits	3	**Exam Duration**	3Hrs

Course objective is to: This course will enable the students to

- Students will be given provided with the knowledge of mathematics, science, and engineering in the in the analysis of following structural systems curved beams.
- Beams on elastic foundation, shear centre and unsymmetrical bending and buckling of non-prismatic columns and beam column.

Module-1	**L3**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials & Basic Structural analysis*

Curved Beams Curved beams, Introduction, assumptions, derivation of WINKLER BACH equation, Radius to the neutral surface of simple geometric figures, Limitation, Stress distribution in open curved members such as Hooks and chain links, Stress distribution in closed rings and chain links. Deformations of open and closed rings.

Laboratory Sessions/ Experimental learning:

- Experiments on Stress analysis of Curved Beams using strain Guages.
- Determination of geometrical influence of Curved beams due to laoding.

Applications:

- Static and Dynamic analysis of curved beams can be done.

Video link / Additional online information:

- https://nptel.ac.in/content/storage2/courses/105106049/lecnotes/mainch10.html

Module-2	**L3,L4**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials & Basic Structural analysis*

Beams on Elastic Foundations

Governing differential equation for elastic line, Interpretation of constants, Infinite beam with point load, moment & UDL with problems. Semi-infinite beams with point load and moment UDL with problems over fixed and hinged support conditions.

Laboratory Sessions/ Experimental learning:

- Structural Behavior of Beams on Elastic Foundation.
- Comparing the equations with experimental result sue to different loading condition on beams.

Applications:

- By the use of equations loads on the foundations can be predicted.
- Critical loading can be avoided hence the foundation can be completely utilized.

Video link / Additional online information:

- https://nptel.ac.in/content/storage2/courses/105106049/lecnotes/mainch11.html

Module-3	**L3,L4**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials & Basic Structural analysis*

Shear Center

Concept of shear centre in torsion induced bending of beams, expression to the Shear Centre for Symmetrical and Unsymmetrical Sections, Derivation of shear centre for angles, channel, semi-circular and built-up sections with numerical problems

Laboratory Sessions/ Experimental learning:

- Determining the location of Shear Centre by Application of load.

Applications:

- Torsion is critical if not taken care. Hence application of load at shear center reduces torsion.
- The Strength of the structure can be completely utilized by this method.

Video link / Additional online information:

- https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/112101095/lec33.pdf
- https://www.youtube.com/watch?v=3Hg0OWZGUbE

Module-4	**L3, L4**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials & Basic Structural analysis*

Unsymmetrical Bending (Asymmetrical Bending)

Theory behind unsymmetrical bending, Assumptions, obtaining the stresses in beams, simply supported and cantilever unsymmetrical beams subjected to inclined loading, Deflections of unsymmetrical simply supported and cantilever beams with numerical problems.

Laboratory Sessions/ Experimental learning:

- Experiment on Unsymmetrical Bending on simply supported beam due to Inclined Loading.
- Experiment on Unsymmetrical Bending on Cantilever beam due to Inclined Loading

Applications:

- Unsymmetrical bending can be mitigated due to inclined loading by this method.
- Stress analysis on the beam can be determined in simply supported and Cantilever beams.

Video link / Additional online information:

- https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/114106043/lec23.pdf
- https://www.youtube.com/watch?v=mbJEQHXz5WA

Module-5	**L3, L4**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of Strength of Materials & Basic Structural analysis*

Buckling of Non Prismatic Columns and Beam-Column

Principle behind Euler's theory of buckling, Governing differential equation applied to buckling of columns and evaluation of constants for various boundary conditions, Obtaining the characteristic equation for the buckling load of non-prismatic compound columns, Analysis of Beam-column, conceptual theory of magnification stresses and deformations subjected to axial and different types of lateral loads with numerical problems.

Laboratory Sessions/ Experimental learning:

- Experiment on Buckling of Non-Prismatic columns.
- Analysis of Stresses in Beam –Column under Axial load and different Lateral Load.

Applications:

- Torsion is critical if not taken care. Hence application of load at shear center reduces torsion.
- The Strength of the structure can be completely utilized by this method.

Video link / Additional online information:

- https://nptel.ac.in/content/storage2/courses/105105109/pdf/m1l2.pdf

Course outcomes: On completion of the course, students would be able to

CO1	Apply Winkler Bach and Strain Energy principles to obtain stresses and deformation in curved members.
CO2	Derive the expressions to Foundation pressure, Deflection, Slope, BM and SF of infinite and semi-infinite Beams resting on Elastic Foundation .
CO3	Obtain the equations for the shear centre for symmetrical and unsymmetrical from fundamental.
CO4	Extrapolate the bending theory to calculate the stresses and deformations in unsymmetrical bending.
CO5	Develop the characteristics equation for compound column under buckling load

Reference Books:	
1.	azirani V N and Ratwani M M "Advanced theory of structures and Matrix Method". 5th Edition,2014
2.	HetenyiM."Beams on elastic foundation" 3rd printing, University of Michigan, USA, 1952. 2nd Edition
3.	Alexander Chatjes "Principles of Structural stability theory", Prentice – Hall of India, New Delhi, 2nd Edition,1974.
4.	Sterling Kinney "Indeterminate Structural Analysis", Oxford & IBH publishers, 5th edition,2016

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	-	1	2	1	-	2	-	2	1	2
CO2	3	-	-	3	-	-	1	2	3		--	2
CO3	3	3	1	1	2	2	2	3	1	3	1	1
CO4	3	1	3	-	-	2	-	1	3	2	1	2
CO5	3	2	-	1	2	1	2	1	-	-	-	1

High-3, Medium-2, Low-1

Course Title	**DESIGN OF HIGH RISE STRUCTURES**	Semester	II
Course Code	MVJ20CSE262	**CIE**	50
Total No. of Contact Hours	60 L: T: P: 40: 0: 20	**SEE**	50
No. of Contact Hours/week	3	**Total**	100
Credits	3	**Exam Duration**	3Hrs

Course objective is to:

- Learn principles of stability of high rise buildings.
- Design the tall buildings for earthquake and wind resistance.
- Gain knowledge of behaviour of structural systems.
- Evaluate the performance of tall structures for strength and stability.
- Introduce to the code provisions.

Module-1	**L3**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of special concrete.*

Design Criteria: Design philosophy, loading, sequential loading, and materials – high performance concrete, fibre reinforced concrete, lightweight concrete, design mixes. Loading and Movement: Gravity loading- dead and live load, methods of live load reduction, Impact gravity loading, construction loads.

Laboratory Sessions/Experimental learning:

- Development of design mixes for high performance, fibre reinforced and lightweight concrete.
- Testing of concrete blocks with different design mixes.

Applications:

- Understanding of characteristics of concrete materials used for the construction of high-rise structures.
- Importance of each individual loads to be considered on high rise structures.

Video link / Additional online information:

- https://www.sefindia.org/forum/files/design_of_tall_buildings_preliminary_design_124.pdf- Introduction to tall buildings.

- https://www.youtube.com/watch?v=XCun_ewg-I8 (Lecture 1)- An overview of tall buildings
- https://www.youtube.com/watch?v=8iHKKM4enic (Lecture 2)- Design philosophy.
- https://www.youtube.com/watch?v=EqWxCDsr1qU (Lecture 7)- Analysis by gravity loads.

Module-2	**L3, L4 & L5**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of structural dynamics.*

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.

Laboratory Sessions/Experimental learning:

- Experimental investigation on wind load analysis of high-rise structures by wind tunnel experimentation method. (Multidisciplinary learning with Aeronautical Engineering Department)
- Model making to understand the structural behavior of high-rise structures under wind and seismic loading.

Applications:

- Better understanding of wind pressure distribution on high-rise structures with different boundary conditions by wind tunnel experiment.
- Importance of method of analysis under wind and earthquake loading.

Video link / Additional online information:

- https://www.youtube.com/watch?v=rjvM6rR8BZ8 (Lecture 3- Part I & 2)- Design criteria.
- https://www.youtube.com/watch?v=hREd8TjRw_8 (Lecture 8- Part III)- Analysis of lateral loads.

Module-3	**L2, L3**	**12 Hrs**

Behaviour 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, outrigger – braced and hybrid mega system.

Laboratory Sessions/Experimental learning:

- Case study on behavior of various structural systems in high rise structures.
- Analysis and design of high-rise structures with various structural systems.

Applications:

- Understanding the performance of high-rise structures under each structural system.
- Gives better knowledge of optimal structural system that could be employed in a high-rise structure.

Video link / Additional online information: Information on various structural systems.

- https://www.sefindia.org/forum/files/design_of_tall_buildings_preliminary_design_124.pdf
- https://www.youtube.com/watch?v=XCun_ewg-I8 (Lecture 1)

Module-4	**L3, L4 & L5**	**12 Hrs**

Analysis and Design: Modelling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift and twist, computerized general three-dimensional analyses. Structural elements: sectional shapes, properties and resisting capacities, design, deflection, cracking, pre-stressing, shear flow. Design for differential movement, creep and shrinkage effects, temperature effects and fire.

Laboratory Sessions/Experimental learning:

- Analytical investigation of forces, lateral displacement and twisting of members of high-rise structures.
- Software analysis and design to understand seismic performance of high-rise structures along with seismic design aspects.

Applications:

- Knowledge on various analytical procedures in accessing overall structural integrity.
- Understanding various secondary effects in high-rise structures.

Video link / Additional online information: Preliminary design of tall structures

- https://www.youtube.com/watch?v=-86A8kVKzwQ (Lecture 5)

Module-5	**L3 & L4**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of structural dynamics.*

Stability of Tall Buildings: Overall buckling analysis of frames, wall frames, approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first order and P-Delta analysis, Transnational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation.

Laboratory Sessions/Experimental learning:

- Analyzing the stability of high-rise buildings by buckling and P-Delta effect using structural software.
- Experiencing construction of high-rise structures at site.

Applications:

- Gain knowledge on analytical approaches with respect to stability of the high-rise structures.
- Practical outlook on construction of high-rise structures.

Video link / Additional online information:

- https://www.youtube.com/watch?v=hREd8TjRw_8 (Lecture 8- Part III)- Analysis of lateral loads.

Course outcomes: On completion of the course, students would be able to

CO1	Familiarize with the problems associated with the large heights of structures with respect to different loads and materials.
CO2	Analyse the structure subjected to lateral loads.
CO3	Design and develop analytical skills.
CO4	Summarize the behavior of various structural systems
CO5	Understand the concepts of overall buckling and P-Delta analysis.

Reference Books:

1.	Taranath B.S, "Structural Analysis and Design of Tall Buildings"- McGraw Hill, 3rd Edition 2011.
2.	Wilf gang Schuller, "High rise building structures"- John Wiley, 4th Edition 2012.
3.	Bryan Stafford Smith & Alexcoull, "Tall building structures Analysis and Design"- John Wiley, 2nd Edition 2017.
4.	T. Y Lin & D.Stotes Burry, "Structural concepts and system for Architects and Engineers"- John Wiley, 4h Edition 2015.
5.	Lynn S.Beedle, "Advances in Tall Buildings"- CBS Publishers and Distributors, 6th Edition 2015.
6.	Dr. Y.P. Gupta – Editor, "Proceedings National Seminar on High Rise Structures- Design and Construction practices for middle level cities"- New Age International Limited, 7th Edition 2014.
7.	IS 1893(Part 1):2016 "Criteria for Earthquake Resistant Design of Structures"- (6th revision) BIS, New Delhi.
8.	IS 875(Part 3):2015 "Code of Practice for Design Loads (Other than Earthquake) for

	Buildings and Structures - Part 3: Wind Loads (3rd revision) BIS, New Delhi.

CO-PO Mapping												
CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	-	-	-	-	-	1	-	1
CO2	3	3	2	1	-	1	-	-	-	1	-	1
CO3	3	3	2	2	-		2	1	1	1	-	1
CO4	3	3	-	2	1	1	1	1	2	1	-	1
CO5	3	3	-	2	1	1	1	1	2	1	-	1

High-3, Medium-2, Low-1

Course Title	**DESIGN OF INDUSTRIAL STRUCTURES**	Semester	II
Course Code	MVJ20CSE263	**CIE**	50
Total No. of Contact Hours	60 L: T: P: 40: 0: 20	**SEE**	50
No. of Contact Hours/Week	3	**Total**	100
Credits	3	**Exam Duration**	3Hrs

Course objective is to:

- Learn principles of design of industrial building.
- Design different components of industrial structures and detail the structures.
- Design industrial storage structures.
- Design various cold formed light gauge sections.
- Evaluate the performance of the Pre- engineered buildings.

Module-1	**L3, L4 & L5**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of design of steel structures.*

Analysis of industrial building - Gravity and Wind load. Analysis and design of framing components namely, girders, trusses, gable frames.

Laboratory Sessions/Experimental learning:

- Modelling and design of industrial components of buildings under gravity and wind loads.

Applications:

- Understanding of principles of design of industrial building as per the code provisions.
- Find out the response of components of structures under gravity and lateral loads.

Video link / Additional online information:

- https://nptel.ac.in/courses/105106113/- Design of gantry girders and trusses.
- https://www.iare.ac.in/sites/default/files/lecture_notes/lec%20notes%20ASD.pdf- Design of Industrial building (girders, trusses and frames)

Module-2	**L3 & L4**	**12 Hrs**

Prerequisites: *Knowledge in the fundamentals of design of steel structures.*

Analysis and design of gantry column (stepped column / column with bracket), purlins, girts, bracings including all connections.

Laboratory Sessions/Experimental learning:

- Draft the detailing of gantry column, purlins, girts and bracings.

Applications:

- Understanding of behavior of different components of industrial structure.
- Learn to detail various components of an industrial building.

Video link / Additional online information:

- https://nptel.ac.in/courses/105106113/- Design of gantry column.
- https://www.iare.ac.in/sites/default/files/lecture_notes/lec%20notes%20ASD.pdf- Design of bracings with connections.

Module-3	**L4, L5**	**12 Hrs**

Design of silos and bunkers – Design of square bunker – Jansen's and Airy's theories IS Codal provisions, design of side plates, stiffeners, Hooper, longitudinal beams. Design of cylindrical silo – Side plates, ring girder, stiffeners.

Laboratory Sessions/Experimental learning:

- Design of Bunkers from FE based software subjected to wind load.
- Modelling and design of silos under dynamic loads.

Applications:

- Understanding of theoretical and design concepts of bunkers and silos with supporting components.

Video link / Additional online information:

- https://www.iare.ac.in/sites/default/files/lecture_notes/lec%20notes%20ASD.pdf- Design of steel bunkers and silos.

Module-4	**L4**	**12 Hrs**

Forms of light gauge sections, Effective width computation of unstiffened, stiffened, multiple stiffened compression elements of cold formed light gauge sections. Concept of local buckling of thin elements. Limiting width to thickness ratio. Post buckling strength.

Laboratory Sessions/Experimental learning:

- Investigation of numerical and finite element analysis of buckling behavior of light gauge sections under compression.

Applications:

- Gives in depth knowledge of influence of local buckling on the structural behavior of light gauge sections.

Video link / Additional online information:

- https://nptel.ac.in/courses/105106113/- Introduction to light gauge sections, local buckling.

Module-5	**L3 & L4**	**12 Hrs**

Design of compression and tension members of cold formed light gauge sections, Design of flexural members (Laterally restrained / laterally unrestrained), Concept of Pre- engineered buildings.

Laboratory Sessions/Experimental learning:

- Experimental and analytical investigation on different forms of light gauge sections under different loading and boundary conditions.
- Case study on pre-engineered buildings.

Applications:

- Learn design of compression and tension members of cold formed light gauge sections.
- Better knowledge on concepts of pre-engineered buildings.

Video link / Additional online information:

- https://nptel.ac.in/courses/105106113/- Design of tension members, flexural members.

Course outcomes: On completion of the course, students would be able to

CO1	Understand the industrial building and the components.
CO2	Summarize the principles of structural design and detailing.
CO3	Design the silos, bunkers and bins along with supporting structures.
CO4	Design cold formed steel structures as per code provisions.
CO5	Understand the concepts of Pre- engineered buildings.

Reference Books:

1.	Bureau of Indian Standards, IS 800-2007, IS 875-1987, IS-801-1975. Steel Tables, SP 6 (1) – 1984
2.	N Subramanian- "Design of Steel Structure" oxford University Press,4th Edition, (2018).
3.	B.C. Punmia, A.K. Jain "Design of Steel Structures", Laxmi Publications, New Delhi. 2nd revised Edition 2012.
4.	Ramchandra and Virendra Gehlot "Design of Steel Structures "Vol 1 (11th edition, 2012) and

	Vol.2 (9^{th} revised edition,2015), Scientific Publishers, Jodhpur.
5.	Duggal "Limit State Design of Steel Structures" TMH, 3rd Edition 2019.
6.	Reimbert, M. L., &Reimbert, A. M. (1987). Silos. Theory and practice. Vertical silos, horizontal silos (retaining walls) (No. Ed. 2). Lavoisier Publishing.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	-	-	-	1	1	1	1	1
CO2	3	3	3	3	-	1	-	1	1	3	1	1
CO3	3	2	3	2	-	-	-	1	1	1	1	2
CO4	3	2	3	2	-	-	-	1	1	1	1	2
CO5	3	2	-	1	-	-	-	1	1	1	1	1

High-3, Medium-2, Low-1

Course Title	**DESIGN OF MASONRY STRUCTURES**	Semester	II
Course Code	MVJ20CSE264	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/week	3	**Total**	100
Credits	3	**Exam. Duration**	3 Hrs

Course objective is to:

- Learn performance of masonry structures.
- Evaluate the strength and stability of the masonry structures.
- Design the masonry structures for different loading conditions.
- Introduce to various code provisions.
- Design the masonry structures for earthquake resistance.

Module-1	**L3**	**12 Hrs.**

Prerequisites: *Knowledge in the fundamentals of Building materials.*

Introduction, Masonry units, materials and types: History of masonry, Masonry units – Brick- Types of bricks, Tests conducted on bricks. Other masonry units - stone, clay block, concrete block, laterite block, stabilized mud block masonry units Masonry materials – Classification and properties of mortars, selection of mortars. Cracks - Cracks in masonry structures, Type of crack, causes and prevention of crack.

Laboratory Sessions/Experimental learning:

- Testing of individual bricks and concrete blocks and testing of mortar cubes for 7 days.
- Visit to the manufacturing unit.
- Preparation and testing of stabilized mud block units.

Applications:

- Understanding the properties and performance of different masonry units and materials.

Video link / Additional online information : Introduction, materials and properties.

- https://nptel.ac.in/courses/105106197/

Module-2	**L3 & L4**	**12 Hrs.**

Prerequisites: *Knowledge of solid mechanics.*

Strength of Masonry in Compression: Behaviour of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength

of masonry in Indian context, Failure theories of masonry under Compression. Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength.

Masonry Bond Strength and Masonry in Shear and Flexure:

Bond between masonry unit and mortar, tests for determining flexural and shear bond strengths, factors affecting bond strength, effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shear strength.

Laboratory Sessions/Experimental learning:

- Casting of masonry wallettes and Prisms of different sizes and bonding arrangements.
- Prism tests to familiarize to the possibility of debonding of the masonry from the mortar.

Applications:

- Understanding of strength and elasticity of masonry under compression.
- Better knowledge on bond strengths between the masonry unit and mortar in flexure and shear.

Video link / Additional online information : Strength and behaviour of masonry.

- https://nptel.ac.in/courses/105106197/

Module-3	**L3, L4 & L5**	**12 Hrs.**

Design of load bearing masonry wall- Permissible stresses:

Prerequisites: *Knowledge in the fundamentals of Building materials and solid mechanics.*

Types of walls, permissible compressive stress, stress reduction and shape modification factors, increase in permissible stresses for eccentric vertical and lateral load, permissible tensile stress and shear stresses. Design Considerations: Effective height of walls and columns, openings in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action in lintels. Problems on design considerations for solid walls, cavity walls, wall with pillars.

Load considerations and design of masonry subjected to axial loads: Design criteria, design examples of walls under UDL, solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers.

Laboratory Sessions/Experimental learning:

- Investigation of different types of walls with different end conditions under the loads to calculate the tensile and shear stresses.

Applications:

- Better understanding of design aspects in accessing the behaviour of types of walls subjected to the axial loads.

Video link / Additional online information : Design of load bearing masonry walls.

- https://nptel.ac.in/courses/105106197/

Module-4	**L3, L4 & L5**	**12 Hrs.**

Prerequisites: *Knowledge in the fundamentals of construction technology.*

Design of walls subjected to concentrated axial loads:

Solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers, design of wall with openings. Design of walls subjected to eccentric loads: Design criteria – stress distribution under eccentric loads – problems on eccentrically loaded solid walls, cavity walls, walls with piers.

Design of laterally and transversely loaded walls:

Design criteria, design of solid wall under wind loading, design of shear wall – design of compound walls.

Laboratory Sessions/Experimental learning:

- Model making to understand the structural behavior of masonry walls under eccentric loads.
- Analysis and design of masonry shear wall.
- Study on Structural Behavior of Masonry Structures subjected to wind load.

Applications:

- Understanding of design aspects of solid walls, cavity walls, walls with piers and walls with openings.
- Gaining of knowledge on the structural performance of masonry shear walls and solid walls under wind loading.

Video link / Additional online information : Design of laterally and transversely loaded walls

- https://nptel.ac.in/courses/105106197/

Module-5	**L3, L4 & L5**	**12 Hrs.**

Earthquake resistant masonry buildings:

Behaviour of masonry during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS code provisions. In-filled frames: Types – modes of failures.

Reinforced brick masonry:

Methods of reinforcing masonry, analysis of reinforced masonry under axial, flexural and shear loading.

Laboratory Sessions/Experimental learning:

- Software analysis and design to understand seismic performance of masonry structures along with seismic design aspects.
- Experiencing reinforced masonry construction at site.
- Preparation of complete construction documents (structural calculations, structural plans and structural specifications) for real masonry structures using architectural plans.

Applications:

- Familiarize with the usage of code provisions in structural design of masonry structures.
- Practical outlook on construction of masonry structures.

Video link / Additional online information : Infilled frames

- https://nptel.ac.in/courses/105106197/

Course outcomes: On completion of the course, students would be able to

CO1	Acquire the knowledge and ability to assess various engineering properties of masonry components.
CO2	Understand the principles of design and construction of masonry structures.
CO3	Design and develop analytical skills.
CO4	Summarize the masonry characteristics.
CO5	Evaluate the strength and stability of the masonry structures.

Reference Books:

1.	Henry, A.W., "Structural Masonry", Macmillan Education Ltd., 1990.
2.	K.S. Jagadish, "Structural masonry", I.K. International Publishing House Pvt. Ltd, 2015.
3.	Dayaratnam P, "Brick and Reinforced Brick Structures", Oxford & IBH, 1987.
4.	MJN Priestley and T Paulay (1997) Seismic design and assessment of reinforced concrete and masonry buildings, John Wiley and Sons.
5.	M. L. Gambhir, "Building and Construction Materials", Mc Graw Hill education Pvt. Ltd, 5th edition, 2014.
6.	M Tomazevic (1999) Earthquake-resistant design of masonry buildings, Series on Innovation in Structures and Construction, Vol. 1, Imperial College Press, London, pp. 268.
7.	IS 1905–1987 "Code of practice for structural use of un-reinforced masonry- (3rd revision) BIS, New Delhi.
8.	SP 20 (S&T) – 1991, "Hand book on masonry design and construction (1st revision) BIS, New Delhi.

9.	National Building Code of India 2016 Vol.1, Part 6 Section 4 Structural Design - Masonry

CO-PO Mapping												
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CO2	3	3	3	2	-	-	-	-	-	1	-	1
CO3	3	3	1	1	-	-	-	-	-	1	-	1
CO4	3	1	-	-	-	-	-	-	-	-	-	1
CO5	3	2	-	-	-	-	-	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	**STRUCTURAL SOFTWARE LAB-2**	Semester	II
Course Code	MVJ20CSEL27	**CIE**	50
Total No. of Contact Hours	01 Hour Tutorial (Instruction) 03 Hours Laboratory	**SEE**	50
No. of Contact Hours/Week	4	**Total**	100
Credits	2	**Exam Duration**	3Hrs

Course objective is to: This course will enable the students to

- Learn the application of ETABS in Dynamic Analysis.
- Learn the application of ANSYS in Structural analysis problems
- Learn the application of FEM

SL.NO	**Experiments**	**L4, L5, L6**
1	Conducting Seismic analysis of multi-storied buildings using ETABS.	
2	Demonstration to ANSYS and its application in various analysis problems.	

Video link / Additional online information:

- https://www.youtube.com/watch?v=k2rAFEUNrTc
- https://www.youtube.com/watch?v=LOtuwW9-G68

Course outcomes: On completion of the course, students would be able to

CO1	Understand the general considerations of analysis.
CO2	Achieve Knowledge application of ETABS.
CO3	Understand the principles FEM
CO4	Achieve Knowledge application of ANSYS.

Reference Books:

1. Mukhopadhaya M , "structural dynamics Vibrations" Oxford IBH, 2nd Edition 2014.
2. Mario Paz "Structural Dynamics" CBS publishers,5th Edition 2004
3. Krishnamoorthy C S, "Finite Element Analysis"- Tata McGraw Hill 2nd Edition 2015
4. Timoshenko S, Van-Nostrand "Vibration Problems in Engineering" C, 5th Edition 2006

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	3	-	-	1	2	1	1	3	1
CO2	3	3	1	-	2	-	3	2	3	3	2	3
CO3	1	2	1	3	-	3	2	3	1	1	3	2
CO4	3	2	-	1	1	1	3	1	-	-	1	1
CO5	2	1	2	3	2	2	3	1	2	-	-	1

High-3, Medium-2, Low-1