NAGARJUNA COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous College under VTU)
(NAAC Accredited with 'A^{+}' Grade, NBA, Accredited)

Syllabus – II Semester M.Tech
STRUCTURAL ENGINEERING

SCHEME AND SYLLABUS

Outcome Based Education Curriculum
2022-2024

Department of Civil Engineering
Nagarjuna College of Engineering & Technology
Mudugurki Village, Venkatagiri Kote Post**,**
Devanahalli Taluk,
Bangalore District-562164

NAGARJUNA
COLLEGE OF ENGINEERING & TECHNOLOGY

An Autonomous College under VTU

DEPARTMENT OF CIVIL ENGINEERING

VISION

To transform the students as leaders in Civil Engineering to achieve professional excellence in the challenging future

MISSION

M1: To provide the Civil Engineering knowledge and skills for students through an excellent academic environment.

M2: Adopting innovative teaching techniques using modern engineering tools for designing, modeling and analyzing the societal and environmental problems.

M3: Developing Communication skill, leadership qualities through team work and skills for continuing education among the students.

M4: To inculcate moral, ethical and professional values among students to serve the society.

M5: Validate engineering knowledge through innovative research projects to enhance their employability and entrepreneurship skills.

Program Educational Objectives (PEOs)

PEO1: Graduates in Civil Engineering will apply the technical knowledge for sustainable societal growth.
PEO2: Graduates of civil Engineering will demonstrate designing, modeling and analyzing skills.
PEO3: Graduates in Civil Engineering will demonstrate good communication skills, dynamic leadership qualities with concern for environmental protection.
PO4: Civil Engineering graduates will be capable of pursuing higher studies, take up research and development work blended with ethics and human values.
PO5: Civil engineering graduates will have the ability to become entrepreneurs thereby switching over from responsive engineering to creative engineering.

Program Outcomes (POs)

PO-1: An ability to independently carry out research /investigation and development work to solve practical problems.
PO-2: An ability to write and present a substantial technical report/document.
PO-3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO-4: Inculcate graduates with qualities of high professional integrity, commitment to societal needs and sustainable development.
PO-5: Use research-based knowledge for innovative projects in Structural engineering.
PO-6: Demonstrate multidisciplinary, individual and teamwork and management principles for entrepreneurship and life-long learning.

Program Specific Outcome (PSO)

PSO-1: Apply the knowledge of Civil Engineering in Sustainable Infrastructure developments.
PSO-2: Identify, analyze and manage Civil Engineering problems with ethical and social responsibilities.
PSO-3: Implementation of relevant codes/ specifications/ guidelines to arrive at comprehensive solutions to address societal needs and exhibit communication and teamwork skills.

TOTAL CREDITS FOR THE COURSE

Sl. No	Semester	Number of Credits
1	First	22
2	Second	18
3	Third	22
4	Fourth	18
	Total Credits	80

Second Semester M.Tech – Scheme

Sl. No	Course	Course Code	Course Title	L:T:P (Hrs/week)	Total Credits	Marks (CIE:SEE)	Total Marks
1	PCC	22CSE21	Earthquake Resistance Design of Structures	3-0-0	3	50:50	100
2	IPCC	22CSE22	Finite Element Analysis	3-0-2	4	50:50	100
3	PEC	22CSE23X	**Elective- I**	3-0-0	3	50:50	100
4	PEC	22CSE24X	**Elective- II**	3-0-0	3	50:50	100
5	MPS	22CSE25	Mini Project with Seminar	3-0-0	3	100:00	100
6	PCCL	22CSE26	Structural Engineering Lab-II	1-0-2	2	50:50	100
7	AUD/ AEC	22AUD/AEC 27	BOS recommended course (Any NPTEL/SWAYAM)				
Total				**16-0-4**	**18**	**350:250**	**600**

Elective–I		
1.	22CSE231	Advanced Design of Pre-stressed Concrete Structures
2.	22CSE232	Design of Bridges
3.	22CSE233	Advanced Structural Analysis
Elective–II		
1.	22CSE241	Design of Tall Structures
2.	22CSE242	Reliability Analysis of Structures
3.	22CSE243	Advanced Design of Steel Structures

BSC: Basic Science Course
PCC: Professional Core
IPCC: Integrated Professional core Courses
MCC: Mandatory Credit Course
AUD/AEC: Audit Course/Ability Enhancement Course
PCCL: Professional Core Course Lab
L: Lecture
P: Practical
T: Tutorial

Note: Mini Project with Seminar: This may be hands-on practice, survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analyzing and authenticating, case studies, etc. Students shall present the seminar based on his /her mini-project. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the program shall be mandatory. The CIE marks awarded for Mini-Project work and Seminar shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester. There is no SEE for this course. Internship: All the students shall have to undergo a mandatory internship of 06 weeks during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in the internship course and have to complete the same during the subsequent University Examination after satisfying the internship requirements.

EARTHQUAKE RESISTANT DESIGN OF STRUCTURES						
Course Code	**L-T-P (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
22CSE21	**3-0-0**	**3**	**50**	**50**	**3 hours**	**40 Hours**

Prerequisites:

Basic understanding of Engineering Seismology, structural analysis and structural dynamics.

Course Objectives:

The Course enable students to learn the basics of engineering seismology, which is required to understand the cause of an earthquake and the movement of seismic waves, through which response spectrum will be developed which is used in design of earthquake resistant structures. The design concepts will be carried out for Reinforced Concrete Structures following IS Codes. In addition to design, students will get an insight to types of seismic analysis for seismic response control.

Syllabus

Module – 1 **[8 hours]**

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 behavior under gravity and seismic loads, Lateral load resisting structural systems, Requirements of efficient earthquake resistant structural system, damping devises, base isolation systems**.**

Module – 2 **[8 hours]**

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 multistoried buildings – using procedures (Equivalent lateral force and dynamic analysis) as per IS-1893.

Module – 3 **[8 hours]**

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, modeling concepts of infill masonry walls. Behavior 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.

Module – 4 **[8 hours]**

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. Structural behavior, design and ductile detailing of shear walls.

Module – 5 **[8 hours]**

Seismic response control concepts – Seismic demand, seismic capacity, Overview of linear and nonlinear procedures of seismic analysis. Performance Based Seismic Engineering methodology, Seismic evaluation and retrofitting of structures.

Course Outcomes:

On completion of this course, students are able to

- Understand the principles of engineering seismology.
- Apply and illustrate lateral load resisting structural systems using codal provisions and seismic response control concepts.
- Design and develop analytical skills.
- Summarize the Seismic evaluation and retrofitting of structures.
- Evaluate the structural response of building under seismic loads.

Text Books:

- Earthquake Resistant Design of Structures, Duggal, 2nd Edition, Oxford University Press.
- Earthquake resistant design of structures - PankajAgarwal, Manish Shrikande – 5 thEdition PHI India.
- Earthquake Resistant Design of Building Structures, 1 st Edition, VinodHosur, WILEY (india)

Reference Books:

- Design of Earthquake Resistant Buildings, Minoru Wakabayashi, 4th Edition, McGraw Hill Pub.
- Seismic Design of Reinforced Concrete and Masonry Buildings, 2 nd Edition, T Paulay and M J N Priestley, John Wiley and son.
- Dynamics of Structures – Theory and Application to Earthquake Engineering- 2nd ed. – Anil K. Chopra, Pearson Education.
- IS – 1893 (Part I): 2002, IS – 13920: 1993, IS – 4326: 1993, IS-13828: 1993

E-Resources

- http://elearning.vtu.ac.in/18/enotes/06CV834/EQ-GPCt.pdf
- https://nptel.ac.in/couses/105/101/105101004

PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1			3		2	1	3	2	1
C2	3		1		2		2	3	3
C3	3		2		2		2	3	3
C4	3		2		2	1	3	2	2
C5	2		3		1		3	3	3
C									

FINITE ELEMENT ANALYSIS						
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
22CSE22	**4-0-0-2**	**4**	**50**	**50**	**3 hours**	**42**

Prerequisites:

Mechanics of Deformable Bodies, Computational Structural Analysis.

Course Objectives:

The students will be able to:

- Provide the fundamental concepts in the theory of finite element analysis.
- Evaluate the problems related to bar element, truss element, beam element and plane element utilizing finite element approach.
- Analyze structure elements by using principles of matrix method.

Syllabus

Module – 1 **[8 hours]**

Introduction: Basic concepts of elasticity – 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.

Module – 2 **[8 hours]**

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

Module – 3 **[8 hours]**

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

Module – 4 **[8 hours]**

Application of Finite Element Method : One dimensional problems - Analysis of simple beams, Beam analysis using two noded element – Strain energy – Potential energy – Minimization of Potential energy, Timoshenko beam element, Two dimensional problems - Analysis of truss. Application to plane stress / strain / axisymmetric problems using CST & Quadrilateral Elements.

Module – 5 **[8 hours]**

Application to Plates & Shells : Bending of thin plates – Introduction, Basic relations in thin plate theory, Displacement models for plate analysis,(C^0, $C^1$and C^2type), Mindlin's plate theory, Stress smoothening technique, Analysis of shells - – Introduction, Forces on shell element, Finite elements for shell analysis.

Course Outcomes:

On completion of this course, students are able to

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of stress-strain behavior of continuum
- Design and develop analytical skills.
- Describe the state of stress in a continuum.
- Understand the concepts of elasticity and plasticity.

Text Books:

- Krishnamorthy C S, "Finite Element Analysis" 2nd Edition, - Tata McGraw Hill.
- Desai C and Abel J F, "Introduction to the Finite Element Method " 1st Edition, - East West PPvt. Ltd., 1972.
- Bathe K J, "Finite Element Procedures in Engineering Analysis " 4th Edition,- Prentice Hall.

Reference Books:

- Bathe K J, "Finite Element Procedures in Engineering Analysis " 4th Edition,- Prentice Hall.
- Rajasekaran. S, "Finite Element Analysis in Engineering Design" 1st Edition,- Whe Publishing.
- Cook R D, Malkan D S &Plesta M.E, "Concepts and Application of Finite Element Analysis"3rdEdition, JohnWiley and Sons Inc., 1989.

E-Resources

- http://www.iitgn.ac.in/fem-course/handouts/Structure-to-FEM.pdf) http://www.engr.uvic.ca/~mech410/lectures/FEA_Theory.pdfhttp://www.adina.com/MI TRES2_002S10_linear.pdfhttp://web.mit.edu/16.810/www/16.810_L4_CAE.pdf
- http://icas.bf.rtu.lv/doc/Book.pdf

PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1	3		2		1			3	
C2	3		2		1			3	
C3	3		2		2			3	
C4	3		1		3			3	
C5	3		1		2			3	
C	3		2		2			3	

ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES						
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
22CSE231	**4-0-0**	**4**	**50**	**50**	**3 hours**	**40**

Prerequisites:

Structural Analysis, Reinforced Cement Concrete, Prestressed Concrete.

Course Objectives:

Students are able to:

- Calculate loss of pre stress in PSC members.
- Study the limit state of PSC beams in flexure and shear, anchorage zone (End block) stress.
- Design of pre-tensioned, post tensioned simple PSC beams, continues and cantilever beam.
- Learn the deflection of PSC beams.
- Understand the behavior of statically indeterminate pre-stressed elements.

Syllabus

Module – 1

Losses of Prestress: Loss of prestress in pre-tensioned and post tensioned members due to various causes like elastic shortening of concrete, shrinkage of concrete, creep of concrete, relaxation of steel, slip in anchorage, bending of member and frictional loss – Analysis of sections for flexure.

Module – 2

Design of Section for Flexure: Allowable stresses, Elastic design of simple beams having rectangular and I-section for flexure, kern lines, cable profile and cable layout. Design of Sections for Shear: Shear and Principal stresses, Improving shear resistance by different prestressing techniques horizontal, sloping and vertical prestressing, Analysis of rectangular and I–beam, Design of shear reinforcement, Indian code provisions.

Module – 3

Deflections of Prestressed Concrete Beams: Short term deflections of uncracked members, Prediction of long-term deflections, load–deflection curve for a PSC beam, IS code requirements for maximum deflections.

Module – 4

Transfer of Prestress in Pretensioned Members : Transmission of prestressing force by bond, Transmission length, Flexural bond stresses, IS code provisions, Anchorage zone stresses in post tensioned members, stress distribution in End block, Anchorage zone reinforcements.

Module – 5

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.

Course Outcomes:

On completion of this course, students will be able to

- Evaluate the loss of pre-stress in different PSC elements.
- Design the PSC elements for flexure and shear.
- Calculate the deflection of PSC beams.
- Analyze the transfer of pre-stress in pre-tensioned members.
- Understand the concepts of statically indeterminate PSC beams.

Reference Books:

1. Krishna Raju, "Prestressed concrete", Tata Mc Graw Hill Book – Co , New Delhi.
2. S. Ramamrutham, "Prestressed concrete", Dhanpat Rai & Sons, Delhi.
3 T.Y. Lin and Burn, "Design of prestress concrete structures", John Wiley, New York.

PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1	3	-	2	-	1	-	2	3	3
C2	2	-	1	-	3	1	2	3	3
C3	2	-	3	-	1	-	2	3	3
C4	3	-	1	-	2	-	2	3	3
C5	2	-	1	-	3	-	2	3	2
C	2	-	2	-	2	1	2	3	2

DESIGN OF BRIDGES						
Course Code	**L-T-P (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
21CSE232	**3-0-0**	**3**	**50**	**50**	**3 hours**	**40**

Prerequisites:

Structural Analysis, Highway Engineering and Design of RC Structures.

Course Objectives:

1. The students will be exposed to the Engineering aspects of concrete bridges
2. The students will understand Various loads that act on the bridges as per IRC.
3. The students will analyze for the maximum BM and SF at critical section using load distributing theories.
4. The students can design various components using limit state method with reinforcement details.

Syllabus

Module – 1 [8 hours]

Introduction & Design of Slab Culvert

Bridge Engineering and its development in past, Ideal site selection for Bridges, Bridge classifications, Forces acting on Bridge. Analysis for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of slab culvert using limit state method with reinforcement details.

Module – 2 [8 hours]

Box Culvert

Introduction to box culvert, advantage of structural continuity, Analysis for maximum BM and SF at critical sections using moment distribution method for various load combinations such as Dead, Surcharge, Soil, Water and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of box culvert using limit state method with reinforcement details.

Module – 3 [8 hours]

T Beam Bridge

Components of T Beam Bridge, Load transfer mechanism, Proportioning the of Components, Analysis of **Slab** using **Pigeauds Method** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of **Slab** using limit state method with reinforcement details. Analysis of **Cross Girder** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of slab using limit state method with reinforcement details. Analysis of **Main Girder** using **Courbon's Method** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of **Main Girder** using limit state method with reinforcement details.

Module – 4 [8 hours]

PSC Bridge

Introduction to Pre & Post Tensioning, Proportioning of Components, Analysis & Structural Design of Slab, Analysis of Main Girder Using **Courbon's Method** for IRC Class AA, Tracked vehicle, Calculations of Prestressing Force, Calculations of Stresses, Cable profile, Design of End Block, Detailing of Main Girder.

Module – 5 **[8 hours]**

Balanced Cantilever Bridge

Introduction & Proportioning of Components, Analysis of Main Girder Using **Courbon's Method** for IRC Class AA, Tracked vehicle Design of Simply Supported Portion, Cantilever Portion, Articulation, using limit state method with reinforcement details.

Course Outcomes:

After studying this course, students will be able to:

1. Describe historical growth, select ideal site and bridge, calculate values of design parameters of slab culvert at critical section as per IRC, design and detailing required for the execution of the project.
2. Carry out analysis of box culvert as per IRC to obtain the values of design parameters and to design and detail the components following IS code procedure.
3. Demonstrate the use of **Pigeauds Method** and **Courbon's Method** in the analysis of T beam bridge as per IRC, design to obtain the safe dimensions various components, optimum reinforcement required following IS code procedure.
4. Display the use of **Courbon's Method** in the analysis of PSC bridge as per IRC,design to obtain the safe value of prestressing force, obtain the dimensions of various components to keep the stresses within codal provisions following IS code procedure.
5. Analysis a balanced cantilever bridge as per IRC and to obtain the safe values of design parameters and to design and detail the components as per IS code procedure

Text Books:

1. Essentials of Bridge Engineering by Dr D Johnson Victor, Oxford & IBH Publishing Co New Delhi
2. Design of Bridges by Dr N Krishna Raju, Oxford & IBH Publishing Co New Delhi

Reference Books:

1. Principles and Practice of Bridge Engineering by S P Bindra, Dhanpat Rai & Sons New Delhi
2. IRC 6 -1966 Standard Specifications And Course Code Of Practice For Road Bridges Section II Loads and Stresses, The Indian Road Congress New Delhi
3. IRC 21 - 1966 Standard Specifications And Course Code Of Practice For Road Bridges Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
4. IS 456 - 2000 Indian Standard Plain and Reinforced Concrete Course Code of Practice (Fourth Revision) BIS New Delhi
5. IS 1343 - Indian Standard Prestressed Concrete Course Code of Practice BIS New Delhi

E-Resources

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PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1									
C2									
C3									
C4									
C5									
C									

ADVANCED STRUCTURAL ANALYSIS						
Course Code	**L-T-P (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
22CSE233	**3-0-0**	**3**	**50**	**50**	**3 hours**	**40 Hours**

Prerequisites:

Strength of Materials and Structural Analysis.

Course Objectives: 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.

Syllabus

Module – 1 **[8 hours]**

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.

Module – 2 **[8 hours]**

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.

Module – 3 **[8 hours]**

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

Module – 4 **[8 hours]**

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.

Module – 5 **[8 hours]**

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.

Course Outcomes:

On completion of this course, students are able to

- Apply Winkler Bach and Strain Energy principles to obtain stresses and deformation in curved members.

• Derive the expressions to Foundation pressure, Deflection, Slope, BM and SF of infinite and semi-infinite Beams resting on Elastic Foundation • Obtain the equations for the shear centre for symmetrical and unsymmetrical from fundamental. • Extrapolate the bending theory to calculate the stresses and deformations in unsymmetrical bending. • Develop the characteristic equation for the buckling load of compound column and stresses and deformations in beam-column.
Text Books: •Krishna Raju N & Gururaj D R "Advanced mechanics of solids and structures", NAROSA Publishers Company Delhi. • Srinath L.S. "Advanced Mechanics of Solids", Tenth Print, Tata McGraw Hill publishing company. New Delhi, 1994. • Vazirani V N and Ratwani M M "Advanced theory of structures and Matrix Method".5th Edition, Khanna publishers, Delhi 1995.
Reference Books: • HetenyiM. "Beams on elastic foundation" 3rd printing, University of Michigan, USA,1952. • Alexander Chatjes "Principles of Structural stability theory", Prentice – Hall of India, NewDelhi, 1974. • Sterling Kinney "Indeterminate Structural Analysis", Oxford & IBH publishers.
E-Resources •https://www.youtube.com/watch?v=s4CN6aVKhPo&list=PLEE5D02698EAAF2C0

PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1	3		2		1		3	2	1
C2	3		2		1		3	2	1
C3	2		3		1		3	2	1
C4	3		2		1		3	3	3
C5	3		2		1		3	3	3
C									

DESIGN OF TALL STRUCTURES						
Course Code	**L-T-P (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
22CSE241	**3-0-0**	**3**	**50**	**50**	**3 hours**	**40**

Prerequisites:

Special Concrete and Structural Dynamics

Course Objectives:

The objective of this course is to make students to learn principles of stability of tall buildings, To design the tall buildings for earthquake and wind resistance. To evaluate the performance of tall structures for strength and stability.

Syllabus

Module – 1 **[8 hours]**

Design Criteria: Design philosophy, loading, sequential loading, and materials – high performance concrete, fiber 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.

Module – 2 **[8 hours]**

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.

Module – 3 **[8 hours]**

Behavior of Various Structural Systems: Factors affecting growth, Height and structural form; High rise behavior, Rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall frames, tubular, cores, Futigger – braced and hybrid mega system.

Module – 4 **[8 hours]**

Analysis and Design: Modeling 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.

Module – 5 **[8 hours]**

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. 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.

Course Outcomes:

On completion of this course, students will be able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of strength and stability
- Design and develop analytical skills.
- Summarize the behavior of various structural systems.
- Understand the concepts of P-Delta analysis understand the concepts of elasticity and plasticity.

Text Books:

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

Reference Books:

- T.Y Lin & D.Stotes Burry, "Structural concepts and system for Architects and Engineers"-John Wiley
- Lynn S.Beedle, "Advances in Tall Buildings"- CBS Publishers and Distributors.
- Dr. Y.P. Gupta – Editor, "Proceedings National Seminar on High Rise Structures-Design andConstruction practices for middle level cities"- New Age International Limited

E-Resources

- https://www.youtube.com/watch?v=-syqppgcoVE&t=15s
- https://www.youtube.com/watch?v=PYZwAWubUeo

PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1									
C2									
C3									
C4									
C5									
C									

RELIABILITY ANALYSIS OF STRUCTURES						
Course Code	**L-T-P (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
22CSE242	**3-0-0**	**3**	**50**	**50**	**3 hours**	**40**

Prerequisites:

Knowledge of Engineering Statistics and basics of structural analysis and RCC

Course Objectives:

- To impart the concept knowledge on data analysis and probability in the context of structural engineering.
- To demonstrate uncertainty in structural engineering with respect to randomness of variables and knowledge of probability distributions.
- To demonstrate principles of structural reliability in order to assess safety due to randomness of variables.
- To perform computations of structural reliability using various methods at component and system level.

Syllabus

Module – 1 **[8 hours]**

Preliminary Data Analysis:

Graphical representation- Histogram, frequency polygon, Measures of central tendency grouped and ungrouped data, measures of dispersion, measures of asymmetry. Curve fitting and Correlation: Fitting a straight line, curve of the form $y = ab_x$, and parabola, Coefficient of correlation.

Module – 2 **[8 hours]**

Probability Concepts: Random events-Sample space and events, Venn diagram and event space, Measures of probability interpretation, probability axioms, addition rule, multiplication rule, conditional probability, probability tree diagram, statistical independence, total probability theorem and Baye's theorem.

Module – 3 **[8 hours]**

Random variables: Probability mass function, probability density function, Mathematical expectation, Chebyshev's theorem. Probability distributions: Discrete distributions. Binomial and Poison distributions, Continuous distributions- Normal, Log normal distributions.

Module – 4 **[8 hours]**

Reliability Analysis: Measures of reliability-factor of safety, safety margin, reliability index, performance function and limiting state. Reliability Methods-First Order Second Moment Method (FOSM), Point Estimate Method (PEM), and Advanced First Order Second Moment Method (Hasofer-Lind's method).

Module – 5 **[8 hours]**

Simulation Techniques: Monte Carlo simulation- Statistical experiments, Confidence limits, sample size and accuracy, Generation of random numbers- random numbers with standard uniform distribution, continuous random variables (normal and lognormal), discrete random variables. System reliability: series, parallel and combined systems.

Course Outcomes:

On completion of this course, students will be able to:

- Understand the concepts of statistics for probabilistic analysis and importance of uncertainty (randomness) in structural analysis and design.
- Apply the theoretical principles of randomness of variables in structural engineering through density functions.
- Analyze components of structure to assess safety using concepts related to structural reliability by various methods.
- Evaluate the safety reliability index at system level

Text Books:

- Ranganathan, R. (1999). "Structural Reliability Analysis and design"- Jaico publishing house, Mumbai, India.
- Devaraj.V & Ravindra.R,(2017),'Reliability based Analysis and Design for Civil Engineers', I.K. International Publishing House Pvt. Ltd, India
- Ang, A. H. S., and Tang, W. H. (1984). "Probability concepts in engineering planning and design"- Volume –I, John Wiley and sons, Inc, New York.

Reference Books:

- Ang, A. H. S., and Tang, W. H. (1984). "Probability concepts in engineering planning and design"-Volume –II, John Wiley and sons, Inc, New York.
- Milton, E. Harr (1987). "Reliability based design in civil engineering"- Mc Graw Hill book Co.
- Nathabandu, T., Kottegoda, and Renzo Rosso (1998). Statistics, "Probability and reliability for Civil and Environmental Engineers"- Mc Graw Hill international edition, Singapore.

E-Resources

- https://www.youtube.com/watch?v=uutg8jKrL9w
- https://www.youtube.com/watch?v=OwuT0B2Uywc&list=PLFEqFwyPC3WwjTp4KDuannMGGtAUVnfE4
- https://www.youtube.com/watch?v=n-YMzb6xTsA&list=PLOnJQiDsowogZnvfY3HUR34pjrH7hZLpD

PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1									
C2									
C3									
C4									
C5									
C									

ADVANCED DESIGN OF STEEL STRUCTURES						
Course Code	**L-T-P- S (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
22CSE243	**4-0-0-0**	**4**	**100**	**100**	**3 hours**	**40 Hrs**

Prerequisites:

Engineering Mechanics, Strength of Materials, Structural Analysis and Design of Steel structures

Course Objectives:

This course will enable students to

1. Understand the behavior and working principles of steel structures and design as per standards.
2. Understand the background to the design provisions for hot-rolled and cold-formed steel structures, including the main differences between them.
3. Proficiency in applying the provisions for design of columns, beams, beam-columns.
4. Design structural sections for adequate fire resistance.

Syllabus

Module – 1 **[8 hours]**

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.

Module – 2 **[8 hours]**

Beam- Columns in Frames: Behavior 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

Module – 3 **[8 hours]**

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).

Module – 4 **[8 hours]**

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**.**

Module – 5 **[8 Hours]**

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.

Course Outcomes:

After studying this course, students will be able to:

- Acquire the knowledge of the use of steel structures for infrastructure development.
- Understand the behavior of Light gauge steel members.
- Use appropriate methods for designing the cold formed/unrestrained beams.
- Analyze beam column behavior.
- Understand fire resistance concept required for present days.

Text Books:

- N. Subramanian, "Design of Steel Structures: Theory and Practice", Oxford university Press, U.S.A, Third Edition, 2011
- Duggal. S. K, "Design of Steel Structures", McGraw Hill New Delhi, 2010
- Dayaratnam P. "Design of Steel Structures, "S. Chand Limited, New Delhi. 2008

Reference Books:

- John E. Lothers, "Structural Design in Steel", Prentice Hall, 1999.
- Neal. B.G.,"Plastic Method of Structural Analysis", Taylor& Francis, Third Edition, 1985.
- Ramchandra, "Design of Steel Structures", Vol I & II Standard Book House, Delhi, 1975.
- Edmin H. Gaylord, J. Charles. N. Gaylord & James E. Stall Meyer, "Design of steel structures", 3rdEdition, McGraw – Hill International1992.

E-Resources

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=qJV5zdx7NJs&t=10s https://www.youtube.com/watch?v=aLgdv91U2OQ Skill Development Activities Suggested • Conduction of technical seminars on recent research activities • Group Discussion

PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1	1		1				1	2	2
C2	2		2	2			1	2	3
C3	2	1	2	2			1	2	3
C4	3	1	2	2			1	2	3
C5	3	2	2	2			1	2	3
C	2.2	1.33	1.8	2			**1**	2	2.8

MINI PROJECT WITH SEMINAR						
Course Code	**L-T-P (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
22CSE25	**3-0-0**	**3**	**100**	**00**	**3 hours**	**---**

Prerequisites:

Basic Knowledge about the Subjects in Civil Engineering and Laboratory tests.

Course Objectives: The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Syllabus

Each student, under the guidance of a Faculty, is required to

• Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.

• Carryout literature survey, organize the Course topics in a systematic order.

• Prepare the report with own sentences.

• Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.

• Present the seminar topic orally and/or through power point slides.

• Answer the queries and involve in debate/discussion.

• Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

Marks distribution Seminar Report: 30 marks Presentation skill: 50 marks Question and Answer: 20 marks.

Course Outcomes:

On completion of this course, students are able to

- Demonstrate the application of relevant subjects of structural engineering
- Exhibit independent thinking and analysis skills
- Adopt research oriented ability to experimental procedures to validate theories
- Develop the interpersonal and improve communication skills
- Prepare and present research projects/reports

PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1	1		3			2	3	2	1
C2	1		3		2		2	3	1
C3	2			1	3		3	3	2
C4		2		1		3	2	3	3
C5		3		2		1	2	2	3
C									

STRUCTURAL ENGINEERING LAB - II						
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**CIE Marks**	**SEE Marks**	**SEE Duration**	**Total Lecture Hours**
22CSEL26	**0-0-4-0**	**2**	**50**	**50**	**3 hours**	**30**

Prerequisites:

Reinforced Cement Concrete, Structural Analysis, Analysis and design lab.

Course Objectives:

The students will be able to:

The objective of this course is to make students to learn the software's used for structural analysis and to access the performance of structures for static and dynamic conditions and also to analyze the behavior of folded plates and shells and to developing the mathematical design sheets using modern tools.

Syllabus

1. Analysis and design of RC structure by using software (ETABS / STAADPRO)
   - Residential building
   - Industrial building
2. Analysis and design of Steel structure by using software (ETABS / STAADPRO)
   - Residential building
   - Industrial building
3. Analysis and design of earthquake resistance building structure by using software.
   - Static analysis
   - Dynamic analysis
4. Analysis of folded plates using software.
5. Analysis of shells using software.
6. Preparation of SPREAD sheets for structural design.

Course Outcomes:

On completion of this course, students are able to

1. Understand the principles of structural analysis and design.
2. Achieve the knowledge of design utilizing software skills.
3. Summarize the performance of structures for static and dynamic forces.
4. Study the concept of folded plates and shells.
5. Prepare the excel sheets for structural design.

Reference Books:

- Software Manuals
- Indian Standard code for concrete mix design 10262: 2019.
- Indian Standard code for plain and reinforced concrete 456: 2000.
- Indian Standard code methods of tests for strength of concrete 516: 1959.
- Indian Standard code for high strength steel bars 1786: 2008.

PO'S CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
C1	3	-	2	-	1	-	-	3	-
C2	2	-	3	-	1	-	-	3	-
C3	2	-	1	-	3	-	-	3	-
C4	2	-	3	-	1	-	-	3	-
C5	2	-	3	-	1	-	-	3	-
C	2.2	-	2.4	-	1.4	-	-	3	-