NAGARJUNA COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous College under VTU)
(NAAC Accredited with 'A' Grade, NBA Accredited)

Syllabus – I to IV Semester M.Tech

STRUCTURAL ENGINEERING SCHEME AND SYLLABUS

NAGARJUNA
COLLEGE OF ENGINEERING & TECHNOLOGY

Outcome Based Education Curriculum

2021-2023

Department of Civil Engineering
NAGARJUNA COLLEGE OF ENGINEERING & TECHNOLOGY
Mudugurki Village, Venkatagiri Kote Post**,**
Devanahalli taluk,
Bangalore district - 562 164

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 teamwork 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)

1. Apply the knowledge of fundamentals of Civil Engineering to analyze complex problems in Structural Engineering.
2. Prepare and present the technical data in to a report/document in the thrust area of structural engineering.
3. Use of modern tool for analysis and design of complex structural systems.
4. Inculcate graduates with qualities of high professional integrity, commitment to societal needs and sustainable development.
5. Use research based knowledge for innovative projects in Structural engineering.
6. Demonstrate multidisciplinary, individual & team work and management principles for 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	23
2	Second	23
3	Third	22
4	Fourth	20
	Total Credits as Per VTU Norms	88

First Semester M.Tech-Scheme

Sl . No	Subject Code	Subject	Teaching Department	L:T:P:S (Hrs/week)	Total Credits	Marks
1.	21CSE11	Advanced Design of RC Structures	CV	4-0-0-2	4	100
2.	21CSE12	Mechanics of Deformable Bodies	CV	4-0-0-2	4	100
3.	21CSE13	Computational Structural Mechanics	CV	4-0-0-2	4	100
4.	21CSE14	Structural Dynamics	CV	4-0-0-2	4	100
5.	21CSE15X	**Elective- I**	CV	3-0-0-2	3	100
6.	21CSE16	Structural Engineering Lab – I	CV	0-0-2-1	2	100
7.	21CSE17	Research Methodology & IPR	CV	2-0-0-1	2	100
Total				**21-0-2-12**	**23**	**700**

Elective- I		
1	21CSE151	Advanced Structural Analysis
2	21CSE152	Soft Computing in Civil Engineering
3	21CSE153	Rehabilitation and Retrofitting of Structures

L - Lecture	T - Tutorials	P - Practical	S - Self Study

Second Semester M.Tech - Scheme

Sl . No	Subject Code	Subject	Teaching Department	L:T:P:S (Hrs/week)	Total Credits	Marks
1.	21CSE21	Reliability Analysis of Structures	CV	4-0-0-2	4	100
2.	21CSE22	Earthquake Resistant Design of Structures	CV	4-0-0-2	4	100
3.	21CSE23	Finite Element Analysis	CV	4-0-0-2	4	100
4.	21CSE24x	**Elective – II**	CV	4-0-0-2	4	100
5.	21CSE25x	**Elective – III**	CV	4-0-0-2	4	100
6.	21CSE26	Structural Engineering Lab – II	CV	0-0-2-1	2	100
7.	21CSE27	Technical Seminar - I	CV	0-0-0-2	1	50
Total				20-0-2-13	**23**	**650**

Elective – II		
1.	21CSE241	Advanced Design of Pre-stressed Concrete Structures
2.	21CSE242	Advanced Design of Bridges
3.	21CSE243	Optimization of Structures
Elective – III		
1.	21CSE251	Design of Tall Structures
2.	21CSE252	Smart Materials
3.	21CSE253	Advanced Design of Steel Structures

L - Lecture	T - Tutorials	P - Practical	S - Self Study

Note:

Technical Seminar1:

1. The students in consultation with their respective guides should select a suitable technical topic for the seminar.
2. 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. The CIE marks awarded for Technical Seminar-1 shall be based on the evaluation of Seminar report, Seminar Presentation skill and question and answer session in the ratio 50:25:25.
3. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

Third Semester M.Tech - Scheme

Sl . No	Subject Code	Subject	Teaching Dept	L:T:P:S (Hrs/week)	Total Credits	Marks
1.	21CSE31	Design of Substructures	CV	4-0-0-2	4	100
2.	21CSE32x	**Elective – IV**	CV	4-0-0-2	4	100
3.	21CSE33x	**Elective – V**	CV	4-0-0-2	4	100
4.	21CSE34	Dissertation - Phase I	CV	0-0-4-4	3	100
5.	21CSE35	Mini project	CV	0-0-2-0	2	100
6.	21CSE36	Internship	CV	0-0-4-0	4	100
7.	21CSE37	Technical Seminar-II	CV	0-0-0-2	1	50
Total				**12-0-10-12**	**22**	**650**

Elective – IV		
1.	21CSE321	Design of Plates and Shells
2.	21CSE322	Design of Precast and Prefabricated Structures
3.	21CSE323	Stability of Structures
Elective – V		
1.	21CSE331	Design of Steel - Concrete Composite Structures
2.	21CSE332	Construction Techniques and Management
3.	21CSE333	Structural Health Monitoring
4.	21CSE334	Formwork Design of Structures

L - Lecture	T - Tutorials	P - Practical	S - Self Study

Note:

Internship:

1. All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters.
2. VIVA VOCE examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester.
3. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Technical Seminar II:

1. The students in consultation with their respective guides should select a suitable technical topic for the seminar.
2. 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. The CIE marks awarded for Technical Seminar-II, shall be based on the evaluation of Seminar report, Seminar Presentation skill and question and answer session in the ratio 50:25:25.
3. Participation in the seminar by all postgraduate students of the same and other semestersof the programme shall be mandatory.

Dissertation Phase-I:

1. Students in consultation with the guide/co-guide if any shall pursue literature survey and complete the preliminary requirements of selected dissertation work. Each student shall prepare relevant introductory dissertation document and present it to the committee.
2. 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. The CIE marks awarded for dissertation phase-1 shall be based on the evaluation of interim dissertation report, presentation skill and question and answer session in the ratio 50:25:25.

Fourth Semester M.Tech – Scheme

Sl. No	Course Code	Course Name	Teaching Department	L:T:P:S (Hrs/week)	Total Credits	Marks
1	21CSE41	Dissertation - phase II	CV	0-0-18-6	4	50
2	21CSE42	Dissertation - phase III	CV	0-0-18-6	4	50
3	21CSE43	Dissertation Evaluation	CV	0-0-6-0	6	100
4	21CSE44	Viva Voce	CV	0-0-6-0	6	100
Total				**0-0-48-12**	20	300

IC - Integrated Course	L - Lecture	T - Tutorials	P - Practical	S - Self Study

Note:

Project Phase - 2, 3 & FINAL VIVA VOCE:

1. CIE marks for Phase II of Dissertation work shall be awarded by a committee comprising of HOD as Chairman, Guide/co-guide, if any, and a senior faculty of the department.
2. CIE marks for Phase III of Dissertation work shall be awarded by a committee comprising of HOD as Chairman, Guide/co-guide, if any, and a senior faculty of the department.
3. SEE shall be at the end of IV semester, the dissertation Report is subjected to plagiarism check. The SEE marks are awarded for conduction of Viva Voce of dissertation work and shall be based on the evaluation of dissertation Report, dissertation Presentation skills and question and answer session in the ratio 50:25:25.

FIRST SEMESTER

ADVANCED DESIGN OF RC STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE11	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The objective of this course is to make students to learn principles of Structural Design, To design different types of structures and to detail the structures. To evaluate performance of the structures.

Syllabus

Module – I

Design of continuous beams with and without redistribution of moments: Introduction, effective span, span /depth ratio, stiffness, loading pattern, moment redistribution, bending moment and shear force co-efficient.

Design of curved beams-analysis of bending and torsional moment in circular beams.

10 hrs

Module – II

Design of flat slabs: Introduction, proportioning of flat slabs, advantages and limitations of flat slabs, determination of bending moment and shear force, the direct design method, equivalent frame method, slab reinforcement, design of flat slabs.

Design of Waffle and grid floors: Introduction, size of beams and topping, Design of grid floor by Rankine's Grashoff method, IS-456:2000 method.

10 hrs

Module – III

Design of bunkers: Introduction, Difference between bunkers and silos, Design ofrectangular bunker, Design of tension member, Design of circular bunker.

Design of silos-silos for storage of cement,

10 hrs

Module – IV

Design of chimneys: Introduction, Design factors, stresses due to self-weight and wind load. Stresses in horizontal reinforcement, temperature stresses, combined effect of self-weight, wind load and temperature stress in hoop reinforcement, Design of chimneys.

10 hrs

Module – V

Design of miscellaneous RC structures:

Shear walls-classification of shear walls, loads in shear walls, design of rectangular and flanged shear walls,

Deep beams-Introduction, parameters influencing design, minimum thickness, design of deep beams, checking for local failure.

Folded plates-General features, types, analysis of folded plates, structural behavior of folded plates, methods.

10 hrs

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 Structural Design and structural performance.
- Design and develop analytical skills.
- Summarize the principles of Structural Design and detailing

Reference Books:

- P.C.Varghese, "Advanced Reinforced Concrete Design", Prentice-Hall of India, New Delhi, 2005
- N.Krishna raju, "Advanced Reinforced Concrete Design".
- S S Bavikatti, "Advanced Reinforced Concrete Design".
- A Park and Paulay, "Reinforced and Prestressed Concrete"2000
- Lin TY and Burns N H, "Reinforced Concrete Design".
- Kong KF and Evans T H "Design of Prestressed Concrete Structures

E-Resources:

- **https://nptel.ac.in/courses/105/106/105106176/**

MECHANICS OF DEFORMABLE BODIES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE12	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

To enable the students to gain the knowledge on principles of Analysis of Stress and Strain which makes them able to predict the stress-strain behaviour of continuum. Expose the students for the evaluation of the stress and strain parameters and their inter relations of the continuum.

Syllabus

Module – I

Theory of Elasticity: Introduction: Definition of stress and strain and strain at a point, components of stress and strain at point of Cartesian and polar co-ordinates. Constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases. 10hrs

Module – II

Transformation of stress and strain at a point, Principal stresses and principal strains, invariants of stress and strain, hydrostatic and deviatric stress, spherical and deviatoric strains, Concepts of maximum shear stress and maximum shear strain.

10hrs

Module – III

Plane stress and plane strain: Airy's stress function approach to 2-D problems of elasticity, simple problems of bending of beams. Solution of axi-symmetric problems, stress concentration due to the presence of a circular hole in plates.

10 hrs

Module – IV

Elementary problems of elasticity in three dimensions, stretching of a prismatic bar by its own weight, twist of circular shafts, torsion of non-circular sections, membrane analogy, Propagation of waves in media. Applications of finite difference equations in elasticity.

10 hrs

Module – V

Theory of Plasticity: Stress – strain diagram in simple tension, perfectly elastic, Rigid – Perfectly plastic, Linear work –hardening, Elastic Perfectly plastic, Elastic Linear work hardening materials, Failure theories, yield conditions, stress – space representation of yield criteria through Westergard stress space, Tresca and Von-Mises criteria of yielding.

10 hrs

Course Outcomes:

Students will be 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 continuum in 2 and 3- dimensions.
- Understand the concepts of elasticity and plasticity.

Reference Books:

- Srinath L.S., Advanced Mechanics of Solids , 10th print, Tata McGraw Hill, New Delhi, 1994.
- Verma P.D.S, "Theory of Elasticity", Vikas Publishing Pvt. Ltd., 1997.
- Chenn W.P and Hendry D.J, "Plasticity for Structural Engineers ", Springer Verlag., 1988
- Valliappan C, "Continuum Mechanics Fundamentals", Oxford IBH Publishing Co. Ltd., 1982.
- Sadhu Singh, "Applied Stress Analysis", 1st Edition, Khanna Publishers., 2014.
- Timoshenko &Goodier, "Theory of Elasticity", 3rd Edition, McGraw Hill New York 1970.

E-Resources:

- https://nptel.ac.in/courses/112/107/112107146/

COMPUTATIONAL STRUCTURAL MECHANICS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE13	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The objective of this course is to understand the principles of Structural Analysis, numerical methods, and analyze the structural members using flexibility and stiffness matrix method.

Syllabus

Module – I

Introduction: Static and Kinematic indeterminacy, numerical problems on static and kinematic indeterminacy. Concepts of stiffness and flexibility. Energy concepts. Principle of minimum potential energy and minimum complementary energy. Flexibility and Stiffness matrices for truss, beam and Portal Frame.

10 hrs

Module – II

Analysis using Flexibility method: Flexibility matrix for continuous beams, plane trusses and rigid plane frames. Analysis of continuous beams, plane trusses and rigid plane frames by flexibility method (having not more than 3 coordinates – 3x3 flexibility matrix.

10 hrs

Module – III

Analysis using Stiffness Method: Stiffness matrix for continuous beams, plane trusses and rigid plane frames. Analysis of continuous beams, plane trusses and rigid plane frames by stiffness method (having not more than 3 coordinates – 3x3 stiffness matrix)

10 hrs

Module – IV

Effects of temperature change and lack of fit: Flexibility method of analysis-continuous beams, plane trusses and rigid plane frames by the flexibility method which are subjected to the effect of temperature change, continuous beams, plane trusses and rigid plane frames by the flexibility method which are subjected to the effect of lack of fit (having not more than 3 coordinates – 3x3 flexibility matrix) .

10 hrs

Module – V

Numerical methods: Solution techniques including numerical problems for simultaneous equation developed in slope deflection method and other methods of structural analysis for beam and frames. Numerical problems on Gauss elimination and Numerical problems on Cholesky method.

10 hrs

Course Outcomes:

On completion of this course, students are able to

- Apply the knowledge of basics of indeterminacy.
- Analyze the different structural elements using flexibility matrix method and stiffness matrix method.
- Determine the stresses developed in structural members due to temperature change and lack of fit.
- Understand the different solution techniques.

Reference Books:

- S.Rajasekaran, "Computational Structural Mechanics", PHI, New Delhi, 2001.
- K.Jain "Advanced Structural Analysis with Computer Application" Nemchand and Brothers, Roorkee, India, 2005.
- F.W.Beaufait et al., "Computer methods of Structural Analysis", Prentice Hall, 1970.
- W.Weaver and J.H.Gere, "Matrix Analysis of Framed Structures", Van Nastran, 1980.
- H.KardeStuncer, "Elementary Matrix Analysis of Structures", McGraw Hill 1974.
- M.F.Rubinstein "Matrix Computer Methods of Structural Analysis "Prentice – Hall., 2010.

E-Resource:

- **https://vtu.ac.in/pdf/cbcs/pg/2018/msesyll.pdf**

STRUCTURAL DYNAMICS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE14	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to learn the basic principles of structural dynamics, and implement principles of structural dynamics through different methods and to apply the same for free and forced vibration of structures to evaluate dynamic characteristics of structure. Also they will be able to study the different dynamic analysis procedures for calculating the response of structures to design structures against wind, earthquake and other dynamic loads.

Syllabus

Module – I

Introduction: Introduction to Dynamic problems in Civil Engineering, Concept of degrees of freedom, D-Alembert's principle, principle of virtual displacement and energy principles Dynamics of Single-degree-of-freedom systems: Mathematical models of Single-degree-of-freedom systems system, Free vibration response of damped and un damped systems. Methods of evaluation of damping.

10Hrs

Module – II

Response of Single-degree-of-freedom systems to harmonic loading (rotation unbalance, reciprocating unbalance) including support motion, vibration isolation, transmissibility, Numerical methods applied to Single-degree-of-freedom systems -Duhamel integral, principle of vibration-measuring instruments – seismometer and accelerometer.

10 Hrs

Module – III

Dynamics of Multi-degree freedom systems: Mathematical models of multi-degree-of-freedom systems, Shear building concept, free vibration of undamped multi-degree-of-freedom systems - Natural frequencies and mode shapes – orthogonality property of modes.

10 Hrs

Module – IV

Response of Shear buildings for harmonic loading without damping using normal mode approach. Response of Shear buildings for forced vibration for harmonic loading with damping using normal mode approach, condition of damping uncoupling.

10 Hrs

Module – V

Approximate methods: Rayleigh's method Dunkarley's method, Stodola's method. Dynamics of Continuous systems: Free longitudinal vibration of bars, flexural vibration of beams with different end conditions. Stiffness matrix, mass matrix (lumped and consistent); equations of motion for the discretized beam in matrix form.

10Hrs

Course Outcomes:

On completion of this course, students are able to

- Understand the principles of Structural Dynamics
- Have the Knowledge of vibration analysis of structures with different degrees of freedom
- Solve problems on single degree of freedom system
- Summarize the solution techniques for dynamics of Multi-degree freedom systems
- Understand the concepts of damping in structures.

Reference Books:

- Structural Dynamics- Mario Paz: CBS publishers.
- Structural Dynamics- Clough & Penzien: TMH
- Vibrations, structural dynamics- M. Mukhopadhaya : Oxford IBH
- Dynamics of Structures – Theory and Application to Earthquake Engineering"- 2nd ed., Anil K. Chopra, Pearson Education.
- Earthquake Resistant Design of Building Structures, Vinod Hosur, WILEY (india)
- Vibration Problems in Engineering Timoshenko, S, Van-Nostrand Co

E-Resources:

- **https://nptel.ac.in/courses/105/106/105106151/**

ADVANCED STRUCTURAL ANALYSIS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE151	**3-0-0-2**	**3**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

This course enables the students to discuss the concepts of moments, deformation and pressure in beams, columns and frames. Apply the concept of mathematics to derive differential equation related to beams, columns and frames.

Syllabus

Module – I

CURVED BEAMS: Introduction to curved beam & assumptions, WINKLER BACH equation, Limitation, Radius of neutral surface of recangular, triangular sections, Trapezoidal and circular sections, Stress distribution in open curved members. Hooks etc, Problems on Hooks, Problems continued, Stress distribution in closed rings, Stress distribution in chain links. Deformations of open, thin curved members, Problems on thin curved members, Deformations of closed thin curved members such as rings, Problems on closed rings.

10Hrs

Module – II

BEAMS ON ELASTIC FOUNDATIONS: Differential equation of elastic line, Interpretation of constants of integration, Infinite beam with concentrated load, Infinite beam with moment & UDL, Infinite beam problems, Semi-infinite beams with Concentrated load and moment, Semi-infinite beam with fixed and hinged conditions, Problems on semi-infinite beams, Finite beams with symmetrical load, Problems on symmetrical load, Finite beams with unsymmetrical load, Problems on unsymmetrical load**.**

10Hrs

Module – III

STABILITY – BENDING OF PRISMATIC BARS : Governing differential equation for axial and lateral loads, Problems on axial and conc. loads, Problems on axial and UDL, Beam column with different end conditions, Problems on Beam columns, Buckling of columns Assumptions, Eulers theory of buckling Governing differential equation, Columns with different end conditions, Columns with different end conditions, Columns with varying cross sections, and frames, Introduction to energy method and problems, Numerical method applied to column, Problems on Numerical methods.

10Hrs

Module – IV

INFLUENCE LINES: Muller Breslau principle, ILD for Reaction, SF, BM of 2 span beams, ILD for Reaction of 3span continuous beam, ILD for shear force of 3 span continuous beams, ILD for moment of 3 span continuous beams, ILD for Reaction components of portal frames.

10Hrs

Module – V

TENSION COEFFICIENT METHOD: Introduction to Tension coefficient method, Application of TCM to 2D frames, Application of TCM to 3D frames, Problems on 3D frames.

10Hrs

Course Outcomes:

On completion of this course, students are able to

- Formulate the differential equation for the beams with various loading condition.
- Evaluate deflection, moments, stresses and shear in beams, columns and frames.
- Analyse the stability of prismatic bars using Euler's theory.
- Examine the influence of geometry, loads, and boundary conditions on the deflection, stresses, moments and shear force of beams, columns and frames.
- Design the 2D and 3D frames using tension coefficient method.

Reference 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.
- HetenyiM."Beams on elastic foundation" 3rd printing, University of Michigan, USA, 1952.
- Alexander Chatjes "Principles of Structural stability theory", Prentice – Hall of India, New Delhi, 1974.
- Junnarkar S.B. "Mechanics of Structure". Vol – III, VIVEK Publications, 1962.
- Sterling Kinney "Indeterminate Structural Analysis", Oxford & IBH publishers.

E-Resources:

- https://nptel.ac.in/courses/105/106/105106050/

SOFT COMPUTING IN CIVIL ENGINEERING				
Course Code	**L:T:P:S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE152	**3-0-0-2**	**3**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to learn various soft computing techniques like Neural Networks, Support Vector machines, Genetic Algorithms, Fuzzy Logic for solving real life civil engineering problem.

Syllabus

Module – I

Introduction: Introduction of soft computing, Characteristics of Neuro Computing and Soft Computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing.

10hrs

Module – II

Neural Networks: What is a Neural Network?, The Human Brain, Models of a Neuron, Neural Networks Viewed As Directed Graphs, Feedback, Network Architectures, Learning Processes, Learning Tasks, Applications of neural networks.

10hrs

Module – III

Support vector machines: Introduction, Optimal Hyperplane for Linearly Separable Patterns, Optimal Hyperplane for Non separable Patterns, The Support Vector Machine Viewed as a Kernel Machine, Design of Support Vector Machines, and Applications.

10hrs

Module – IV

Introduction to Genetic Algorithms (GA): Introduction, Fundamentals, Population, Fitness Function, Parent Selection, Crossover, Mutation, Survivor Selection, Termination Condition, Applications of GA.

10hrs

Module – V

Introduction to Fuzzy Logic: Introduction, Classical sets and Fuzzy sets, Basic concepts in Fuzzy Set theory – Operations of Fuzzy sets , classical relations and fuzzy relations, membership functions and its properties, Fuzzy Logic Principles – Fuzzy inference – Fuzzy Rule based systems – Fuzzification and defuzzification – Types.

10hrs

Course Outcomes:

On completion of this course, students will be able to

- Learn various soft computing frame works.
- Understand different soft computing techniques like Neural Networks, Support Vector machines, Genetic Algorithms, Fuzzy Logic.
- Recognize the feasibility of applying a soft computing methodology for a particular problem.
- Effectively use existing software tools to solve real problems using a soft computing approach.

Reference Books:

- Neural Networks and Learning Machines, S.Haykins, 3rd edition, Prentice Hall of India, 2009.
- Fuzzy logic with engineering application, Ross T.J., McGraw Hill International Edition, 1995.
- Engineering Optimization- Theory and Practice, S S Rao, 4th edition, John Wiley & sons, 2009.

RETROFITTING AND REHABILITATION OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE153	**3-0-0-2**	**3**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The course seeks to recognize the mechanisms of degradation of concrete structures, provide the students with the knowledge of available techniques and their application for strengthening or upgrading existing structural systems. It also provides how to conduct field monitoring and non-destructive evaluation of concrete structures.

Syllabus

Module – I

General: Introduction 3R, Cause of deterioration of concrete structures includes Fire attack, frost attack, abrasion, erosion etc., Condition survey of affected structure, Diagnostic methods, interpretation & assessment out of preliminary investigations, experimental investigations using NDT & PDT/load testing, Types of reinforcement, assessing the quality of steel , corrosion mapping, core drilling and other instrumental methods Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking.Introduction to Forensic science & Law.

10Hrs

Module – II

Influence on Serviceability and Durability: Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection, introduction to service life estimation.

10Hrs

Module – III

Maintenance and Repair Strategies: Definitions: Maintenance, repair and rehabilitation, Facets of Maintenance importance of Maintenance Preventive measures on various aspects. Structural repairs of prestress concrete systems, Inspection, Assessment procedure for evaluating a damaged structure cause of deterioration – testing techniques.

10Hrs

Module – IV

Materials for Repair: Special concretes and mortars, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiber reinforced concrete. Techniques for Repair: Rust eliminators and polymers coating for rebar during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shot Crete Epoxy injection, Mortar repair for cracks, shoring and underpinning.

10 Hrs

Module – V

Examples of Repair to Structures: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure, engineered demolition techniques for dilapidated structures - case studies.

10 Hrs.

Course Outcomes:

On completion of this course, students are able to

- Get the knowledge of cause for distress and remedial measures in damaged structures.
- Analyze systematically the distressed structures.
- Design and development of repair materials and technology.
- Use modern NDT tools to diagnose distressed structures elements.
- Identify rehabilitation and retrofitting techniques for the damaged structures.

Reference Books:

- Dr B Vidivelli "Rehabilitation of Concrete Structures". 1st edition., Standard Publisher Distributors., 2009.
- Sidney, M. Johnson "Deterioration, Maintenance and Repair of Structures". Krieger Publishing Co. 1980.
- Denison Campbell, Allen & Harold Roper, "Concrete Structures – Materials, Maintenance and Repair"- Longman Scientific and Technical., 1991.
- R.T. Allen, S.C. Edwards and D N Shaw, "Repair of Concrete Structures"-Blakie and Sons, CRC Press, 1992.
- Raiker R.N., "Learning for failure from Deficiencies in Design, Construction and service"-R&D Center (SDCPL)., 1987.

STRUCTURAL ENGINEERING LAB - I				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE16	**0-0-2-1**	**2**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Apprehend the principles of concrete mix design as per Indian standards.
- Acquire the knowledge on behavior of concrete in fresh and hardened state.
- Provide an exposure to modern techniques to test rate of corrosion and Non-Destructive testing methods.
- Evaluate dynamic behavior of multi-story building.

Syllabus

1. **Conventional concrete Mix Design** – OPC / PPC / PSC, Fresh property, Mechanical properties and Durability properties - RCPT, water absorption and chemical attack at different ages.
2. **High performance concrete and High Strength Concrete Mix design** – Fresh property, Mechanical properties and Durability properties - RCPT, water absorption and chemical attack at different ages.
3. Accelerated corrosion test by impressed voltage.
4. Corrosion damage measurement by Open Circuit Potential method.
5. In situ testing of concrete structures by Rebound Hammer and Ultrasonic Pulse Velocity.
6. Experiments on vibration of multi storey frame models for Natural frequency and modes.

Course Outcomes:

On completion of this course, students are able to

- Design and conceptualize concrete mixes as per Indian Standards for structural components.
- Determine the engineering properties of concrete as per Indian Standards.
- Comprehend the factors affecting mechanical properties and durability properties of concrete.
- Evaluate the extent of reinforcement corrosion embedded in different cement composites.
- Access the quality of structural elements by conducting Non-Destructive Tests.
- Determine the natural frequency and modes of multi-story framed models to stimulated vibration.

Reference Books:

- 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.
- Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration ASTM C 1202 – 19.
- Indian Standard code for high strength steel bars 1786: 2008.
- Indian Standard code non-destructive testing of concrete (Ultrasonic Pulse Velocity) - methods of test IS 13311 (Part 1): 1992.

- Indian Standard code non-destructive testing of concrete (Rebound Hammer) - methods of test IS 13311 (Part 2): 1992.
- Neville A.M. "Properties of Concrete"- 5th Ed., Pearson Education Ltd., 2011.

E-Resource:

- https://civilenggascent.com/is-10262-2019-pdf/
- http://www.spongeiron.in/standards/is.1786.2008.pdf
- https://www.iitk.ac.in/ce/test/IS-codes/is.13311.1.1992.pdf
- https://www.iitk.ac.in/ce/test/IS-codes/is.13311.2.1992.pdf

RESEARCH METHODOLOGY AND IPR				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE17	**2-0-0-1**	**2**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Understand research problem formulation
- Analyze research related information.
- Understand the preparation of a research project thesis report
- Understand that when IPR would take such important place in growth of individuals & nation.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D.

Syllabus

Module – I

General: Introduction, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical -Research process - Criteria of good research - Developing a research plan.

Research problem: Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem - Importance of literature review in defining a problem - Reviews, treatise, monographs patents - web as a source - Identifying gap areas from literature review – Development of working hypothesis. **05hr**

Module – II

Research design and methods: Research design – Basic Principles- Need of research design – Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models - Developing a research plan - Exploration, Description, Diagnosis, and Experimentation - Determining experimental and sample designs. **05hr**

Module – III

Sampling design: Steps in sampling design - Characteristics of a good sample design - Types of sample designs - Measurement and scaling techniques -Methods of data collection – Collection of primary data - Data collection instruments.

Testing of hypotheses: Basic concepts - Procedure for hypotheses testing flow diagram for hypotheses testing - Data analysis with Statistical Packages – Correlation and Regression - Important parametric test - Chi-square test -Analysis of variance and Covariance. **05hr**

Module – IV

IPRs, Invention and Creativity: Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs) - A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs - Integrated Circuits Geographical Indications- Establishment of WIPO-Application and Procedures. **05hr**

Module – V

Interpretation and report writing: Techniques of interpretation - Structure and components of scientific reports - Different steps in the preparation - Layout, structure and language of the report - Illustrations and tables - Types of report- Technical reports and thesis.

05hr

Course Outcomes:

On completion of this course, students are able to

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs and their characteristics.
- Explain the art of writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.

Reference Books:

- C.R. Kothari, Gaurav Garg, 4 th Edition "Research Methodology: Methods and Techniques" New Age International, 2018.
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008
- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction" Model Curriculum of Engineering & Technology PG Courses [Volume -II] [15]
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.

E-Resource:

- https://nptel.ac.in/courses/121/106/121106007/
- https://gnits.ac.in/sites/default/files/pics/ece/econtent/rmipr/Module6-PatentRights.pdf

SECOND SEMESTER

RELIABILITY ANALYSIS OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE21	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to understand the basics of data analysis and review mathematical tools for quantifying uncertainties using theories of probability. And also develop the methods of structural reliability and simulation techniques.

Syllabus

Module – I

Preliminary Data Analysis: Graphical representation- Histogram, frequency polygon, Measures of central tendency- grouped and ungrouped data, measures of dispersion, and measures of asymmetry.

Curve fitting and Correlation: Fitting a straight line, curve of the form y= ab + x, and parabola, Coefficient of correlation.

10hrs

Module – II

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.

10hrs

Module – III

Random variables: Probability mass function, probability density function, Mathematical expectation, Chebyshev's theorem.

Probability distributions: Discrete distributions- Binomial and poison distributions, Continuous distributions- Normal, Lognormal distributions.

10hrs

Module – IV

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).

10hrs

Module – V

System reliability: Influence of correlation coefficient, redundant and non-redundant systems-series, parallel and combined systems, Uncertainty in reliability assessments- Confidence limits, Bayesian revision of reliability.

Simulation Techniques: Monte Carlo simulation- Statistical experiments, sample size and accuracy, Generation of random numbers- random numbers with standard uniform distribution, continuous random variables, discrete random variables.

10hrs

Course Outcomes:

On completion of this course, students are able to

- Achieve Knowledge of design and development of problem solving skills.
- Outline the basic principles of reliability analysis.
- Design and develop analytical skills.
- Summarize the Probability distributions.
- Analyse the necessary background to carry out reliability based design.

Reference Books:

- Ranganathan, R. (1999). "Structural Reliability Analysis and design"- 2nd Edition,Jaico publishing house, Mumbai, India.
- AchintyaHaldar, and SankaranMahadevan (2000). "Probability, Reliability and Statistical methods in Engineering design"- 3rd Edition,John Wiley and Sons. Inc.
- Nathabdndu, T., Kottegoda, and Renzo Rosso (1998). Statistics, "Probability and reliability for Civil and Environmental Engineers"- 1stEdition, McGraw Hill international edition, Singapore.
- Ang, A. H. S., and Tang, W. H. (1984). "Probability concepts in engineering planning and design"- 2ndEdition,Volume –I, John Wiley and sons, Inc, New York.
- Ang, A. H. S., and Tang, W. H. (1984). "Probability concepts in engineering planning and design"- 2ndEdition,Volume –II, John Wiley and sons, Inc, New York.
- Milton, E. Harr (1987). "Reliability based design in civil engineering"- 3rd Edition,McGraw Hill book Co.
- Thoft-christensen, P., and Baker, M., J., (1982), "Structural reliability theory and its applications"-1st Edition, Springer-Verlag.

E-Resources:

- https://nptel.ac.in/courses/105/103/105103140/
- http://web.mae.ufl.edu/nkim/eas6939/RBDO_Class.pdf
- http://www2.tku.edu.tw/~tkjse/12-4/01-CE9604.pdf

EARTHQUAKE RESISTANT DESIGN OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE22	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

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 – I

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**.**

10hrs

Module – II

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. 10hrs

Module – III

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. 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.

10hrs

Module – IV

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 behaviour, design and ductile detailing of shear walls. 10hrs

Module – V

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. 10hrs

Course Outcomes:

On completion of this course, students will be 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.

Reference Books:

- Earthquake Resistant Design of Structures, Duggal, 2nd Edition, Oxford University Press.
- Earthquake resistant design of structures - PankajAgarwal, Manish Shrikande – 5thEdition PHI India.
- IS – 1893 (Part I): 2002, IS – 13920: 1993, IS – 4326: 1993, IS-13828: 1993
- Design of Earthquake Resistant Buildings, Minoru Wakabayashi, 4th Edition, McGraw Hill Pub.
- Seismic Design of Reinforced Concrete and Masonry Buildings, 2nd 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.
- Earthquake Resistant Design of Building Structures, 1st Edition, VinodHosur, WILEY (india)

E-Resources:

- https://upodofoxan.files.wordpress.com/2014/01/51ea7jh.pdfhttp://www.scribd.com/doc/193099014/Earthquake-resistant-design-of-structures-by-pankaj-agarwal#scribd
- http://elearning.vtu.ac.in/18/enotes/06CV834/EQ-GPCt.pdf
- https://nptel.ac.in/couses/105/101/105101004

FINITE ELEMENT ANALYSIS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE23	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

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 – I

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.

10 hrs

Module – II

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 &three dimensional elements.

10 hrs

Module – III

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

10 hrs

Module – IV

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.

10 hrs

Module – V

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.

10 hrs

Course Outcomes:

On completion of this course, students are able to

- Summarize the importance of finite element approach in structural engineering.
- Understand and apply the basic principles of finite element in structural analysis.
- Analyze 1D, 2D and 3D structural elements by principles of numerical technique.
- Apply finite element method to solve bar element, truss element, beam element and plane element.
- Comprehend and analyze plates and shells by finite element approach.

Reference 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 P Pvt. Ltd., 1972.
- 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-Resource:

- 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/MITRES2_002S10_linear.pdfhttp://web.mit.edu/16.810/www/16.810_L4_CAE.pdf
- http://icas.bf.rtu.lv/doc/Book.pdf

ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES

Course Code	L:T:P:S (Hrs/week)	Credits	Exam Marks	Exam Duration
21CSE241	4-0-0-2	4	CIE: SEE Marks 50 : 50	3 Hours

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 – I

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. 10 hr

Module – II

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. 10 hrs

Module – III

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. 10 hrs

Module – IV

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. 10 hrs

Module – V

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. 10hrs

Course Outcomes:

On completion f 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.

ADVANCED DESIGN OF BRIDGES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE242	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to learn various forces and loads acting on RCC and PSC bridges and culverts; and design suitably as per IS standards. Also learn stability analysis of bridge substructures and design of foundations as per specifications.

Syllabus

Module – I

Introduction: Classification of Bridges, Forces on Bridges, 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.

10 hrs

Module – II

Box 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.

10 hrs

Module – III

T Beam Bridge:

Slab Design: Proportioning of Components, Analysis of Slab using IRC Class AA Tracked Vehicle, Analysis of Slab Using IRC Class AA Wheeled Vehicle, Analysis of Slab using IRC Class A Loading, Structural Design of Slab.

Cross Girder: Analysis of Cross Girder for Dead Load & IRC Class AA Tracked Vehicle, Analysis of Cross Girder for IRC Class AA Wheeled Vehicle & Class A Loads, Structural Design of Cross Girder.

Main Girder: Analysis of Main Girder Using COURBON'S Method for IRC Class AA Tracked vehicle for B M, Analysis of Main Girder Using COURBON'S Method for IRC Class AA Wheeled vehicle for B M, Calculation of Live load SF, Calculation of Dead load BM and SF, Structural Design of Main Girder, Reinforcement Details of Main Girder.

10hrs

Module – IV

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.

10 hrs

Module – V

Balanced Cantilever Bridge: Introduction & Proportioning of Components, Design of Simply Supported Portion, Design of Articulation, Reinforcement Details of Main Girder.

Bridge Substructures: Stability analysis of abutments and piers, Bearings and Expansion joints, Bridge foundation: Well and pile foundations.

10hrs

Course Outcomes:

On completion of this course, students are able to

- Acquire knowledge of basic components and working principles of RCC and PSC bridges and culverts.
- Analyze bridges and culverts for different IRC loadings.
- Outline the design principles of bridge substructures.
- Detailing of bridges, culverts and substructures as per IS standards.
- Principles and Practice of Bridge Engineering by S P Bindra, Dhanpat Rai& Sons New Delhi
- IRC 6 -1966 Standard Specifications And Course Code Of Practice For Road Bridges Section IILoads and Stresses, The Indian Road Congress New Delhi
- IRC 21 - 1966 Standard Specifications And Course Code Of Practice For Road Bridges SectionIII Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
- IS 456 - 2000 Indian Standard Plain and Reinforced Concrete Course Code of Practice (FourthRevision) BIS New Delhi
- IS 1343 - Indian Standard Prestressed Concrete Course Code of Practice BIS New Delhi
- Raina V.K., "Concrete Bridge Practice"- 2nd Edition, Tata McGraw Hill
- Bakht B &Jaeggar, "Bridge Analysis Simplified"- 3rd Edition, McGraw Hill
- Ponnuswamy . S, "Bridge Engineering"- 1st Edition, Tata McGraw Hill. 2008.
- Derrick Beckett, "An Introduction to Structural Design of Concrete Bridges"- 2nd Edition,Surrey University Press, 2003.

E-Resources:

- https://onlinecourses.nptel.ac.in/noc20_ce40/preview
- https://vssut.ac.in/doc/Transportation-1_Lecture-Note.pdf

OPTIMIZATION OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE243	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

Students will be able to present modern concepts of optimal design of structures and develop the basic ideas from optimization theory to solve simple design examples. Analytical and numerical methods are developed and their applications discussed along with structural design sensitivity analysis and approximation methods.

Syllabus

Module – I

Optimization Techniques

Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.

10hrs

Module – II

Linear Programming

Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.

10hrs

Module – III

Non-linear programming

Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods.

10hrs

Module – IV

Non-linear Programming

constrained optimization techniques such as direct methods, the complex methods,
cutting plane method, exterior penalty function methods for structural engineering problems

Geometric programming

Geometric programming, conversion of NLP as a sequence of LP/ geometric programming

10hrs

Module – V

Dynamic programming

Dynamic programming conversion of NLP as a sequence of LP/ Dynamic programming.

Structural Optimization

Formulation and solution of structural optimization problems by different techniques.

10hrs

Course Outcomes:

On completion of this course, Students will be able to

- Understand the basics of optimization.
- Apply linear and nonlinear programming to solve problems in structural problems.
- Optimize structural problems using geometric or dynamic programming.
- Formulate engineering design problems for simple load-bearing structures as optimization problems,
- implement optimization algorithms

Reference Books:

- Rao S.S, "Optimization – Theory and Practice", Wiley Eastern Ltd
- Spunt, "Optimum Structural Design", Prentice Hall
- Uri Krisch, "Optimum Structural Design", McGraw Hill
- Richard Bronson, "Operation Research", Schaum's Outline Series

DESIGN OF TALL STRUCTURES				
Course Code	**L:T:P:S (Hrs/week)**	**Credits**	**Exam marks**	**Exam Duration**
21CSE251	**4-0-0-2**	**4**	**CIE: SEE MARKS 50 : 50**	**3 Hours**

Course Objectives:

The objective of this course is to enable the students to gain the knowledge on the principles of stability of tall buildings. To expose the students for the design of tall buildings for earthquake and wind resistance which in turn they can able to analyse and evaluate the performance of tall structures for strength and stability.

Syllabus

Module – I

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. working stress design, Limit state design, Plastic design.

10hrs

Module – II

Lateral loads and analysis: static and dynamic approach, Analytical and wind tunnel experimentation method. Equivalent lateral force, modal analysis, combinations of loading, Design of different types of bracings. Numerical problems on calculating lateral load on tall structures

10hrs

Module – III

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

10hrs

Module – IV

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.

10hrs

Module – V

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 plumb 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. Differential movement, creep and shrinkage effects, temperature effects and fire.

10hrs

Course Outcomes:

On completion of this course, students will be able to

- Achieve Knowledge of design, different types of loads and their influence on tall buildings and development of problem solving skills.
- Analyse the concept of lateral loads and their influence on tall buildings
- Understand the design principles of strength and stability of structures.
- Design and develop analytical skills and summarize the behaviour of various structural systems.
- Understand the concepts of load displacement relationship and its compatibility for modern days need.

Reference Books:

- Taranath B.S, "Structural Analysis and Design of Tall Buildings"- 2nd Edition, McGraw Hill
- Wilf gang Schuller, "High rise building structures"- John Wiley, 1977.
- Bryan Stafford Smith & Alexcoull, "Tall building structures Analysis and Design"- 2nd Edition, John Wiley
- T.Y Lin & D. Stotes Burry, "Structural concepts and system for Architects and Engineers"- 3rd Edition, John Wiley
- Lynn S.Beedle, "Advances in Tall Buildings"- 3rd Edition, CBS Publishers and Distributors.
- Dr. Y.P. Gupta – Editor, "Proceedings National Seminar on High Rise Structures- Design and Construction practices for middle level cities"- 1st Edition, New Age International Limited.

E-Resource:

- http://publications.lib.chalmers.se/records/fulltext/3785.pdf
- http://www.scribd.com/doc/149804560/Analysis-and-Design-of-Tall-Buildings-Bungale-S- Taranath#scribd

SMART MATERIALS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE252	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

This course is designed to give an insight into the latest developments regarding smart materials and their use in structures.

Syllabus

Module – I

Introduction to Smart Materials and Structures – Instrumented structures functions and response – Sensing systems – Self -diagnosis – Signal processing consideration – Actuation systems and effectors.

Measuring techniques: Strain Measuring Techniques using Electrical strain gauges, Types – Resistance – Capacitance – Inductance – Wheatstone bridges – Pressure transducers – Load cells – Temperature Compensation – Strain Rosettes.

10Hrs

Module – II

Sensing Technology – Types of Sensors – Physical Measurement using Piezo Electric Strain measurement – Inductively Read Transducers – LVDT.

Chemical and Bio-Chemical sensing in structural Assessment – Absorptive chemical sensors – Spectroscopes – Fiber Optic Chemical Sensing Systems and Distributed measurement.

10 Hrs

Module – III

Actuator Techniques – Actuator and actuator materials –Electrostrictive Material – Magneto structure Material – Shape Memory Alloys – Electro rheological fluids – Electromagnetic actuation – Role of actuators and Actuator Materials.

Data Acquisition and Processing – Signal Processing and Control for Smart Structures – Sensors as Geometrical Processors – Signal Processing – Control System – Linear and Non-Linear.

10 Hrs

Module – IV

FibreOptics: Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors, Twisted and Braided Fibre Optic sensors, Optical fibres as load bearing elements, Crack detection applications, Integration of Fibre optic sensors.

Micro-Electro-Mechanical Systems (MEMS): History of MEMS, Intrinsic Characteristics, Microfabrication: Photolithography, Thermal oxidation, Thin film deposition, etching types, Doping, Dicing, Bonding. Microelectronics fabrication process flow, Silicon based Process selection and design.

10 Hrs

Module – V

Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations.

10 Hrs

Course Outcomes:

On completion of this course, Students will be able to

- Identify the different sensory techniques.
- Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS.
- Explain the principle concepts of Smart materials, structures, Fibre optics, ER & MR Fluids, MEMS with principles of working.
- Analyze the properties of smart structure with the applications and select suitable procedure for fabrication.
- Understand applications of Micro fabrications, types of polymers used in MEMS, Fibre optics, piezoelectric sensing and actuation

Reference Books:

- Brain Culshaw – "Smart Structure and Materials"Artech House – Borton. London-1996.
- "Smart Structures –Analysis and Design", A.V.Srinivasan, Cambridge University Press, New York, 2001, (ISBN:0521650267).
- "Smart Materials and Structures", M.V.Gandhi and B.S.Thompson Chapmen & Hall, London, 1992 (ISBN:0412370107)
- "Foundation of MEMS", by Chang Liu. Pearson Education. (ISBN:9788131764756)
- Srinivasan, A. V. and Michael McFarland, D., "Smart Structures: Analysis and Design", Cambridge University Press, 2009.
- Michelle Addington and Daniel L. Schodek, "Smart Materials and Technologies: For the Architecture and Design Professions", Routledge 2004.
- L. S. Srinath, "Experimental Stress Analysis", Tata McGraw-Hill, 1998.
- J. W. Dally and W. F. Riley, "Experimental Stress Analysis", Tata McGraw-Hill, 1998.

E-Resources:

- https://nptel.ac.in/courses/112/104/112104251/
- http://brharnetc.edu.in/br/wp-content/uploads/2018/11/18.pdf
- https://www.hindawi.com/journals/amse/si/157903/

ADVANCED DESIGN OF STEEL STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE253	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to learn about steel structures used for various applications as per specifications. And understand the behavior and working principles of steel structures and design as per IS standards.

Syllabus

Module – I

Plastic And Local Buckling Behaviour of Structural Steel: Introduction, Plastic Theory, General Requirements for plastic design, Plastic hinge Concept, Plastic collapse load, Conditions of plastic analysis, Theorems of plastic collapse, Methods of plastic analysis, Plastic design of continuous beams, Plastic design of portal frames.

10Hrs

Module – II

Design of Light Gauge Steel: Introduction, Forms of Light gauge section, Local Buckling of thin elements, Stiffened & Un-stiffened elements, Effective section properties, IS801 & IS811 Codal provision, Axially Loaded compression members, Laterally supported & un-supported beams, numerical problems.

10 Hrs

Module – III

Transmission Towers: Basic structural configuration, Free-standing and guyed towers, Loads on towers, Analysis and design of lattice tower, Transmission line towers – sag and tension calculations, Design of Preliminary Geometry of a Tower.

10 Hrs

Module – IV

Chimneys: Introduction, Dimensions of steel stacks, Chimney lining, Breech openings and access ladder, Loading and load combinations, Design considerations, Stability considerations, Design of base plate, Design of foundation bolts, Design of foundation.

10 Hrs

Module – V

Pre-Engineered Buildings: Introduction, Concepts, Design considerations and methodology.

Space Truss: Introduction, Advantages of Space Structures, Guidelines for Preliminary Planning, Cambering and Slope, Depth and Module size, Erection methods of Space Structures.

10Hr**s**

Course Outcomes:

On completion of this course, students will be able to

- Acquire knowledge of the use of steel structures for Infrastructure developments.
- Summarize the basic components of steel structures used as in bridges, girders, Industrial structures, etc.
- Apply appropriate method of analysis for design of steel structures as per IS standards.
- Detailing of steel members as per IS codes.

Text Books:

- Duggal "Limit State Design of Steel Structures",Tata McGraw Hill., 2014.
- N Subramanian- "Design of Steel Structure", Oxford University Press, 2014.
- S. S. Bhavikatti, "Design of Steel Structures", I. K. International Publishing House Pvt Ltd., 2010.
- Wie Wen Yu, "Design of Cold Formed Steel Structures", McGraw Hill Book Company, 1996.
- Bureau of Indian Standards, IS800-2007, IS-801-1975. Steel Tables, SP 6 (1) – 1984

E-Resources:

- https://nptel.ac.in/courses/105/106/105106113/

STRUCTURAL ENGINEERING LAB - II				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE26	**0-0-2-1**	**2**	**CIE: SEE MARKS 50 : 50**	**3 Hours**

Course Objectives:

The objective of this course is to make students to learn the softwares 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

- Achieve Knowledge of design and development of programming skills.
- Understand the principles of structural analysis and design
- Evaluate the concept of folded plates and shells.
- Summarize the performance of structures for static and dynamic forces
- Practice the excel sheets for structural design.

Reference Books:

Software Manuals

TECHNICAL SEMINAR-I				
Course Code	**L:T:P:S (Hrs/Week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE27	**0-0-0-2**	**1**	**CIE: SEE Marks: 50**	**20 m**

Course Objectives:

- To develop students written and oral communication competencies to enhance technical effectiveness.
- To provide students an opportunity to learn new concepts and to express their presentation skills
- Instill students with initiative, independence, reflection and knowledge transfer
- To develop students ability to think strategically and express their views without hesitation.

Syllabus

The student will have to give a presentation for 20 minutes on any current civil engineering topic chosen by him or her after discussion with guide.

Course Outcomes:

On completion of this course, students are able to

- Students get the awareness about the recent technology trends based on their field of interest
- Able to prepare an effective written technical report
- Able to plan and produce presentation materials which most effectively communicate the intended message for their technical oral presentation

THIRD SEMESTER

DESIGN OF SUBSTRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE31	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to design the substructure based on the properties of the soil and forces acting on the structure and also to select the structure based on suitability.

Syllabus

Module – I

Introduction, Classification of foundations systems. General requirement of foundations, Selection of foundations, Concept of soil shear strength parameters, Concept of bearing capacity, 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 Loads, Numerical problems

10Hrs

Module – II

Design of Combined footings (rectangular & trapezoidal), strap footings, Types of rafts, Design of raft foundation, Rigid methods, Elastic theory in raft foundations.

10 Hrs

Module – III

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 Pile groups: Bearing capacity, settlement, uplift capacity

10 Hrs

Module – IV

Retaining Wall: Retaining walls: Types of retaining walls, Failure of retaining walls by sliding, overturning and bearing. Stability and principles of the design of retaining walls – cantilever retaining walls, modes of failure of retaining walls, Numerical problems

Cantilever Sheet Pile Walls: Types of sheet pile walls, free cantilever sheet pile in cohesion less soils and cohesive soil, Numerical problems

10 Hrs

Module – V

Forces of Offshore Structure: Wind forces, Wave generation process, wave forces on vertical inclined cylinders, Current forces

Analyses of Offshore Structures: Different types of Offshore structures, Static method of analysis foundation analysis and dynamics of offshore structures

10Hrs

Course Outcomes:

On completion of this course, students are able to

- Determination of shear strength parameters and its effect on the bearing capacity of soil
- Design of shallow foundation
- Determination of load carrying capacity of pile foundation
- Evaluate basic parameters for design of offshore structure

Reference Books:

- J.E. Bowles – "Foundation Analysis and Design"- McGraw-Hill Int. Editions, Fifth Ed., 1996.
- Swami Saran – "Analysis & Design of Substructures"- 3rd Edition, Oxford & IBH Pub. Co.Pvt. Ltd., 1998.
- V.N.S. Murthy – "Advanced Foundation Engineering" 1st ebook Edition, CBS Publishers and Distributors, New Delhi.
- Nainan P Kurian – "Design of Foundation Systems"- 3rd Edition, Narosa Publishing House, 1992.
- R.B. Peck, W.E. Hanson & T.H. Thornburn – "Foundation Engineering"- Wiley Eastern
- Ltd., Second Edition, 1984.
- W.C. Teng – "Foundation Design"- Prentice Hall of India Pvt. Ltd., 2003.
- Bureau of Indian Standards:IS-1498, IS-1892, IS-1904, IS-6403, IS-8009, IS-2950, IS- 11089, IS-11233, IS-2911 and all other relevant codes.

E-Resources:

- https://nptel.ac.in/courses/105/101/105101083/
- https://nptel.ac.in/courses/105/105/105105176/
- https://www.scribd.com/document/439590251/Design-of-sub-structures-notes

DESIGN OF PLATES AND SHELLS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE321	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

To enable the students to gain knowledge on methods of analysis of plates and shells to develop the solutions by using energy concepts. To expose the students to the design and detailing of simple shells.

Syllabus

Module – I

Plate Theory: Introduction to plate theory, Differential equation for cylindrical bending of plates, Pure Bending: Derivation of slope and curvature equation of slightly bent plates, Relation between bending moments and curvature. Differential equation of the deflection surface for laterally loaded plates with boundary conditions.

10hrs

MODULE II

Simply supported rectangular plates under sinusoidal load, Derivation of Navier Solution for simply supported rectangular slabs with uniformly distributed load and a single load distributed uniformly over an area. Problems on Navier solution. Levy's Solution for simply supported rectangular slabs with uniformly distributed load, concentrated load and under hydrostatic pressure.

10hrs

Module – III

Energy Methods: Introduction to energy methods, derivation for the rectangular and circular plates with clamped edges subjected to symmetric loadings, derivation for the total energy using Ritz Method and problems. Folded Plates: Introduction, assumptions, method of analysis of folded plates using plate and slab method. Whitney method of analysis..

10hrs

Module – IV

Shells: Introduction to curved surfaces, classification of shells, derivation for shells in the form of a surface of revolution and loaded symmetrically, membrane theory for spherical shells, cylindrical shells, hyperbolic paraboloids, elliptic paraboloid and conoids.

10hrs

Module – V

Shallow Shells of Double Curvature: Introduction to shallow shells, assumptions, bending theory of doubly curved shallow shells, axially symmetric bending of shells of revolution, closed cylindrical shells, water tanks and Geckler's approximation. Design and detailing of simple shell problems – spherical domes, water tanks, barrel vaults and hyperbolic parabolic roofs.

10hrs

Course Outcomes:

On completion of this course, students are able to

- Achieve the knowledge of analysing the plates under different boundary conditions.
- To assess the strength of plate panels under point, linearly varying and uniformly distributed loads.
- To analyse plates under different boundary conditions by various classical methods and approximate methods.
- To be familiar with classification of shells and classical shell theories and apply them in engineering design
    - To be exposed to singly curved shells, doubly curved shells and cylindrical shells.

Reference Books:

- Szilard R., "Theory and Analysis of Plates – Classical and Numerical Methods", Prentice Hall Inc 1995.
- Timoshenko S. and Kreiger S.W., "Theory of Plates and Shells"., McGraw Hill Books Company, Newyork-1990.
- CHANDRASHEKHARA K, "Theory of Plates" Universities Press(India)Ltd., Hyderabad 2001.
- ANSEL C.UGURAL, "Stresses in Plates and shells", Second Edition, McGraw-Hill International Editions 1999.

E-Resources:

- https://iitg.ac.in/mech/academics/pg-courses-electives/latest/theory-of-plates-and-shells/
- https://onlinecourses.nptel.ac.in/noc21_ce59/preview
- https://ocw.mit.edu/courses/mechanical-engineering/2-081j-plates-and-shells-spring-2007/

DESIGN OF PRECAST AND PREFABRICATED STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE322	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to learn the components and structural systems of precast structures applying suitable design concepts meeting specific requirements. And understand elastic behavior of composite elements for the design of composite structures.

Syllabus

Module – I

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.

10 hrs

Module – II

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

10 hrs

Module – III

Design of precast concrete columns and walls: Design of braced and un braced 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.

10hrs

Module – IV

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

Prefabricated Components: Behaviour of structural components, Large panel constructions, Construction of roof and floor slab, Wall panels, Columns, Shear walls.

10hrs

Module – V

Design Principles: Disuniting of structures, Design of cross section based on efficiency of material used, Problems in design because of joint flexibility, Allowance for joint deformation.

Joint in Structural Members: Joints for different structural connections, Dimensions and detailing, Design of expansion joints

10hrs

Course Outcomes:

On completion of course, Students will be able to

- Understand the behaviour and principles of precast and prefabricated structures.
- Analyze and design the precast and prefabricated structural elements.
- Assess the structural integrity of precast and prefabricated structures and connections.
- Analyze and detail the joints for different structural connections and expansion joints.

Reference Books:

- Hass A.M. – Precast Concrete – Design and applications Applied Science, 1983.
- David Sheppard – "Plant cast, Precast and Prestressed concrete – McGraw Hill; 1989
- R.P. Johnson: Composite Structure of Steel and Concrete (Volume 1), Blackwell Scientific Publication (Second Edition), U.K., 1994.
- Koncz T., Manual of precast concrete construction, Vols. I, II and III, Bauverlag, GMBH, 1971.
- Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 1978.
- NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15916- 2011,IS 11447,IS6061 – I and III
- IS: 11384-1985, Code of Practice for Composite Construction in Structural Steel and Concrete.
- INSDAG Teaching Resource Chapter 21 to 27: www.steel-insdag.org.

E-Resource:

- https://learnengineering.in/ce6016-prefabricated-structures/

Reference Books:

- Hass A.M. – Precast Concrete – Design and applications Applied Science, 1983.
- David Sheppard – "Plant cast, Precast and Prestressed concrete – McGraw Hill; 1989
- R.P. Johnson: Composite Structure of Steel and Concrete (Volume 1), Blackwell Scientific Publication (Second Edition), U.K., 1994.
- Koncz T., Manual of precast concrete construction, Vols. I, II and III, Bauverlag, GMBH, 1971.
- Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 1978.
- NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15916- 2011,IS 11447,IS6061 – I and III
- IS: 11384-1985, Code of Practice for Composite Construction in Structural Steel and Concrete.
- INSDAG Teaching Resource Chapter 21 to 27: www.steel-insdag.org.

E-Resource:

- https://learnengineering.in/ce6016-prefabricated-structures/

STABILITY OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE323	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The objective of this course is to enable the students to learn principles of stability of structure, also the stability of the structural elements is determined. To evaluate the use of strain energy in plate bending theory.

Syllabus

Module – I

Beam column: Differential equation. Beam column subjected to (i) lateral concentrated load, (ii) several concentrated loads, (iii) Continuous lateral load. Application of trigonometric series. Euler's formulation using fourth order differential equation for pinned-pinned, fixed-fixed, fixed-free and fixed pinned columns.

10 hrs.

Module – II

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. Columns subjected to non-conservative follower and pulsating forces.

10 hrs.

Module – III

Stability analysis by finite element approach: Derivation of shape functions for a two noded Bernoulli-Euler beam element (lateral and translational dof) –element stiffness and Element geometric stiffness matrices – Assembled stiffness and geometric stiffness matrices for a discretized column with different boundary conditions – Evaluation of critical loads for a discretized (two elements) column (both ends built-in). Algorithm to generate geometric stiffness matrix for four noded and eight Noded isoparametric plate elements. Buckling of pin jointed frames (maximum of two active dof)- symmetrical single bay Portal frame.

10 hrs.

Module – IV

Buckling of simply supported rectangular plate: 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- Buckling of a rectangular plate simply supported along two opposite sides and uniformly compressed in the direction parallel to those sides.

10 hrs.

Module – V

Buckling of simply supported rectangular plate – Combined effects: Buckling of a simply supported rectangular plate under combined bending and compression – Buckling of rectangular plates under the action of shearing stresses – Other cases of buckling of rectangular plates..

10 hrs.

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 strength and stability.
- Design and develop analytical skills.
- Appraise the Stability analysis by finite element approach.
- Understand the concepts of lateral buckling of beams.

Reference Books:

- Rubinstein M.F, "Matrix Computer Methods of Structural Analysis" Prentice-Hall,First edition ,ISBN : 81-7800-018
- Bathe.K.J, "Finite element procedures in Engineering Analysis". PHI. New Delhi
- Rajasekaran.S, "Computational Structural Mechanics", PHI, New Delhi 2001, ISBN: 978-81-203-1734-5.
- Reddy.C.S, "Basic Structural Analysis," TMH, New Delhi 2001, 3rd edition, ISBN 10: 0070702764 / ISBN 13: 9780070702769

E-Resource:

- www.rocscience.com
- https://searchworks.stanford.edu/view/1061184
- www.nibs.org/**resource**/resmgr/bssc/p751_ch6.pd

DESIGN OF STEEL-CONCRETE COMPOSITE STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE331	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

Students will be able to learn the components and structural systems of steel-concrete composite structures applying suitable design concepts meeting specific requirements. And understand seismic behavior of composite elements for the design of composite structures.

Syllabus

Module – I

Introduction :

Introduction to Steel- Concrete composite construction – Advantages- Theory of Composite structures- Introduction to steel-Concrete, Steel sandwich construction.

10hrs

Module – II

Design of Composite Beams, Columns and Trusses :

Behaviour of composite beams- Design of Composite beams- Behaviour of composite columns-Steel-Concrete composite columns and Design of composite trusses.

10hrs

Module – III

Design of Connections :

Types of connections-Design of connections in the composite structures-shear connections- Design of connections in composite trusses.

10hrs

Module – IV

Composite Box Girder Bridges :

Introduction- Behaviour of Box girder bridges- Design concepts and problems

10 hrs

Module – V

Seismic behaviour of composite structures:

General Seismic behaviour of composite structures-Case studies on steel- Concrete composite construction in buildings.

10hrs

Course Outcomes:

On completion of this course, students are able to

- Acquire knowledge of behavior and design of composite beams & columns and trusses.
- Analyze and design composite box girder bridges.
- Assess the structural integrity of connections of composite structures.
- Outline the Seismic behaviour of composite structures.

Reference Books:

- Johnson R.P., "Composite structures of steel and concrete", Blackwell Scientific Publications, Second Edition, UK, 1994.
- Owens G.W. and Knowels. P., "Steel Designers Manual", Fifth edition, Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 1992.
- Steel Concrete Composite Construction, INSDAG Publication, Kolkatta
- 4 Proceedings of a workshop on "Steel Concrete Composite Structures", conducted at Anna

University, 2000.

E-Resource:

https://www.sciencedirect.com/book/9780080445458/composite-structures-design- safety

CONSTRUCTION TECHNIQUES AND MANAGEMENT				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE332	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to learn the latest construction techniques applied to engineering construction for substructure and superstructure for buildings and special structures. Also understand the principles of financial management and decision theory in construction.

Syllabus

Module – I

Sub Structure Construction: Box jacking-Pipe jacking -Under water construction of diaphragm walls and basement -Tunneling techniques -Piling techniques -Driving well and caisson -sinking cofferdam -cable anchoring and grouting -Driving diaphragm walls, Sheet piles -Laying operations for built up offshore system -Shoring for deep cutting -Large reservoir construction -well points -Dewatering for underground open excavation.

10Hrs

Module – II

Super Structure Construction for Buildings: Vacuum dewatering of concrete flooring –Concrete paving technology – Techniques of construction for continuous concreting operation in tall buildings of various shapes and varying sections –Erection techniques of tall structures, Large span structures – launching techniques for heavy decks – insitu prestressing in high rise structures, Post tensioning of slab-aerial transporting –Handling and erecting lightweight components on tall structures.

10Hrs

Module – III

Construction of Special Structures: Erection of lattice towers -Rigging of transmission line structures – Construction sequence in cooling towers, Silos, chimney, sky scrapers -Bow string bridges, Cable stayed bridges –Launching and pushing of box decks – Construction of jetties and break water structures –Construction sequence and methods in domes –Support structure for heavy equipment and machinery in heavy industries –Erection of articulated structures and space decks.

10Hrs

Module – IV

Financial Management: Working Capital Management –Compound Interest and Present Value methods –Discounted Cash Flow Techniques –Capital Budgeting.

Decision Theory: Decision Theory –Decision Rules –Decision making under conditions of certainty, risk and uncertainty –Decision trees –Utility Theory.

10Hrs

Module – V

Construction Management: Sources of lost time, productivity assessment tools such as productivity measurement system, work sampling, foreman delay survey; productivity improvement tools such as crew balance charts, process diagrams, Basic theories of motivation, leadership, communication and team behaviors adapted and applied to construction management; case studies.

10Hrs

Course Outcomes:

On completion of this course, students are able to

- Outline various techniques used for construction of substructure and superstructure.
- Choose appropriate latest techniques for construction of special structures.
- Apply principles of financial management and decision theory.
- Demonstrate use of Construction Management for improvement of productivity.

Reference Books:

- Sankar, S.K. and Saraswati, S., Construction Technology, Oxford University Press, New Delhi, 2008
- Vohra, Nd., Quantitative Techniques in Management, Third Edition, Tata McGraw-Hill Company Ltd, 2007
- Jerry Irvine, Advanced Construction Techniques, CA Rocketr, 1984
- Patrick Powers. J., Construction Dewatering: New Methods and Applications, John Wiley & Sons,1992.
- Peter.H.Emmons, "Concrete repair and maintenance illustrated", Galgotia Publications Pvt. Ltd., 2001.Press, 2008

E-Resources:

- https://nptel.ac.in/courses/105/104/105104161/
- https://nptel.ac.in/courses/105/103/105103206/

STRUCTURAL HEALTH MONITORING				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE333	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to understand basics of structural health monitoring for data acquisition using appropriate sensors w.r.t load and environmental effects. Also, will familiarize about sensor system installation for layout preparation for various applications.

Syllabus

Module – I

Introduction: Structural health monitoring (SHM), On-Structure Instrumentation System (OSIS), Load-Effects: Wind measurements, Temperature measurements, Traffic measurements, Environmental effects: Humidity & Rainfall. Bridge response: Displacement, Stresses and strain, Dynamic characteristics.

10Hrs

Module – II

Sensor system and installation: Sensors for monitoring load effects, Environmental effects and response of the bridge by anemometers, Temperature sensors. Accelerometers. Strain gauges, vibrating Wire Strain gauge sensor, Displacement transducers, Precipitation sensor, Barometric pressure sensor, Air quality sensor, sensor for Air temperature and relative humidity, GPS and Weigh in motion (WHM).

10 Hrs

Module – III

Data measurement: Wind speeds and wind direction, Deflections, Acceleration, Air temperature and relative humidity, Barometric pressure, Rainfall, temperature and strain for the concrete, WIM, pylon deflection using GPS and displacement measurement.

10 Hrs

Module – IV

Portable data acquisition system, measurement and calibration of sensors. Acceleration measurement of cables and analysis by FFT. Presenting engineering data on the cable using simple harmonics principle

10 Hrs

Module – V

Layout drawing preparation for sensors, data acquisition and networking.

10 Hrs

Course Outcomes:

On completion of this course, Students will be able to

- Understand basic concepts of the infrastructural health diagnosing their distress.
- Assess the structural distress using sensor system.
- Acquire strains and vibrations through sensor installation.
- Prepare the sensor layout plan for data collection.

Reference Books:

- Daniel Balageas, Claus- Peter Fritzenaml Alfredo Guemes, " Structural health monitoring",Published by ISTE Ltd., U.K.2006.
- Victor Giurglutiu, Academic "Structural Health Monitoring with Wafer Active Sensiors", Academic Press Inc, 2007.
- Sirohi.R.S, Radhakrishna.H.C, "Mechanical Measurements", New Age International (P) Ltd. 1997.
- J.P Ou,H.Li and Z.D. Daun, "Structural Health Monitoring and Intelligent Infrastructure", Vol 1, Taylor and Francis group, London, UK,2006.
- Douglas E Adams "Health Monitoring of Structural Materials and Components-Methods with Applications", John Wiley and sons, 2007.
- Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2006.

E-Resources:

- https://nptel.ac.in/courses/114/106/114106046/

FORMWORK DESIGN OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE334	**4-0-0-2**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

Students will be able to study and understand the overall and detailed planning of formwork, plant and site equipment and design for various elements such as slabs, beams, columns, walls, shells, tunnels, decks and false works. Also the students will know about different forms of erecting the formwork building and know about the latest methods of form construction.

Syllabus

Module – I

Introduction: Formwork and false work, Temporary work systems, Construction planning and site constraints, Materials and construction of the common formwork and false work systems, Special and proprietary forms. 10hr

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Module – II

Formwork Design: Basic simplification - Beam formulae - Allowable stresses - Deflection, Bending - Lateral stability - Shear, Bearing - Design of Wall forms - Slab forms - Beam forms - Column forms - Examples in each, Concrete pressure on forms, Design of timber and steel forms, Loading and moment of formwork 10hr

Module – III

Design of Decks and False works: Types of beam, decking and column formwork, Design of decking, False work design, Effects of wind load, Foundation and soil on false work design. 10hr

Module – IV

Building and Erecting the Formwork: Carpentry Shop and job mill - Forms for Footings - Wall footings - Column footings - Sloped footing forms - Strap footing - Stepped footing - Slab form systems - Sky deck and Multiplex - Customized slab table - Standard Table module forms - Swivel head and uniportal head - Assembly sequence-Cycling with lifting fork - Moving with table trolley and table prop. Various causes of failures - ACI -Design deficiencies - Permitted and gradual irregularities. 10hr

Module – V

Special Forms and Safety in use of Formwork: The use and applications of special forms, Safety use of formwork and false work. 10hr

Course Outcomes:

On completion of this course, students are able to:

- Understand the sequence of construction of civil engineering structures.
- Appraise a right material for manufacturing false work and form work suiting specific requirements.
- Design decking, form work and false work.
- Understand the safety steps involved in the design of form work and false work

Reference Books:

1) Austin, C.K., Formwork for concrete, Cleaver - Hume Press Ltd., London, 1996
2) Michael P. Hurst, Construction Press, London and New York., 2003
3) Robert L. Peurifoy and Garold D. Oberiender, Formwork for Concrete Structures, McGraw-Hill, 1996.
4) Tudor Dinescu and Constantin Radulescu, Slip Form Techniques, Abacus Press, Turn Bridge Wells, Kent, 2004.

E-Resource:

- www.atkinsglobal.com/.../Concrete...
- www.worldcat.org/…mwork-for-concrete-structures/...
- http://www.Webcrawler.com
- thacampbell.typepad.com/…lass_handouts/Formwork.pdf
- www.okorder.com/Formwork+Design

MINI PROJECT				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
21 CSE35	**0-0-2-0**	**2**	**CIE Marks 100**	**3 Hours**

Course Objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Syllabus

Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course Outcomes:

At the end of the course the student will be able to:

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

TECHNICAL SEMINAR-II				
Course Code	**L:T:P:S (Hrs/Week)**	**Credits**	**Exam Marks**	**Exam Duration**
21CSE37	**0-0-0-2**	**1**	**CIE: SEE Marks: 50**	**20 m**

Course Objectives:

- To develop students written and oral communication competencies to enhance technical effectiveness.
- To provide students an opportunity to learn new concepts and to express their presentation skills
- Instill students with initiative, independence, reflection and knowledge transfer
- To develop students ability to think strategically and express their views without hesitation.

Syllabus

The student will have to give a presentation for 20 minutes on any current civil engineering topic chosen by him or her after discussion with guide.

Course Outcomes:

On completion of this course, students are able to

- Students get the awareness about the recent technology trends based on their field of interest
- Able to prepare an effective written technical report
- Able to plan and produce presentation materials which most effectively communicate the intended message for their technical oral presentation