NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

Honors in

ENGINEERING STRUCTURES

SCHEME OF INSTRUCTION AND SYLLABI

(for students of B.Tech., Civil Engineering)

(Effective from 2021-22)

DEPARTMENT OF CIVIL ENGINEERING

SCHEME OF INSTRUCTION

Honours Program – Engineering Structures

S. No.	Course Code	Name of the Course	L	T	P	Credits	Sem.
1	CE5203	Structural Dynamics	3	0	0	3	V
2	CE5251	Structural Stability	3	0	0	3	VI
3	CE5253	Seismic Analysis and Design of Structures	3	0	0	3	VI
4	CE5202	Behaviour of Concrete Structures	3	0	0	3	VII
5	CE5211	Analysis and Design of Bridges	3	0	0	3	VII
6	CE5262	Vulnerability and Risk Analysis	3	0	0	3	VIII
		Total				**18**	

DETAILED SYLLABUS

Honors

Engineering Structures

Course Code: CE5203	STRUCTURAL DYNAMICS	Credits 3-0-0: 3

Pre-requisites: None

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

CO1	Model and Formulate dynamic equilibrium equations for SDOF and MDOF
CO2	Analyse SDOF and MDOF systems using classical and numerical methods.
CO3	Perform modal analysis and Compute seismic response of Structural systems.
CO4	Analyze the effects of system/modal parameters on dynamic response.

Syllabus:

Single Degree of Freedom Systems: Response under time dependent Transient and Steady state forcing functions – Damping effects – Greens function - Damping Vibrations system - response under general type of excitation – numerical methods- response spectrum.

Multi degree of Freedom Systems: Free vibration - Determination of Natural frequencies and mode shapes - Vanello Stodola and Matrix iteration methods – Energy Methods – Lagrange's equation – Simple applications.

Continuous Systems: Free and forced vibrations of beams - Approximate solutions - Rayleigh and Rayleigh - Ritz Methods – Vibrating of building frames – modal analysis.

Learning Resources:

Text Books:

1. Structural Dynamics - Theory & Computations, Mario Paz, Springer publisher, 2018, 6th Edition.
2. Dynamics of Structures, Clough and Penzien, McGraw Hill Book Co., 2015, 5th Edition.
3. Dynamics of Structures (SI Units), A.K. Chopra, Pearson, 2019, 5th Edition.

Reference Books:

1. Mechanical Vibrations, R Venkatachalam, PHI learning, 2014, 1st Edition.
2. Introduction to Structural Dynamics, J N Biggs, McGraw Hill Book Co., 1964.
3. Dynamics of Structures, J. Humar, CBS Press, 2012, 3rd Edition.
4. Dynamics of Structures, Patrick Paultre, Wiley Publishers, 2011.
5. Dynamic Analysis of Structures, John T. Katsikadelis, Elsevier Academic Press, 2020

Online Resources:

1. https://nptel.ac.in/courses/105/106/105106151/
2. https://nptel.ac.in/courses/105/104/105104189/

Course Code: CE5251	STRUCTURAL STABILITY	Credits 3-0-0: 3

Pre-requisites: None

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

CO1	Determine critical loads for straight columns for different loading and end conditions.
CO2	Determine the critical loads for discrete and continuous systems.
CO3	Assess the buckling of thin walled bars and lateral buckling of beams.
CO4	Assess the buckling of rectangular plates.

Syllabus:

Buckling of Columns: Critical loads with different end conditions and loading - Inelastic buckling - Energy methods - Prismatic and non-prismatic columns under discrete and distributed loadings - General Principles of elastic stability of framed structures.

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.

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 of Beams: Beams under pure bending - I Beams under transverse loading - Energy methods.

Buckling of Plates& Shells: Buckling of Rectangular Plates with various boundary conditions, Introduction to buckling of axially compressed cylindrical shells.

Learning Resources:

Text Books:

1. Theory of Elastic Stability, S. Timoshenko and J Gere, McGraw Hill Education; 2017, 2nd Edition.
2. Principles of Structural Stability Theory, Alexander Chajes, Prentice Hall Inc., 1974.
3. Structural Stability of Columns and Plates, N.G.R Iyengar, Ellis Horwood Ltd, 1988.

Reference Books:

1. Fundamentals of Structural Stability, George J. Simitses and Dewey H. Hodges, Butterworth-Heinemann, 2006.
2. Structural Stability Of Steel:Concepts And Applications For Structural Engineers, Theodore V. Galambos Andrea E. Surovek, John Wiley & Sons, Inc., 2008
3. Thin Walled Structures, A.H. Chilver, Chatto and Windus Ltd., 1967.
4. The Buckling of Plates and Shells, Coxhl, H.L. Pergaman press, 1963.
5. Engineering Analysis - A Survey of Numerical Procedures, Stephen H. Crandall, Krieger Publishing Co.,1986.
6. Buckling of Metal Structures, Bleich, McGraw Hill Book Co., New York, 1952.

Online Resources:

1. https://nptel.ac.in/courses/105/108/105108141/

Course Code: CE5253	SEISMIC ANALYSIS AND DESIGN OF STRUCTURES	Credits 3-0-0: 3

Pre-requisites: None

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

CO1	Identify the Causes and effects of earthquakes
CO2	*Apply concepts of seismic design to structural systems*
CO3	*Perform* earthquake analysis of linear and non linear systems
CO4	Perform Earthquake resistant design of structures

Syllabus:

Causes and Effects: Engineering Seismology, seismic waves, Earthquake size, causes, classification of earthquakes, effects, strong motion characteristics

Concepts of seismic design: Seismic design and seismic performance - Seismic design limit states – serviceability – damage – survival limit states - Structural properties – strength stiffness and ductility - Definition of design quantities – philosophy of capacity design.

Essentials of structural systems for seismic resistance: Structural systems – frames, walls, dual systems - Response in elevation – plan - Influence of building configuration – structural classification.

Earthquake analysis of linear and non linear systems: Response history analysis - Modal analysis – modal response - Response spectrum analysis.

Earthquake resistant design: Application to RCC and Masonry structures

Codal Provisions: Structural modelling – assumptions - Regularity in framing systems – moment redistribution - Principles of design of beams, columns – beam column joints - Ductility demand – soft story concept.

Learning Resources:

Text Books:

1. Dynamics of structures, A.K. Chopra, Prentice Hall, 2020.
2. I.S. 1893 - 2002, Criteria for Earthquake Resistance design of Structures.
3. Earthquake resistant design of structures, Pankaj Agarwal and Manish Shrikhande, 2017.
4. Earthquake Resistant Design and Risk Reduction, D J Dowrick, Willey India, 2011.

Reference Books:

1. Dynamics of Structures, Clough R.W, 2015, 2nd Edition.
2. Structural Dynamics: Theory and Computation, Mario Paz and Young Hoon Kim, Springer Publisher,2018, 6th Edition.
3. Earthquake Resistant Design of Structures, Shashikant K. Duggal, Oxford, 2013, 2nd Edition.
4. Design of multi-story RC Buildings for Earthquake Motions, J A Blume, Newmark and Coming, Portland Cement Association, 1961.
5. Seismic Design of RC and Masonry Buildings, T Paulay and M J N Priestley, Wiley Inter Seience, 1992.

Online Resources:

1. https://nptel.ac.in/courses/105/107/105107204/

Course Code: CE5202	BEHAVIOUR OF CONCRETE STRUCTURES	Credits 3-0-0: 3

Pre-requisites: Concrete Technology, Design of Concrete Structures

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

CO1	Apply the principles of structural concrete and behaviour of beams in flexure.
CO2	Analyze the behavior of beams in shear and torsion.
CO3	Design of columns under combined loading.
CO4	Design RC and PSC members as per Indian Standards and specifications.
CO5	Detail reinforcement in RC and PSC members as per Codes of Practice.

Syllabus:

Introduction: A brief review of Limit State Design Philosophy - Application to beams.

Behaviour of slender Columns: Rectangular and circular columns - Interaction diagrams - Biaxial bending - Interaction surfaces - Design for bi-axial bending.

Behaviour of RC Members in Shear and Torsion: Kani's theory for shear - Skew bending theory for torsion - Different modes of failure in torsion and bending - Design of beams in combined Shear, Bending, and Torque as per I.S. code.

Design of Statically Indeterminate RC Structures: Development of moment curvature diagrams - moment redistribution - Baker's method of design - Ductile Detailing of RC Structures – Earthquake and fire - Confined concrete - Cambridge method of design - Generation of load deflection diagrams.

Yield line theory of Slabs: Analysis and design of slabs.

Pre-stressed Concrete Structures: Moment - Curvature diagrams - Moment redistribution in Pre-stressed concrete beam - Design of continuous beams - Concordant cable and Linear Transformation - Limit state of crack width.

PSC under combined Loading: Behaviour of Pre-stressed Concrete Structures in combined shear, Bending Moment and Torque-I.S. code method.

Serviceability design of RC Structures: Serviceability - Deflection- Short term-Long term deflection due to Shrinkage, Creep- Cracking-Crack width calculation- Vibration control-limits.

Deep Beams: Strut and Tie mechanism - Strut and Tie models – corbels – shear walls.

Learning Resources:

Text Books:

1. Reinforced Cement Concrete Structures, R. Park and T. Paulay, MISL-WILEY Series, Wiley India Pvt. Ltd, 2009.
2. Reinforced and Prestressed Concrete Structures, F.K. Kong and R.H. Evans, CRC Press, 2017, 3rd Edition.
3. Reinforced Concrete: A fundamental Approach, E.G. Nawy, CRC Press, 2002, 5th Edition

Reference Books:

1. Design of Reinforced Concrete Structures: IS:456-2000, N Krishna Raju, CBS Publishers & Distributors; 2019, 4th Edition.
2. Reinforced Concrete Design, C K Wang, C G Salmon, John Wiley & Sons 1998, 6th Edition.
3. Reinforced Concrete Design, Devdas Menon and S. Pillai, McGraw Hill, 2017, 3rd Edition.

Online Resources:

1. https://nptel.ac.in/courses/105/105/105105104/
2. https://nptel.ac.in/courses/105/105/105105105/
3. https://nptel.ac.in/courses/105/106/105106117/

Course Code: CE5211	ANALYSIS AND DESIGN OF BRIDGES	Credits 3-0-0: 3

Pre-requisites: None

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

CO1	Apply the codal provisions for loading and design standards of bridges.
CO2	Design the substructure including pier and pier cap and well elements.
CO3	Design the superstructure of bridge using different methods.
CO4	Design girder bridges and cable stayed bridges.
CO5	Design and select materials suitable for bearings.

Syllabus:

Introduction: Bridge components - Classification – Investigation for bridges – Loads and Loading standards – IRC and Railway loads – Impact.

Bridge substructure: Determination of maximum flood discharge - Determination of linear water way - Determination of maximum depth of scour - Loads acting on substructure - Design of abutment, pier and pier cap - Design of well elements - Sinking of wells.

Bridge Superstructure: Pigeaud's curves method for design of slab - Analysis of beams– Courbon's Method – Hendry Jaeger Method – Guyon and Massonet Method - Box Girder Bridges - Grillage analogy.

Cable Bridges: Advantages - Arrangement of stay cables - types of towers - Linear analysis of cables and towers

Bridge Bearings and expansion joints: Functions, types and selection of bearings - Bearing materials - Design of elastomeric bearings and spherical pot bearings for different conditions - Expansion joints – types of expansion joints.

Learning Resources:

Text Books:

1. Analysis and Design of Substructures: Limit State Design, Swami Saran, Oxford & IBH Publishing Co., 2018, 2nd Edition.
2. Bearings in Structural Engineering, J.E. Long, Wiley, 2016.
3. Essentials of Bridge Engineering, D Johnson Victor, Oxford, 2017,6th edition.
4. Bridge Engineering, S Ponnuswamy, McGraw Hill Education; 2017, 3rd edition.
5. Design of Bridges, N Krishna Raju, Oxford and IBH publishing, 2019, 5th Edition.

Reference Books:

1. Concrete Bridge Design, R.E. Rowe, Elsevier Science and Technology, 1962, 1st Edition.
2. The Analysis of Grid Frameworks and Related Structures, L.G. Hendry and A.W. Jaeger, Chatto & Windus, 1958.
3. Bridge Analysis by Microcomputer, Jaeger & Bakht, Mc Graw Hill, 1989.
4. Grillage Analogy in Bridge Deck Analysis C.S Surana & R. Agarwal, Narosa Publication, 2001.
5. Method of Analysis and Design of Concrete Box Beams with Side Cantilever, Maisel and Roll, Cement and Concrete Associations, 1974.
6. Cable Stayed Bridges: An approach to Modern Bridge Design, M.S. Troitsky, Van Nostrand Reinhold Company, 1988, 2nd edition.
7. Design of Bridge Structures, T.R. Jagdeesh and M.A. Jayaram, Prentice Hall of India Pvt. Ltd., 2020, 2nd Edition

Online Resources:

1. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce23/

Course Code: CE5262	VULNERABILITY AND RISK ANALYSIS	Credits 3-0-0: 3

Pre-requisites: None

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

CO1	Apply Concepts of Risk to earthquake hazards
CO2	Model various components of structures using FEM software.
CO3	Assess seismic vulnerability characteristics of structures.
CO4	Perform Post Earthquake Damage Studies and communicate risk.

Syllabus:

Concepts and Components of Risk: Introduction to Hazard, vulnerability, exposure and risk; Estimation of risk from components for an earthquake hazard.

Overview of Modeling of structures: Application of finite element modelling of structural components Viz., various components of buildings, Bridges etc. (SAP 2000 Software can be used)

Vulnerability assessment of Buildings: Empirical and analytical approaches, building topology, use of intensity scales for estimating seismic vulnerability, Hazus methodology, displacement based approach (Capacity design method).

Risk estimation: Convolution of hazard, vulnerability and exposure to quantify risk, loss ratios, indoor and outdoor casualty rates; Case studies of different projects- Viz., HAZUS, EU-RISK.

Post Earthquake Damage Studies: Earthquake damage surveys, data to be collected, handling and processing of data, classification of damage, and Estimation of fragility from damage data.

Risk Communication: Role of planners, architects, engineers, banks and insurers; Rating of damage assessment, disaster impact analysis given a hazard.

Learning Resources:

Text Books:

1. Earthquake Hazard Analysis, Issues and Insights, Reiter, L. Columbia University Press, 2001.
2. Seismic Hazard and Risk Analysis, McGuire, Robin K., Earthquake Engineering Research Institute, 2004.

Reference Books:

1. Geotechnical Earthquake Engineering, Krammer, S. L., Pearson Education, 1996.
2. Earthquake Protection, Coburn, A. and Spence R., John Wiley and Sons, Ltd. 2002.
3. HAZUS-MH, MR1 & MR2 Technical Manual, FEMA, Federal Emergency Management Agency, Washington, D.C, 2006.

Online Resources:

1. https://nptel.ac.in/noc/courses/noc16/SEM1/noc16-oe01/