NAGARJUNA COLLEGE OFENGINEERING & TECHNOLOGY

(An Autonomous College under VTU)
(NAACAccreditedwith *'A'* Grade, NBA Accredited)

Syllabus – I to IV Semester
M.Tech (Structural Engineering)
Outcome Based Education Curriculum

2020-2021

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

Program Outcome (PO)

PO1: Engineering Knowledge:

Apply the knowledge of mathematics, science, engineering fundamentals and Civil Engineering principles to the solution of complex problems inCivil Engineering.

PO2: Problem Analysis

Identify, formulate, research literature and analyze complex Civil Engineering problems reaching substantiated conclusions using first principlesof mathematics and engineering sciences.

PO3: Design/Development of Solutions:

Design solutions for complex Civil Engineering problems and design system components or processes that meet the specified needs withappropriate consideration for the public health and safety, cultural, societal and environmental considerations.

PO4: Conduct Investigations of Complex problems:

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of theinformation to provide valid conclusions related to Civil Engineering problems.

PO5: Modern Tool Usage:

Create, select, and apply appropriate techniques, resources, and modern engineering tools such as CAD, FEM, GIS, etc. including prediction andmodeling to complex Civil Engineering activities with an understanding of the limitations.

PO6: The Engineer and Society:

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequentresponsibilities relevant to the professional Civil Engineering practice.

PO7: Environment and Sustainability:

Understand the impact of the professional Civil Engineering solutions in societal and environmental contexts and demonstrate the knowledgeand the need for sustainable development.

PO8: Ethics

Apply ethical principles and commit to professional ethics and responsibilities while following the Civil Engineering practice.

PO9: Individual and Team work

Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

PO10: Communication

Communicate effectively on complex Civil Engineering activities with the engineering community and with society at large, such as, being able tocomprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a memberand leader in a team, to manage Civil Engineering projects and in multidisciplinary environments.

PO12: Life Long Learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO)

Program Specific Outcomes (PSOs) are what the graduates of a specific undergraduate engineering program should be able to do at the time of
graduation.

PSO1: To carryout surveying, prepare layout plans, maps for structures and alignments for canals and roads.

PSO2: To specify, analyze, design, estimate and supervise construction activities such as, test and evaluate foundations and superstructures for buildings, industries, irrigation and hydraulic structures, highways, railways, airports, docks and harbors.

PSO3: To understand the impact of water, air and noise pollution; the methods of waste collection, disposal and processing; specify, design andanalyze water supply system, sewerage and industrial effluent conveying and treatment systems.

First Semester M.Tech (Structural Engineering) - Scheme

Sl. No	Course Code	Course	Teaching Department	L-T-P-S (Hrs/week)	Total Credits	Marks
1	20CSE11	ADVANCED DESIGN OF RCC STRUCTURES	CE	4-0-0-0	4	100
2	20CSE12	MECHANICS OF DEFORMABLE BODIES	CE	4-0-0-0	4	100
3	20CSE13	COMPUTATIONAL STRUCTURAL MECHANICS	CE	4-0-0-0	4	100
4	20CSE14	STRUCTURAL DYNAMICS	CE	4-0-0-0	4	100
5	20CSE15X	ELECTIVE - I	CE	3-0-0-0	3	100
6	20CSE16	STRUCTURAL ENGINEERING LAB-1	CE	0-0-2-0	2	100
7	20CSE17	RESEARCH METHODOLOGY AND IPR	CE	2-0-0-0	2	100
Total				21-0-2-0	23	700

Elective – I		
Sl. No	**Course Code**	**Course**
1	20CSE151	ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES
2	20CSE152	DESIGN OF PRECAST AND COMPOSITE STRUCTURES
3	20CSE153	REPAIR AND REHABILITATION OF STRUCTURES

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

Second Semester M.Tech(Structural Engineering) - Scheme

Sl. No	Course Code	Course	Teaching Department	L-T-P-S (Hrs/week)	Total Credits	Marks
1	20CSE21	ADVANCED DESIGN OF STEEL STRUCTURES	CE	4-0-0-0	4	100
2	20CSE22	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	CE	4-0-0-0	4	100
3	20CSE23	FINITE ELEMENT METHOD OF ANALYSIS	CE	4-0-0-0	4	100
4	20CSE24X	ELECTIVE - II	CE	4-0-0-0	4	100
5	20CSE25X	ELECTIVE – III	CE	4-0-0-0	4	100
6	20CSE26	STRUCTURAL ENGINEERING LAB-2	CE	0-0-2-0	2	100
7	20CSE27	TECHNICAL SEMINAR-I	CE	0-0-0-2	1	50
Total				20-0-2-2	23	650

Elective – II		
Sl. No	**Course Code**	**Course**
1	20CSE241	ADVANCED STRUCTURAL ANALYSIS
2	20CSE242	DESIGN OF RC BRIDGES
3	20CSE243	OPTIMIZATION OF STRUCTURES

Elective – III		
Sl. No	**Course Code**	**Course**
1	20CSE251	DESIGN OF TALL STRUCTURES
2	20CSE252	STRUCTURAL HEALTH MONITORING
3	20CSE253	RELIABILITY ANALYSIS OF STRUCTURES

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

M.Tech Structural Engineering

Third Semester- Scheme

Sl . No	Subject Code	Subject	Teaching Dept	L-T-P-S (Hrs/week)	Total Credits	Marks
1.	19CSE31	Stability of Structures	Civil Engineering	4-0-0-0	4	100
2.	19CSE32x	**Elective – 4**	Civil Engineering	4-0-0-0	4	100
3.	19CSE33x	**Elective – 5**	Civil Engineering	4-0-0-0	4	100
4.	19CSE34	Dissertation Phase– 1 & Seminar	Civil Engineering	0-0-4-4	3	100
5.	19CSE35	Internship/Term paper/Mini project	Civil Engineering	0-0-0-24	6	100
Total				**12-0-4-28**	**21**	**500**

Elective – 4		
1.	19CSE321	Design of Floating Structures
2.	19CSE322	Advanced Construction Techniques
3.	19CSE323	Design of Plates and Shells
Elective – 5		
1.	19CSE331	Design of Composite Structures
2.	19CSE332	Design of Masonry Structures
3.	19CSE333	Formwork Design for Structures

Fourth Semester - Scheme

Sl . No	Subject Code	Subject	Teaching Dept	L-T-P-S (Hrs/week)	Total Credits	Marks
1	19CSE41	Dissertation Phase II	Civil Engg.	0-0-14-0	06	100
2	19CSE42	Dissertation Phase III	Civil Engg.	0-0-14-0	06	100
3	19CSE43	Dissertation final Viva Voce	Civil Engg.	0-0-4-0	04	100
Total				**0-0-32-0**	**16**	**300**

FIRST SEMESTER

ADVANCED DESIGN OF RCC STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE11	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Learn principles of advanced structural design of RC elements
- Design different types of structures and to detail the structures.
- Evaluate performance of the structures.
- Understand the principles of Structural Design.
- Design and develop analytical skills.

Syllabus

Module – I

Design of continuous beams with and without redistribution of moments: Introduction, effective span, stiffness, loading pattern, moment redistribution, bending moment and shear force co-efficient. **Design of curved 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'sGrashoff method, IS-456:2000 method. 10 hrs

Module – III

Design of silos and bunkers: Introduction, Difference between bunkers and silos, Design of rectangular bunker, Design of tension member, Design of circular bunker, Design of silos. 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: Plain concrete wall and shear walls, Deep beams, Folded plates, cylindrical shells, Corbels and slender columns. 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.

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

Reference Books:

- 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**
- P.C.Varghese, "**Advanced Reinforced Concrete Design**", Prentice-Hall of India, New Delhi, 2005

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**
20CSE12	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Learn the principles of Analysis of Stress and Strain,
- Predict the stress strain behavior of continuum.
- Evaluate the stress and strain parameters and their inter relations of the continuum.
- Solve plane stress and strain problems.
- Understand the theory of plasticity.

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, max, 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 prismatical 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 – spacerepresentation 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:

http://linlspringer.com
http://crcnetbase.com

COMPUTATIONAL STRUCTURAL MECHANICS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE13	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Learn principles of Structural Analysis.
- Implement these principles through different methods and to analyze various types of structures.
- Evaluate the force and displacement parameters of the structures.
- Understand the concepts of matrix methods such as flexibility and stiffness matrix methods, particularly direct stiffness method, and learn the analysis of indeterminate structures, such as plane trusses.
- Analyze indeterminate structures, such as continuous beams and 2D frames, using direct stiffness method

Syllabus

Module – I

Fundamental concepts: 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 hr.

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 hr.

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 hr.

Module – IV

Effects of temperature change and lack of fit: Related numerical Truss problems by Flexibility method . 10 hr.

Module – V

Solution techniques: Solution techniques including numerical problems for simultaneous equation, Gauss elimination and Cholesky method. 10 hr.

Course Outcomes:

On completion of this course, students are able to

- Achieve Knowledge of basics of indeterminacy.
- Comprehend the matrix methods and method of direct stiffness method of analysis of trusses with different support and loading conditions. Design and develop analytical skills.
- Apply the direct stiffness method to analyze the continuous beams and 2D frames with different support and loading conditions.
- Learn the flexibility method to analyze the continuous beams and 2D frames with different support and loading conditions.
- Understand the different solution techniques.

Reference Books:

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

E-Resource:

- http://linlspringer.com
- http://crcnetbase.com

STRUCTURAL DYNAMICS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE14	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Learn principles of structural dynamics
- Implement principles of structural dynamics through different methods and to apply the same for free and forced vibration of structures
- Evaluate dynamic characteristics of structure
- Study the different dynamic analysis procedures for calculating the response of structures
- Design structures for 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 undamped 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:

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

E-Resources:

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

ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES

Course Code	L:T:P:S (Hrs/week)	Credits	Exam Marks	Exam Duration
20CSE151	3-0-0-0	3	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.

E-Resource:

http://linlspringer.com

DESIGN OF PRECAST AND COMPOSITE STRUCTURES				
Course Code	**L:T:P:S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE152	**3-0-0-0**	**3**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

Students are able to

- Understand the concepts and techniques of precast construction.
- Select precast elements suitable for project specific requirements.
- Analyze and design precast systems to ensure integrity and safety of the structure and to avoid progressive collapse.
- Design composite floors and beam elements.
- Learn elastic behaviour of composite beams.

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.

10hrs

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. 10hrs.

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. 10hrs

Module – V

Design of Steel Concrete Composite Floors and Beams Composite Floors:
Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, Design Example
Composite Beams:
Elastic Behaviour, Ultimate Load behaviour of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams. 10hrs

Course Outcomes:

On completion of this course, students will be able to

- Understand the concepts of precast construction and pre cast elements.
- Design the precast reinforced and pre-stressed beams.
- Develop the design of precast concrete wall and column.
- Select appropriate connections for structural integrity.
- Explain the concepts of composite beams.

Reference Books:

1. Hass A.M. – Precast Concrete – Design and applications Applied Science, 1983.
2. David Sheppard – "Plant cast, Precast and Prestressed concrete – McGraw Hill; 1989
3. NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15916- 2011,IS 11447,IS6061 – I and III
4. R.P.Johnson: Composite Structure of Steel and Concrete (Volume 1), Blackwell Scientific Publication (Second Edition), U.K., 1994.
5. IS: 11384-1985, Code of Practice for Composite Construction in Structural Steel and Concrete.
6. INSDAG Teaching Resource Chapter 21 to 27: www.steel-insdag.org

E-Resource:

http://linlspringer.com
http://crcnetbase.com

REPAIR AND REHABILITATION OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE153	**3-0-0-0**	**3**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Identify the cause of deterioration of concrete structures.
- Understand the importance of maintenance of structures.
- Strategies different repair and rehabilitation of structures.
- Evaluate the performance of the materials for repair.
- Study various repair techniques for damaged structures corroded structures.

Syllabus

Module – I

General: Introduction, Cause of deterioration of concrete structures, Diagnostic methods & analysis, preliminary investigations, experimental investigations using NDT, load testing, corrosion mapping, core drilling and other instrumental methods Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking.

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, and cathodic protection. **10Hrs**

Module – III

Maintenance and Repair Strategies: Definitions: Maintenance, repair and rehabilitation, Facets of Maintenance importance of Maintenance Preventive measures on various aspects. Inspection, Assessment procedure for evaluating a damaged structure causes 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

- Assessing the damage of corroded structures.
- Understands the concept of Serviceability and Durability.
- Summarize damage assessment and Rapid Visual inspection of a building showing signs of deterioration.
- Apply the importance of quality control in concrete construction and significance of protection maintenance of structures.
- Use of repair materials and techniques for the damaged structures.

Reference Books:

1 Dr. B Vidivelli "Rehabilitation of Concrete Structures". 1st edition. Standard Publisher Distributors. 2009.

2 Sidney, M. Johnson "Deterioration, Maintenance and Repair of Structures". Krieger Publishing Co. 1980.

3 Denison Campbell, Allen & Harold Roper, "Concrete Structures – Materials, Maintenance and Repair"- Longman Scientific and Technical. 1991.

4 R.T. Allen, S.C. Edwards and D N Shaw, "Repair of Concrete Structures"-Blakie and Sons, CRC Press, 1992.

5 Raiker R.N., "Learning for failure from Deficiencies in Design, Construction and service"-R&D Center (SDCPL)., 1987.

E-Resources:

- http://linlspringer.com
- http://crcnetbase.com

STRUCTURAL ENGINEERING LAB-1				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE16	**0-0-2-0**	**2**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

Students are able:

- To make students to learn the principles of mix design.
- To investigate the performance of structural elements.

To analyze the natural frequency and modes

Syllabus

EXPERIMENTS

1. Experiments on Concrete, including Mix design.
2. Testing of beams for deflection, flexure and shear.
3. Experiments on vibration of multi storey frame models for Natural frequency and modes.
4. Use of Non destructive testing (NDT) equipments – Rebound hammer, Ultra sonic pulse velocity meter and Pro fometer.

Course Outcomes:

On completion of this course, students are able to

- Achieve the knowledge of mix design.
- Develop of experimenting skills.
- Study the concept of natural frequency and modes.

Reference Books:

1. IS Codes : IS 10262: 2009 and IS 456: 2000

E-Resource:

- http://linlspringer.com

RESEARCH METHODOLOGY AND IPR				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE17	**2-0-0-0**	**2**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

Students will be able to

- Understand research problem formulation
- Analyze research related information
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding 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

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations 5 hrs

Module – II

Effective literature studies approaches, analysis, Plagiarism, Research ethics**.** 5 hrs

Module – III

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee 5 hrs

Module – IV

Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. 5 hrs

Module – V

Patent Rights:

Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases. Geographical Indications.

New Developments in IPR:

Administration of Patent System. New developments in IPR; IPRof Biological Systems, Computer Software etc. Traditionalknowledge Case Studies, IPR and IITs. 5 hrs

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 an conceptual frameworks and writing a review.
- Explain various research designs and their characteristics.
- Explain the art of interpretation and 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:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: AnIntroduction" Model Curriculum of Engineering & Technology PG Courses [Volume -II] [15]
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide forbeginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007
5. Mayall , "Industrial Design", McGraw Hill, 1992
6. Niebel , "Product Design", McGraw Hill, 1974
7. Asimov , "Introduction to Design", Prentice Hall, 1962
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property inNew Technological
Age", 2016
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

E-Resource:

- http://linlspringer.com

SECOND SEMESTER

ADVANCED DESIGN OF STEEL STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE21	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Understand the background to the design provisions for hot-rolled and cold formed steel structures, including the main differences between them.
- Proficiency in applying the provisions for design of columns, beams, beam columns.
- Design structural sections for adequate fire resistance
- Learn methodology for transmission towers and chimneys.
- Evaluate the performance of pre-engineered buildings.

Syllabus

Module – I

Cold Formed Steel Sections: Techniques and properties, Advantages, Typical profiles, Stiffened and unstiffened elements, Effective section properties, – Numerical examples- Column design. 10hrs

Module – II

Design of Light Gauge Steel Structures: Behavior of compression elements, Effective width for load and deflection determination, Behavior of stiffened and unstiffened elements, Local and post buckling of thin elements, Limiting width to thickness ratio, Design of Beam. 10hrs

Module – III

Transmission Towers: Basic structural configuration, Free-standing and guyed towers, Loads on towers, Analysis and design of steel monopoles, Transmission line towers – sag and tension calculations, Design of Preliminary Geometry of a Tower. 10hrs

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. 10hrs

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. 10hrs

Course Outcomes:

On completion of this course, students are able to

- Understand behaviour of light gauge steel members.
- Analyse and design concepts of cold formed steel structures.
- Learn the design concepts of transmission towers.
- Understand the design concepts of chimneys.
- Understand the concept of pre-engineered buildings and space truss.

Reference Books:

- Duggal "Limit State Design of Steel Structures",Tata McGraw Hill., 2014.
- N Subramanian- "Design of Steel Structure", Oxford University Press, 2014.
- 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
- S. S. Bhavikatti, "Design of Steel Structures", I. K. International Publishing House Pvt Ltd., 2010.

E-Resources:

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

EARTHQUAKE RESISTANT DESIGN OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE22	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Learn the principles of engineering seismology.
- Evaluate the seismic response of the structures
- Study the damages caused by previous earthquakes and understand the importance of earthquake resistant design.
- Apply the philosophy of earthquake resistant design and the methodology to design as per IS code.
- To know the importance of ductility in earthquake resistant design of RC structures.

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

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of engineering seismology.
- Design and develop analytical skills.
- Summarize the Seismic evaluation and retrofitting of structures.
- Explain the concepts of earthquake resistance of reinforced concrete buildings.

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

FINITE ELEMENT METHOD OF ANALYSIS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE23	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Apply the Finite Element Method for the analysis of one and two dimensional problems.
- Evaluate the stress and strain parameters and their inter relations of the continuum.
- Learn the concept of finite element method, displacement model and weighted residual methods in the analysis of structures.
- Understand the importance of shape functions and its development using different approaches for various types of elements.
- Develop element stress, strain and stiffness matrices, isoparametric elements and solving simple beams using finite element analysis.

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: Analysis of one &two dimensional problems - Analysis of simple beams and plane trusses. 10 hrs

Module – V

Application to Plates & Shells: Choice of displacement function (C^0, $C^1$and C^2type) – Techniques for Non – linear Analysis. 10 hrs

Course Outcomes:

On completion of this course, students are able to

- Understanding the concept of fem.
- Learn the concept of shape functions/ interpolation functions for bar element and beam element.
- Apply the FEM to analyze cantilever and simply supported beams.
- Describe the state of stress in a continuum.
- Analyze Plates and shells using FEM.

Reference Books:

1. Krishnamorthy C S, "Finite Element Analysis" 2nd Edition, - Tata McGraw Hill.
2. Desai C and Abel J F, "Introduction to the Finite Element Method " 1st Edition, - East West P Pvt. Ltd., 1972.
3. Bathe K J, "Finite Element Procedures in Engineering Analysis " 4th Edition,- Prentice Hall.
4. Rajasekaran. S, "Finite Element Analysis in Engineering Design" 1st Edition,- Whe Publishing.
5. 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 STRUCTURAL ANALYSIS				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE241	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Analyse the curved beams for moment, shear and torsion.
- Develop the differential equation for beams on elastic foundation.
- Construct a differential equation for the prismatic bars with various loading condition.
- Adopt concept of influence line diagrams for continuous beams and frames.
- Use the tension coefficient method for 2D and 3d frame.

Syllabus

Module – I

CURVED BEAMS: Introduction to curved beam & assumptions, WINKLER BACH equation, Limitation, Radius of neutral surface of rectangular, 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

- Determine the moment, shear and torsion for curved beams.
- Compute the differential equation for the beams with various loading condition.
- Analyse the stability of prismatic bars using Euler's theory.
- Apply the concept of influence line diagramfor continuous beams.
- Design the 2D and 3D frames using tension coefficient method.

Reference Books:

1. Krishna Raju N &Gururaj D R "Advanced mechanics of solids and structures", NAROSA Publishers Company Delhi.
2. Srinath L.S. "Advanced Mechanics of Solids", Tenth Print, Tata McGraw Hill publishing company. New Delhi, 1994.
3. Vazirani V N and Ratwani M M "Advanced theory of structures and Matrix Method". 5th Edition, Khanna publishers, Delhi 1995.
4. HetenyiM."Beams on elastic foundation" 3rd printing, University of Michigan, USA, 1952.
5. Alexander Chatjes "Principles of Structural stability theory", Prentice – Hall of India, New Delhi, 1974.
6. Junnarkar S.B. "Mechanics of Structure". Vol – III, VIVEK Publications, 1962.
7. Sterling Kinney "Indeterminate Structural Analysis", Oxford & IBH publishers.

E-Resources:

- http://linlspringer.com
- http://crcnetbase.com

DESIGN OF RC BRIDGES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE242	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Know about history, components and classification of bridges.
- Introduce the theory and application of analysis and design of RC bridges as applicable to roads and railways.
- Understand different types of loads standardized by IRC and Indian railways in analyzing and designing of deck slabs of concrete bridges carrying wheel loads.
- Design the different types of bridges.
- Various loads that act on the bridges as per IRC.

Syllabus

Module – I

Introduction: Historical Developments, Site Selection for Bridges, Classification of Bridges Forces on Bridges. Bridge substructures: Abutments, piers and wing walls Balanced Cantilever Bridge: Introduction and proportioning of components, Design of simply supported portion and design of cantilever portion, design of articulation 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 Simply Supported Portion, Design of Simply Supported Portion, Design of Cantilever Portion, Design of Cantilever Portion, Design of Articulation, Design of Articulation, Reinforcement Details of Main Girder 10hrs

Course Outcomes:

On completion of this course, students are able to

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

Reference Books:

- Principles and Practice of Bridge Engineering by S P Bindra, DhanpatRai& Sons New Delhi
- IRC 6 -1966 Standard Specifications And Course Code Of Practice For Road Bridges Section II Loads and Stresses, The Indian Road Congress New Delhi
- IRC 21 - 1966 Standard Specifications And Course Code Of Practice For Road Bridges Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
- IS 456 - 2000 Indian Standard Plain and Reinforced Concrete Course Code of Practice (Fourth Revision) 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:

http://linlspringer.com

http://crcnetbase.com

OPTIMIZATION OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE243	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

Students will be able to :

- Learn optimization techniques
- Find solutions to problems by linear programming
- Find solutions to problems by non linear programming
- Learn about geometric programming
- Formulate and optimize structural problems in the design of structural elements

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

10hrs

Module – IV

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.

10hr

Course Outcomes:

On completion of this course, Students will be able to

- Understand the basics of optimization.
- Apply linear and non linear programming to solve problems in structural problems.
- Optimize structural problems using geometric programming.
- Analyze dynamic programming to solve structural problems.
- Formulate structural optimization problem by different techniques..

Reference Books:

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

E-Resource:

- http://linlspringer.com
- http://crcnetbase.com

DESIGN OF TALL STRUCTURES				
Course Code	**L:T:P:S (Hrs/week)**	**Credits**	**Exam marks**	**Exam Duration**
20CSE251	**4-0-0-0**	**4**	**CIE: SEE MARKS 50 : 50**	**3 Hours**

Course Objectives:

Students are able to

- Learn principles of stability of tall buildings.
- Design the tall buildings for earthquake and wind resistance.
- Analyse evaluate the performance of tall structures for strength and stability.
- Achieve Knowledge of design, different types of loads and their influence on tall buildings and development of problem solving skills.
- Understand the concepts of P-Delta analysis.

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. 10hrs

Module – III

Behavior 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

- Describe the concept of lateral loads and their influence on tall buildings
- Understand the principles of strength and stability.
- Design and develop analytical skills.
- Summarize the behavior of various structural systems.
- Explain the concepts of P-Delta analysis.

Reference Books:

1. Taranath B.S, "Structural Analysis and Design of Tall Buildings"- 2nd Edition, McGraw Hill
2. Wilf gang Schuller, "High rise building structures"- John Wiley, 1977.
3. Bryan Stafford Smith & Alexcoull, "Tall building structures Analysis and Design"- 2nd Edition, John Wiley
4. T.Y Lin & D. Stotes Burry, "Structural concepts and system for Architects and Engineers"- 3rd Edition, John Wiley
5. Lynn S.Beedle, "Advances in Tall Buildings"- 3rd Edition, CBS Publishers and Distributors.
6. 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

STRUCTURAL HEALTH MONITORING				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE252	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Monitor the systems for long term to keep infrastructure under constant surveillance
- Measure static and dynamic response of structures
- Achieve knowledge about how to measure data by field tests
- Familiarize about sensor system and their installation and applications
- Understand to measure the data and to draw layout plan.

Syllabus

Module – I

Introduction to 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

- Diagnosis the distress in the structure by understanding the causes and factors
- Asses the health of structure using field tests
- Achieve knowledge about sensor system and their installation
- Measure strains and vibrations through sensors
- Understand and able to draw layout plan.

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/**

RELIABILITY ANALYSIS OF STRUCTURES				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE253	**4-0-0-0**	**4**	**CIE: SEE Marks 50 : 50**	**3 Hours**

Course Objectives:

The students will be able to:

- Learn principles of reliability
- Review mathematical tools for quantifying uncertainties using theories of probability
- Implement the Probability Concepts for the Reliability Analysis
- Evaluate different methods of reliability analysis.
- Develop the theory of methods of structural reliability.

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 probabilityinterpretation,probability axioms, addition rule, multiplication rule, conditional probability, probability tree diagram,statistical independence, total probability theorem and Baye's theorem.

10 Hrs

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.

10 Hrs

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).

10 Hrs

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 will be able to

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

Text 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.

Reference Books:

- 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

STRUCTURAL ENGINEERING LAB-2				
Course Code	**L-T-P-S (Hrs/week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE26	**0-0-2-0**	**2**	**CIE: SEE MARKS 50 : 50**	**3 Hours**

Course Objectives:

Students are able:

- To make students to learn the software for structural analysis and design.
- To assess the performance of structures for static and dynamic analysis.
- To analyze the folded plates and shells.
  To develop the knowledge of preparing the excel sheets for structural design

Syllabus

1. Static and Dynamic analysis of Building structure using software (ETABS / STAADPRO)
2. Design of RCC and Steel structure using software (ETABS / STAADPRO)
3. Analysis of folded plates and shells using software.
4. Preparation of EXCEL sheets for structural design.

Course Outcomes:

On completion of this course, students are able to

On completion of this course, students are able to

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

Reference Books:

Software Manuals

E-Resource:

- http://linlspringer.com
- http://crcnetbase.com

TECHNICAL SEMINAR-I				
Course Code	**L:T:P:S (Hrs/Week)**	**Credits**	**Exam Marks**	**Exam Duration**
20CSE27	**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

Stability of Structures

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19CSE31	4:2:0:0	4	CIE:50 SEE:50	3 hours	FC

Course Objectives:

To provide a detailed treatment of buckling characteristics of various structural elements, and to present different methods to solve stability problems including integration with finite element procedures

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. 10hrs

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. 10hrs

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 stiffn ess matrices for a discretised column with different boundary conditions – Evaluation of critical loads for a discretised (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. 10hrs

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. 10hrs

Module – V

Buckling of simply supported rectangular plate – Co mbined effects: Buckling of a simply supported rectangular plate under combined bending and compression – Buckling of rectangular p lates under the action of shearing stresses – Other cases of buckli ng of rectangular plates. 10hrs

Course Outcomes:

Students will be able to

1. Understand the concepts of stability; types of buckling.
2. Compute buckling loads of columns; elastic buckling of frames and Plates.

Text Books:

1. Rajasekaran.S, "Computational Structural Mechani cs", PHI, New Delhi 2001, ISBN: 978-81-203-1734-5.
2. Reddy.C.S, "Basic Structural Analysis," TMH, New Delhi 2001, 3rd edition, ISBN 10: 0070702764 / ISBN 13: 9780070702769.
3. Robert D Cook et al, "Concepts and Applications of Finite Element Analysis", 3rd Edition, JohnWiley and Sons, New York, 4th edition ISBN: 978-0-471-35605-9.

Reference Books:

1. Beaufait.F.W. et al., "Computer Methods of Structur al Analysis", Prentice Hall, 1970.
2. Weaver.W and Gere.J.H.,"Matrix Analysis of Framed S tructures", Van Nastran, 1980.
3. Rubinstein M.F, "Matrix Computer Methods of Structu ral Analysis" Prentice-Hall,First edition ,ISBN : 81-7800-018-0.
4. Bathe.K.J, "Finite element procedures in Engineerin g Analysis". PHI. New Delhi.

E-Resource:

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

DESIGN OF FLOATING STRUCTURES

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
19CSE321	4:0:0:0	4	CIE:50 SEE:50	3 hours	FC

MODULE I

WAVE THEORIES

Wave generation process, small and finite amplitude wave theories. 10 hrs

MODULE II

FORCES OF OFFSHORE STRUCTURES

Wind forces, Wave forces on vertical, inclined cylinders, structures - Current forces and use of Morison equation. 10 hrs

MODULE III

OFFSHORE SOIL AND STRUCTURE MODELLING

Different types of offshore structures, foundation Modelling, Structural modelling. 10 hrs

MODULE IV

ANALYSIS OF OFFSHORE STRUCTURES

Static Method of Analysis, foundation analysis and dynamics of offshore structures 10 hrs

MODULE V

DESIGN OF OFFSHORE STRUCTURES

Design of Platforms, helipads, Jacket tower and mooring cables and pipelines 10 hrs

TEXT / REFERENCE BOOKS:

1. Chakrabarti, S.K. “Hydrodynamics of Offshore Structures”, Computational Mechanics Publications, 1987.
2. Thomson H. Dawson, “Offshore Structural Engineering”, Prentice Hall Inc Englewood Cliffs, N.J. 1983.
3. Reddy D.V and Arockiasamy , M. “Offshore Structures’, Vol. 1., Krieger Publishing Company, Malabar, Florida, 1991.

ADVANCED CONSTRUCTION TECHNIQUES

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19CSE322	4:0:0:0	4	CIE:50 SEE:50	3 hours	FC

Course Objectives:

To study and understand the latest construction techniques applied to engineering construction for sub structure, super structure, special structures, rehabilitation and strengthening techniques and demolition techniques.

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 – in-situ prestressing in high rise structures, Post tensioning of slab- aerial transporting – Handling and erecting lightweight components on tall structures. 10 hrs

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. 10 hrs

Module – IV

REHABILITATION AND STRENGTHENING TECHNIQUES : Seismic retrofitting - Strengthening of beams - Strengthening of columns - Strengthening of slab - Strengthening of masonry wall ,Protection methods of structures ,Mud jacking and grouting for foundation – Micro piling and underpinning for strengthening floor and shallow profile. Sub grade- water proofing, Soil Stabilization techniques. 10 hrs

Module – V

DEMOLITION: Demolition Techniques, Demolition by Machines, Demolition by Explosives, Advanced techniques using Robotic Machines, Demolition Sequence, Dismantling Techniques, Safety precaution in Demolition and Dismantling. 10hrs

Course Outcomes:

Students will be able to

- On completion of this course the students will know the modern construction techniques to be used in the construction of buildings
- Techniques to be adopted in special structures
- Emphasis of rehabilitation and strengthening techniques

- Utilise special and significant demolition techniques.

Text Books:

1. Jerry Irvine, Advanced Construction Techniques, CA Rocketr, 1984
2. Patrick Powers. J., Construction Dewatering: New Methods and Applications, John Wiley & Sons, 1992.

Reference Books:

1. Peter.H.Emmons, "Concrete repair and maintenance illustrated", Galgotia Publications Pvt. Ltd., 2001.Press, 2008.
2. Robertwade Brown, Practical foundation engineering hand book, McGraw Hill Publications, 1995.
3. Sankar, S.K. and Saraswati, S., Construction Technology, Oxford University Press, New Delhi, 2008.

E-Resource:

- https://www.cosmosim.org/cms/documentation/database.../substructures/
- www.ncbi.nlm.nih.gov › NCBI › Literature › PubMed Central (PMC)
- www.pmrjournal.org/article/S1934-1482(12)01050-7/references
- www.controlled-demolition.com/
- www.debunking911.com/pull.htm

DESIGN OF PLATES AND SHELLS

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
19CSE323	4:2:0:0	4	CIE:50 SEE:50	3 hours	FC

Course Objectives:

- To learn different methods of analysis of plates and shells.
- To develop the knowledge of energy concepts.
- To design and detail the simple shells.

Syllabus

Module – 1

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.

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.

10hr

Module – 2

Energy Methods: Introduction to energy methods, derivation for the rectangular and circular plateswith 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.

10hr

Module – 3

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.

10hr

Module – 4

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.

10hr

Module – 5

Design and detailing of simple shell problems – spherical domes, water tanks, barrel vaults and hyperbolic paraboloid roofs.

10hr

Course Outcome: On completion of this course, students are able to

- Achieve the knowledge of analyzing the plates under different boundary conditions.
- Understand the concept of energy principles.
- Summarize the concepts of curved surfaces.
- Develop the analytical knowledge about shallow shells.
- Design and detailing of shells.

Reference Books:

1. Timosheko, S. and Woinowsky-Krieger, W., "Theory of Plates and Shells" 2nd Edition, McGraw-
Hill Co., New York, 1959.
2. Ramaswamy G.S. – "Design and Constructions of Concrete Shell Roofs" – 2005 Edition, CBS Publishers and Distributors – New Delhi.
3. Ugural, A. C. "Stresses in Plates and Shells", 2nd edition, McGraw-Hill, 1999.
4. R. Szilard, "Theory and analysis of plates - classical and numerical methods", 3rd Edition,Prentice Hall, 1994.
5. Chatterjee.B.K. – "Theory and Design of Concrete Shell", 3rd Edition, Chapman & Hall, New York-third edition, 1988

E-Resources:

https://ia700807.us.archive.org/34/items/TheoryOfPlatesAndShells/TheoryOfPlatesAndShellsS.timoshenko2ndEdition_text.pdf

DESIGN OF COMPOSITE STRUCTURES					
Course Code	**L:T:P:S**	**Credits**	**Exam marks**	**Exam Duration**	**Course Type**
19CSE331	**4:2:0:0**	**4**	**CIE:50 SEE:50**	**3 hours**	**FC**

Course Objectives:

- Understand the concepts and techniques of precast construction and Select or design precast elements suitable for project specific requirements
- Design precast systems to ensure integrity and safety of the structure and to avoid progressive collapse and Design composite floors and beam elements

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.
10hrs

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 unbraced columns with corbels subjected to pattern and full loading. Design of Corbels Design of RC walls subjected to Vertical, Horizontal loads and moments, Design of vertical ties and horizontal joints.
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.10hrs

Module – V

Design of Steel Concrete Composite Floors and Beams Composite Floors: Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, Design Example 10hrs

Course Outcomes:

Students will be able to

- Summarise the masonry materials and their characteristics.
- Understand the strength and elastic properties of masonry and its constituent materials.
- Understand behaviour of bond between the constituent masonry materials and its influence on strength.
- Design masonry structures for gravity, wind and seismic loads.
- Understand the components, classification and the construction procedure of masonry arches, domes and vaults.

Reference Books:

1. Hass A.M. – Precast Concrete – Design and applications Applied Science, 1983.

2. David Sheppard – "Plant cast, Precast and Prestressed concrete – McGraw Hill; 1989

3. NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15916- 2011,IS 11447,IS6061 – I and III

4. R.P.Johnson: Composite Structure of Steel and Concrete (Volume 1), Blackwell Scientific Publication (Second Edition), U.K., 1994.

5. IS: 11384-1985, Code of Practice for Composite Construction in Structural Steel and Concrete.

6. INSDAG Teaching Resource Chapter 21 to 27: www.steel-insdag.org

E-Resource:

- accessengineeringlibrary.com/browse/**masonry**-**structural**-design
- https://law.resource.org/pub/eu/eurocode/en.1996.1.1.2005.pdf
- https://law.resource.org/pub/eu/eurocode/en.1996.2.2006.pdf
- www.**masonry**society.org/.../2013MSJC_Working_Draft_through_2013-...

MASONRY STRUCTURES					
Course Code	**L:T:P:S**	**Credits**	**Exam marks**	**Exam Duration**	**Course Type**
19CSE332	**4:2:0:0**	**4**	**CIE:50 SEE:50**	**3 hours**	**FC**

Course Objectives:

- Students are expected to understand the strength and elastic properties of masonry and its constituent materials.
- Make students learn the behaviour and performance of masonry structures.
- To evaluate the strength and stability of masonry structures.
- Students shall be introduced to design of load bearing masonry buildings.
- To design the masonry structures for earthquake resistance.
- Students shall be introduced to masonry arches, domes and vaults.

Syllabus

Module – I

Introduction: Masonry Units, Materials and Types: History of masonry Characteristics of Brick, stone, clay block, concrete block, stabilized mud block masonry units – strength, modulus of elasticity and water absorption. Masonry materials – Classification and properties of mortars, selection of mortars. 10hrs

Module – II

Strength of Masonry in Compression: Behaviour of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength. Effects of slenderness and eccentricity-design of wall under eccentric load, effect of rate of absorption, effect of curing, effect of ageing. Problems on compression members loaded axially. 10 hrs

Module – III

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

10hrs

Module – IV

Design of load bearing masonry buildings: Permissible stresses, stress reduction and shape reduction factors, increase in permissible stresses for eccentric vertical and lateral loads, permissible tensile and shear stresses, Effective height of walls and columns, opening in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action, lintels. Wall carrying axial load, eccentric load with different eccentricity ratios, wall with openings, freestanding wall. Design of load bearing masonry for buildings up to 3 to 8 storeys using BIS codal provisions. 10hrs

Module – V

Introduction to reinforced masonry: Concepts for vertical and horizontal reinforcement schemes for masonry, construction process, BIS codal provisions

Masonry arches, domes and vaults: Components and classification of masonry arches, domes and vaults. Design of walls under seismic loads.

10hrs

Course Outcomes:

Students will be able to

- Summarise the masonry materials and their characteristics.
- Understand the strength and elastic properties of masonry and its constituent materials.
- Understand behaviour of bond between the constituent masonry materials and its influence on strength.
- Design masonry structures for gravity, wind and seismic loads.
- Understand the components, classification and the construction procedure of masonry arches, domes and vaults.

Text Books:

- Structural masonry: Hendry A.W. -Macmillan Education Ltd.,
- Design of Masonry structures - Sinha B.P & Davis -S.R. E & FN Spon.

Reference Books:

- Brick and Reinforced Brick Structures, Dayaratnam P., Oxford & IBH, 1987
- Design of Reinforced and Prestressed Masonry- Curtin- Thomas Telford
- Structural Masonry- Sven Sahlin- Prentice Hall
- Alternative Building Materials & Technologies- Jagadish.K.S, Venkatarama Reddy B V &Nanjunda Rao K S- New Age International, New Delhi & Bangalore
- IS 1905 (1993 and revised ed.) BIS, New Delhi. SP 20 (S & T) - BIS, New Delhi

E-Resource:

- accessengineeringlibrary.com/browse/**masonry**-**structural**-design
- https://law.resource.org/pub/eu/eurocode/en.1996.1.1.2005.pdf
- https://law.resource.org/pub/eu/eurocode/en.1996.2.2006.pdf
- www.**masonry**society.org/.../2013MSJC_Working_Draft_through_2013-...

FORMWORK DESIGN OF STRUCTURES					
Course Code	**L:T:P:S**	**Credits**	**Exam marks**	**Exam Duration**	**Course Type**
19CSE333	**4:2:0:0**	**4**	**CIE:50 SEE:50**	**3 hours**	**FC**

Course Objectives:

- To study and understand the overall and detailed planning of formwork, plant and site equipment.
- To understand the Design for various elements such as slabs, beams, columns, walls, shells and tunnels.
- To attain the knowledge of design of Decks and False works
- To know different forms of and Erecting the Formwork Building
- To know 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. 10hrs

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. 10hrs

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. 10hrs

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. 10hrs

Module – V

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

Course Outcomes:

Students will be 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.

Text 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

Reference Books:

1. Robert L. Peurifoy and Garold D. Oberiender, Formwork for Concrete Structures, McGraw-Hill, 1996.

2. 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