VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination – 2018-19
M.Tech (Computer Aided Design of Structures)
Choice Based Credit System (CBCS)

I SEMESTER

Sl. No	Course	Course Code	CourseTitle	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18CCS11	Finite Element Analysis of Structural Systems - Concepts and Procedures	04	--	03	40	60	100	4
2	PCC	18CCS12	Computational Structural mechanics - Classical and FE approach	04	--	03	40	60	100	4
3	PCC	18CCS13	Continuum mechanics – Classical and FE approach	04	--	03	40	60	100	4
4	PCC	18CCS14	Advanced Design of RC Structural Elements	04	--	03	40	60	100	4
5	PEC	18CCS15	Structural Dynamics- Theory and Computations	04	--	03	40	60	100	4
6	PCC	18CCSL16	Cad Lab – Structural Analysis	-	04	03	40	60	100	2
7	PCC	18RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Internship: 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. A University examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. 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 failed and have to complete during the subsequent University examination after satisfying the internship requirements.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18CCS21	Analysis of Plates – Classical and FE Approach	04	--	03	40	60	100	4
2	PCC	18 CCS 22	Advanced Design of Steel Structures	04	--	03	40	60	100	4
3	PCC	18 CCS 23	Structural stability analysis - Classical and FE approach	04	--	03	40	60	100	4
3	PEC	18 CCS 24X	Professional elective 1	04	--	03	40	60	100	4
4	PEC	18 CCS 25X	Professional elective 2	04	--	03	40	60	100	4
6	PCC	18 CCS L26	Cad Lab – FE Analysis Of 2Dand 3D Continuum	--	04	03	40	60	100	2
7	PCC	18 CCS 27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective

Professional Elective 1

Course Code under 18 CCS 24X	Course title
18 CCS 241	Geotechnical aspects of Foundations and Earth Retaining Structures
18 CCS 242	Action and Response of Structural Systems
18 CCS 243	Reliability analysis and design of structural elements

Professional Elective 2

Course Code under 18 CCS 25X	Course title
18 CCS 251	Design of Precast concrete and composite Structures.
18 CCS 252	Design of structural systems for bridges
18 CCS 253	Composite and smart materials

Note:

1.Technical Seminar:CIE marks shall be awarded by a committee comprising of HOD as Chairman, Guide/co-guide in any and a senior faculty of the department. Participation in seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination will be conducted during III semester and prescribed credit shall be included in the III semester. 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 failed and have to complete during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	18CCS31	Analysis and Design of Shell Roof Structures – Classical And FE Approach	04	--	03	40	60	100	4
2	PEC	18CCS32X	Professional elective 3	04	--	03	40	60	100	4
3	PEC	18CCS33X	Professional elective 4	04	--	03	40	60	100	4
4	Project	18CCS34	Evaluation of Project phase -1	--	02	--	100	--	100	2
5	Internship	18CCSI35	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				**12**	**02**	**12**	**260**	**240**	**500**	**20**

Note: PCC: Professional core, PEC: Professional Elective

Professional Elective 3

Course Code under 18 CCS 32X	Course title
18 CCS 321	Structural Optimization - Theory & Computations.
18 CCS 322	Design of Masonry Structures
18 CCS 323	Advanced Mechanics of Materials

Professional Elective 4

Course Code under 18 CCS 33X	Course title
18 CCS 331	Design of Stack , Tower And Water Storage Structural Systems
18 CCS 332	Seismic Resistant Design of Structural Systems for buildings.
18 CCS 333	AI and Expert Systems in Structural engineering

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

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 project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as failed and have to complete during subsequent University examinations after satisfying the internship requirements.

Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Proj	**18CCS41**	**Project work phase -2**	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-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 project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject:	**FINITE ELEMENT ANALYSIS OF STRUCTURAL SYSTEMS - CONCEPTS AND PROCEDURES**		
Subject Code	**18CCS11**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the mathematical concepts of numerical procedures used in structural engineering.
2. Achieve Knowledge of big picture of computer aided methods.
3. Understand the implementation procedures of such methods in computer programs.

Modules	**Teaching Hours**
Module -1	
Approximate Solutions of differential equations Mathematical back ground, Need and importance of differential equations, Initial and boundary value problems, Differential equation for axial deformation of bars, exact solution for axial deformation of a uniform bar, tapered bar with linearly varying cross section (illustration about the difficulty). Axial Deformation Of Bars with uniform cross section using Galerkin and Raleigh-Ritz Method. Finite element method: Concept and basic procedure, Idealization of continuum using different types of elements (Bar, Beam, Membrane, Plate and Shell), Choice of displacement function, Generalized and Natural coordinates. Interpolation (shape) functions. Formulation using principle of virtual work.	**10 Hours (L1,L2)**
Module -2	
Interpolation (shape) functions of Bar, Beam and Triangular elements Bar elements: Generalized coordinate approach, Lagrange interpolation for Linear, quadratic and cubic variation in Generalized and natural coordinates. Beam elements : Two noded (Hermitian interpolation in generalized and natural coordinates) Triangular elements: Three nodes (Generalized and area coordinates), six nodes and transition elements with four and five nodes in area coordinates.	**10 Hours (L1,L2,L3)**
Module -3	

Interpolation (shape) functions of Rectangular and Solid elements Rectangular elements: Four nodes (Cartesian, natural coordinates and Lagrange formula), eight nodes (serendipity element) in natural coordinates, Nine nodes (Lagrange element) using Lagrange formula and transition elements with seven nodes in natural coordinates. Tetrahedral element: Four nodes, ten nodes (volume coordinates), Hexahedron (Brick element): Lagrange formula in natural coordinates.	**10 Hours (L1,L2,L3)**
Module -4	
Mapping techniques using interpolation functions Mapping a Straight Line, Curve, and quadrilateral areas with straight and curved edges, Requirement for valid mapping Guidelines for Mapped Element Shapes. Numerical examples	**10 Hours (L1,L2,L3)**
Module -5	
Numerical integration- Gauss quadrature Line or one-Dimensional Integrals: One point, Two point and Three point formula. Procedure and Numerical examples. Area or two-dimensional Integrals: procedure and Numerical examples. Volume or three-dimensional Integrals: procedure and Numerical examples.	**10 Hours (L1,L2,L3)**

Course outcomes:

After studying this course, students will be able to understand the concept and implementation of computer oriented procedures for structural analysis.

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons.
2. Robert D Cook et al, “Concepts and Applications of Finite Element Analysis”, 3 rd Edition, John Wiley and Sons, New York.

Reference Books:

1. Bathe.K.J, Finite element procedures in Engineering Analysis. PHI. New Delhi
2. David.V.Hutton, Fundamentals of finite element analysis,McGrawhill
3. O.C. Zeinkiewicz and R.L. Taylor, The finite element method,Fifth edition, Volume 1: The basis, Butterworh –Heinemann.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject:	**COMPUTATIONAL STRUCTURAL MECHANICS - CLASSICAL AND FE APPROACH**		
Subject Code	**18CCS12**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Idealize the actual structural systems, for the purpose of analysis, in the form of an acceptable simple frame work consisting of one dimensional elements being connected at joint locations.
2. Achieve Knowledge of problem solving skills using computer aided methods.
3. Understand implementation procedures of such methods in computer programs.

Modules	Teaching Hours
Module -1	
Direct Stiffness Method – Trusses Degrees of Static and Kinematic indeterminacies, Concepts ofStiffness and Flexibility, Local and Global Coordinate System, Analysis of indeterminate Trusses, with and without initial strains for different types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports, support settlement. Numerical examples.	**10 Hours (L1-L5)**
Module -2	
Direct Stiffness Method - Continuous Beam, and Frames Analysis of Continuous beams, fordifferent types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports, support settlement. Numerical examples Element stiffness matrix formulation for 2D, Grids and 3D frames (Local and Global).	**10 Hours (L1-L5)**
Module -3	
FE Analysis using Bar Elements: Element Stiffness matrix of two and three noded elements. Examples with constant and varying cross sectional area subjected to concentrated loads, distributed body force and surface traction and Initial strains due to temperature.	**10 Hours (L1-L3)**

Module -4	
Isoparametric formulation of Bar Elements Element stiffness matrix of two noded element with constant area, linear variation in area, Consistent Load due to body force, Surface traction Element stiffness matrix of three noded bar Element, Consistent load due to UDL, Linearly Varying Load, Quadratic Varying Load.	**10 Hours (L1-L3)**
Module -5	
FE Analysis using Beam Element Element Stiffness matrix, Consistent Nodal loads,, Concept of Reduced or Lumped Loads, Examples : Cantilever and Simply Supported beams.	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to understand the concept and implementation of computer oriented procedures for structural analysis.

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Rajasekaran.S, "Computational Structural Mechanics" , PHI, New Delhi 2001.
2. Reddy.C.S, "Basic Structural Analysis," TMH, New De lhi 2001.
3. Robert D Cook et al, "Concepts and Applications of Finite Element Analysis", 3 rd Edition, John Wiley and Sons, New York.

Reference Books:

1. Beaufait.F.W. et al., Computer Methods of Structural Analysis, Prentice Hall, 1970.
2. Weaver.W and Gere.J.H., Matrix Analysis of Framed Structures, Van Nastran, 1980.
3. Rubinstein M.F, Matrix Computer Methods of Structural Analysis Prentice-Hall.
4. Bathe.K.J, Finite element procedures in Engineering Analysis. PHI. New Delhi
5. M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject:	**CONTINUUM MECHANICS - CLASSICAL AND FE APPROACH**		
Subject Code	**18CCS13**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Ability to apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
2. Formulate, analyze and solve problems in elasticity using classical approach.
3. Understand the formulation of and implementation of Isoparametric finite element models for two and three-dimensional deforming bodies
4. Use finite element methods for solving continuum mechanics problems.
5. Read and Comprehend scientific articles in the field of Computational Mechanics of deformable bodies.

Modules	**Teaching Hours**
Module -1	
Basic Concepts Definition of stress and strain at a point, components of stress and strain at apoint, strain displacement relations in Cartesian co-ordinates, constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases, plane stress, plane strain – Definition.	**10 Hours (L1-L3)**
Module -2	
Two-dimensional problems in Rectangular Coordinates Airy's stress function approach to2-D problems of elasticity. Solution by Polynomials – End Effects, Saint – Venant's Principle – solution of some simple beam problems, including working out of displacement components.	**10 Hours (L1-L5)**
Module -3	
Two - dimensional problems in Polar coordinates General equation in Polar coordinates –Strain and displacement relations, equilibrium equations - Stress distribution symmetrical about an axis – Pure bending of curved bars – Displacements for sym metrical stress distributions –Bending of a curved bar by a force at the end – The effect of a small circular hole on stress distribution in a large plate subjected to uni-axial tension and pure shear.	**10 Hours (L1-L5)**
Module -4	

Analysis of Stress and Strain in Three Dimensions: Introduction – Principal stresses –Determination of the principal stresses and principal planes.– Stress invariants – Determination of the maximum shearing stress- Octahedral stress components, Principal strains – strain invariants.	**10 Hours (L1-L3)**
Module -5	
FE approach FE formulation using CST Elements, Element Nodal load vector- Body force, surface traction, Numerical examples. Isoparametric formulation of General Quadrilateral Elements in Two Dimensions: Strain-displacement matrix, Element stiffness matrix, Numerical examples. Computation of Nodal Loads in rectangular element: Linear and quadratic variation in displacement and load. Finite Element Formulation of Axisymmetric triangular Element.	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to:

- Incorporate the design based two dimensional and three dimensional and applied in the field with their suitability

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Timoshenko and Goodier, Theory of elasticity, McGraw Hill Book Company, III Edition, 1983.
2. Valliappan. S, Continuum Mechanics fundamentals, Oxford and IBH.
3. Robert D Cook et al, “Concepts and Applications of Finite Element Analysis”, 3 rd Edition, John Wiley and Sons, New York.

Reference Books:

1. Bathe. K.J, Finite element procedures in Engineering Analysis. PHI. New Delhi.
2. Zienkiewicz. O.C, “The Finite Element Method”, Tata -McGraw-Hill PublishingCompany
3. M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject:	**ADVANCED DESIGN OF RC STRUCTURAL ELEMENTS**		
Subject Code	**18CCS14**	IA Marks	40
Number of Lecture Hours/Week	04	Exam Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the underlying concepts for the design of elements subjected to shear and Torsion
2. Use the concept of redistribution of moments in design
3. Develop equations for the design of compression members of arbitrary sections subjected to general loading
4. Compute effective length of columns based on structural framing, instead of simplified values. Select proper method for Design of Flat slab systems

Modules	**Teaching Hours**
Module -1	
Behaviour of RC Beams in Shear and Torsion: Modes of Cracking , Shear Transfer Mechanisms , Shear Failure Modes, Critical Sections for Shear Design , Influence of Axial Force on Design Shear Strength, Shear Resistance of Web Reinforcement, Compression Field Theory, Strut-and-Tie Model. Equilibrium Torsion and Compatibility Torsion, Design Strength in Torsion, Design Torsional Strength with Torsional Reinforcement- Space Truss Analogy and Skew Bending Theory- Numerical examples.	**10 Hours (L1-L5)**
Module -2	
Redistribution of Moments in RC Beams: Conditions for Moment Redistribution – Final shape of redistributed bending moment diagram. Advantages and disadvantages of Moment redistribution – Modification of clear distance between bars in beams (for limiting crack width) with redistribution, Moment – curvature Relations of Reinforced Concrete sections. Moment redistribution for a two-span continuous beam. Curtailment of tension Reinforcement - code procedure – Numerical Examples.	**10 Hours (L1-L5)**
Module -3	
Design of Reinforced Concrete Deep Beams: Introduction, definition, Types of deep beams, Minimum thickness - Steps for designing Deep beams as per IS 456 - Detailing of Deep beams. Design examples.	**10 Hours (L1-L5)**

Module -4	
Behaviour and Analysis of Compression Members: Effective Length Ratios of Columns in Frames, Code Charts – Numerical Examples, Short Columns - Modes of Failure in Eccentric Compression, Axial Load to Moment Interaction equation**,** Slender Column: Braced and Unbraced, Design Methods as per IS 456. Design examples	**10 Hours (L1-L3)**
Module -5	
Flat Slab Design: Behaviour of Slab supported on Stiff , Flexible and no beams ,Equivalent Frame Concept, ,Proportioning of Slab Thickness, Drop Panel and Column Head, Transfer of Shear from Slab to column, Direct Design Method, Equivalent Frame Method – Design Examples. FE analysis and design of Slab Panels based on Wood-Armer equations.	**10 Hours (L1-L5)**
Course outcomes: After studying this course, students will be able to: • Design and execute the structural elements in different aspects	
Question paper pattern: • The question paper will have Ten questions, each full question carrying 16 marks. • There will be two full questions (with a maximum Three sub divisions, if necessary) from each module. • Each full question shall cover the topics under a module. • The students shall answer Five full questions selecting one full question from each module. • If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.	
Text Books: 1. S. Pillai, Devdas Menon- Reinforced Concrete Design 3/ED 3rd Edition 2. Varghese. P.C., Advanced Reinforced Concrete design, prentice, Hall of India, Neevpeth.	
Reference Books: 1. Krishna Raju – "Advanced R.C. Design", CBSRD,1986, 2. Park R. and Paulay, T., Reinforced Concrete Structures, John Wiley and Sons. 3. N. Subramanian , Design of Reinforced Concrete Structures, Oxford IBH	

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

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SEMESTER – I

Subject:	**STRUCTURAL DYNAMICS –THEORY AND COMPUTATIONS**		
Subject Code	**18CCS15**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Understand effect of structural vibrations on safety and reliability of structural systems.
2. Apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
3. Apply modal methods to calculate the forced response of these systems. Use finite element methods for the analysis of the vibrations of structures.

Modules	**Teaching Hours**
Module -1	
Single Degree of Freedom System: Degrees of freedom, undamped system, springs in parallel, in series. Newton's laws of motion, free body diagrams. D'Alembert's principle, solution of the differential equation of motion, frequency and period, amplitude of motion. Damped Single degree of freedom system – viscous damping, equation of motion, critically damped system, over damped system, under damped system, and logarithmic decrement. Response of single degree of freedom system to harmonic loading – undamped harmonic excitation, damped harmonic excitation, evaluation of damping at resonance, bandwidth method (Half power) to evaluate damping, response to support motion, force transmitted to the foundation, seismic instruments.	**10 Hours (L1-L3)**
Module -2	
Response to General Dynamic Loading Impulsive loading and Duhamel's integral,numerical evaluation of Duhamel's integral, un-damped system, numerical evaluation of Duhamel's integral, damped system. Fourier analysis and response in frequency domain – Fourier analysis, Fourier co-efficient for piece-wise liner functions, exponential form of Fourier series, discrete Fourier analysis, fast Fourier transform.	**10 Hours (L1-L3)**
Module -3	
Generalised Co-ordinates and Rayleigh's method Principle of virtual work, generalized single degree of freedom system (rigid body and distributed elasticity), Raylegh's method. Multistory Shear Building. *Free vibration* – natural frequencies	**10 Hours (L1-L3)**

and normal modes, Zero modes of vibration. *Forced motion* – modal superposition method – response of a shear building to base motion. Damped motion of shear building – equations of motions – uncoupled damped equation – conditions for uncoupling. Damping.	
Module -4	
Discretization of Continuous Systems Longitudinal Vibration of a uniform rod. Transverse vibration of a pre-tensioned cable. Free transverse vibration of uniform beams – Rotary inertia and shear effects – The effect of axial loading. Orthogonality of normal modes. Undamped forced vibration of beams by mode superposition.	**10 Hours (L1-L3)**
Module -5	
Dynamic Analysis of Beams Stiffness matrix, mass matrix (lumped and consistent); equations of motion for the discretiesed beam in matrix form and its solutions.	**10 Hours (L1-L3)**
Course outcomes: After studying this course, students will be able to: • Learn the effect of damping in the structures • Analyse the systems using FE	
Question paper pattern: • The question paper will have Ten questions, each full question carrying 12 marks. • There will be two full questions (with a maximum Three sub divisions, if necessary) from each module. • Each full question shall cover the topics under a module. • The students shall answer Five full questions selecting one full question from each module. • If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.	
Text Books: 1. Mario Paz, "Structural dynamics, Theory and computation", 2 nd Edition, CBS Publisher and Distributors, New Delhi. 2. Mukhopadyaya, "Vibration, Dynamics and structural p roblems," Oxford IBH Publishers.	
Reference Books: 1. Clough, Ray W and Penzien J, "Dynamics of Structure s", 2nd Edition, McGraw-Hill, New Delhi. 2. Roy R. Craig, Andrew J. Kurdila, "Fundamentals of S tructural Dynamics", John Wiley & Sons	

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

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SEMESTER – I

Subject	**CAD LAB – STRUCTURAL ANALYSIS**		
Subject Code	**18CCSL16**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**42**	Exam Hours	**03**

CREDITS – 02

Course objectives: This course will enable students to

1. Use industry standard software in a professional set up.
2. understand the elements of finite element modeling, specification of loads and boundary condition, performing analysis and interpretation of results for final design
3. Develop customized design automation tools.

Experiments

1. Structural Analysis of 2D and 3D Trusses	**3 hours (L1-L5)**
2. Structural Analysis of Continuous Beams using for different types of loadings and support conditions.	**6 hours (L1-L5)**
3. Structural Analysis of 2D and 3D Rigid and Braced Frames for different types of loadings , support conditions, section orientations and stiffness variation between columns and beams, Member offsets, End release, Tension only members, Active and Inactive member specifications, Soil - Structure Interaction Problems using Winkler Springs.	**12 hours (L1-L5)**
4. Excel Spread Sheet for analysis of truss, beams and frames, using Direct Stiffness Method.	**12 hours (L1-L5)**
5. Program Development for Design of RC Structural Elements	**6 hours (L1-L5)**

Exercises 1 to 3 on Structural Analysis are aimed at using Excel or MATLAB and Industry Standard Softwares.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

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SEMESTER – I

Subject	**RESEARCH METHODOLOGY AND IPR**		
Subject Code	**18RMI17**	IA Marks	**40**
Number of Lecture Hours/Week	**02**	Exam Marks	**60**
Total Number of Lecture Hours	**25**	Exam Hours	**03**

CREDITS – 02

Modules	**Teaching Hours**
Module -1	
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.	**5 Hours (L1-L2)**
Module -2	
Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.	**5 Hours (L1-L2)**
Module -3	
Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. Design of Sample Surveys: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.	**5 Hours (L1-L2)**
Module -4	

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Interpretation and Report Writing (continued): of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.	**5 Hours (L1-L4)**
Module -5	
Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property	**5 Hours (L1-L4)**
Course outcomes: At the end of the course the student will be 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 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

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Research Methodology: Methods and Techniques C.R. Kothari, Gaurav Garg New Age International 4th Edition, 2018
2. ResearchMethodology a step-by-step guide for beginners. (For the topic Reviewing the literature Ranjit Kumar SAGE Publications Ltd 3rd Edition, 2011 .
3. Study Material (For the topic Intellectual Property under module 5) Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body

Reference Books:

1. Research Methods: the concise knowledge base Trochim Atomic Dog Publishing 2005.
2. Conducting Research Literature Reviews: From the Internet to Paper Fink A Sage Publications 2009.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject:	**ANALYSIS OF PLATES – CLASSICAL AND FE APPROACH**		
Subject Code	**18CCS21**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. apply knowledge of mathematics, science, and engineering related to plate theory
2. use finite element methods in plate analysis.

Modules	**Teaching Hours**
Module -1	
Bending of plates: Introduction - Slope and curvature of slightly bent plates – relations between bending moments and curvature in pure bending of plates – strain energy in pure bending – Differential equation for cylindrical bending of plates–Differential equation for symmetrical bending of laterally loaded circular plates – uniformly loaded circular plates with and without central cut outs, with two different boundary conditions (simply supported and clamped). Centrally loaded clamped circular plate - Circular plate on elastic foundation.	**10 Hours (L1-L5)**
Module -2	
Simply supported rectangular plates: Differential equation of the deflection surface –boundary conditions. Simply supported rectangular plates subjected to harmonic loading. Navier's solution for simply supported plate subjected to udl, patch udl, point load and hydrostatic pressure – Bending of rectangular simply supported plate subjected to a distributed moments at a pair of opposite edges.	**10 Hours (L1-L5)**
Module -3	
Rectangular plates with different Edge conditions(By Levy's Method): Bending of rectangular plates subjected to udl (i) two opposite edges simply supported and the other two edges clamped, (ii) three edges simply supported and one edge built-in and (iii) all edges built-in. Bending of rectangular plates subjected to uniformly varying lateral load (i) all edges built-in and (ii) three edges simply supported and one edge built-in.	**10 Hours (L1-L5)**
Module -4	

Buckling of plates: General, plate buckling equation, critical load for rectangular plates- Isotropic plates-plate with all edges simply supported under uniaxial and biaxial compression, **Large Deflections of Plates:** Approximate formulae for uniformly loaded circular plate, exact solution for circular plate with clamped edge, rectangular plates with simply supported edges,	**10 Hours (L1-L3)**
Module -5	
FE approach: Finite Element Analysis of Thin Plate: Triangular Plate Bending Element, Rectangular Plate Bending Element, Finite Element Analysis of Thick Plate.	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to:

- Perform cylindrical bending of long rectangular plates, pure bending of rectangular and circular plates, and small deflection theories for various boundary conditions.
- Understand finite element application on bending ofplates

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Timoshenko and Krieger, “Theory of Plates and Shell s”, McGraw-Hill International Book Company.
2. Chandrashekara K, “Theory of Plates”, University Press
3. Robert D Cook et al, “Concepts and Applications of Finite Element Analysis”, 3rd Edition, John Wiley and Sons, New York.

Reference Books:

1. Szilard. R, “Theory and analysis of plates - Classical and numerical methods”
2. Ugural A C, “Stress in Plates and shells”, McGraw-H ill International Book Company.

3. Bathe.K.J, Finite element procedures in Engineering Analysis. PHI. New Delhi

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject	**ADVANCED DESIGN OF STEEL STRUCTURES**		
Subject Code	**18CCS22**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

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

Modules	**Teaching Hours**
Module -1	
Laterally Unrestrained Beams: Lateral Buckling of Beams, Factors affecting lateral stability, IS 800 code provisions, Design Approach. Lateral buckling strength of Cantilever beams, continuous beams, beams with continuous and discrete lateral restraints, Mono- symmetric and non-uniform beams – Design Examples. Concepts of -Shear Center, Warping, Uniform and Non-Uniform torsion.	**10 Hours (L1-L5)**
Module -2	
Beam- Columns in Frames: Behaviour of Short and Long Beam - Columns, Effects of Slenderness Ratio and Axial Force on Modes of Failure, Biaxial bending, Strength of Beam Columns, Sway and Non-Sway Frames, Strength and Stability of rigid jointed frames, Effective Length of Columns-, Methods in IS 800 - Examples	**10 Hours (L1-L5)**
Module -3	
Steel Beams with Web Openings: Shape of the web openings, practical guide lines, and Force distribution and failure patterns, Analysis of beams with perforated thin and thick webs, Design of laterally restrained castellated beams for given sectional properties, Vierendeel girders (design for given analysis results)	**10 Hours (L1-L5)**
Module -4	
Cold formed steel sections: Techniques and properties, Advantages, Typical profiles, Stiffened and unstiffened elements, Local buckling effects, effective section properties, IS 801& 811 code provisions, numerical examples-beam design, column design.	**10 Hours (L1-L3)**

Module -5

Fire resistance: Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members, Methods of fire protection, Fire resistance ratings- Numerical Examples.	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to:

- To learn the different methods of approach of the steel structures
- Implement the better technology.

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. N. Subramanian, “Design of Steel Structures”, Oxford,IBH
2. Duggal.S.K., Design of Steel structures.

Reference Books:

Edition, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co
1. IS 1641, 1642,1643
2. IS 800: 2007, IS 811, IS 801
3. INSDAG Teaching Resource Chapter 11 to 20: www.steel-insdag.org

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject	**STRUCTURAL STABILITY ANALYSIS – CLASSICAL AND FE APPROACH**		
Subject Code	**18 CCS 23**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

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

Modules	**Teaching Hours**
Module -1	
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 Hours (L1-L4)**
Module -2	
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 Hours (L1-L4)**
Module -3	
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 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.	**10 Hours (L1-L3)**

Module -4	
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 Hours (L1-L3)**
Module -5	
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 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to:

- Determine the critical loads for discrete and continuous systems
- Application of the shape functions in the structures
- Determine the critical load of the plates

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Stephen P. Timoshenko, James M. Gere, “Theory of Elastic Stability”, 2 nd Edition, McGraw-Hill, New Delhi.
2. Zeiglar.H,” Principles of Structural Stability”, Blaisdall Publication
3. Robert D Cook et al, “Concepts and Applications of Finite Element Analysis”, 3 rd Edition, John Wiley and Sons, New York.

Reference Books:

1. Rajashekaran. S, “Computational Structural Mechanic s”, Prentice-Hall, India.
2. Ray W Clough and J Penzien, “Dynamics of Structures ”, 2 nd Edition, McGraw-Hill, New Delhi.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject:	**GEOTECHNICAL ASPECTS OF FOUNDATIONS AND EARTH RETAINING STRUCTURES**		
Subject Code	**18CCS241**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Plan a subsurface exploration
2. Evaluate appropriate bearing capacity correction factors to use in design
3. Identify strategies to mitigate the effects of expansive soils on foundations
4. Select the appropriate deep foundation type for different soil profiles
5. Compute earth pressure and implement the design procedure for block foundation

Modules	**Teaching Hours**
Module -1	
Bearing Capacity of Soils: Generalized Bearing Capacity Equation; Field tests for BearingCapacity and settlement estimation; Settlement of shallow foundations - Elastic and consolidation settlements; Settlement estimates from penetration tests; Settlement tolerance; Allowable bearing pressure.	**10 Hours (L1-L3)**
Module -2	
Design Parameters for Substructures: Factors influencing selection of depth of Foundation,Subgrade Reaction, Winkler hypothesis and Beams on Elastic Foundation Approach; Soil Line Method;. Foundations on expansive soils. Geotechnical failure of foundations during earthquake – Earthquake Resistant design of Shallow foundation –Liquefaction and Remedial measures.	**10 Hours (L1-L3)**
Module -3	
Pile Foundations; Classification of pile foundations and general considerations of design;Ultimate load capacity of piles; Pile settlement; Analysis of single pile and pile group; laterally loaded piles and ultimate lateral resistance. Uplift resistance of piles and anchored foundations; under reamed Pile; Pile load tests; Design examples.	**10 Hours (L1-L3)**

Module -4	
Retaining structures: Earth pressure theories, Fill Walls, Concrete/Gravity walls, Mechanically Stabilized Earth (MSE) walls- Analysis and Design,; Sheet pile walls, internally braced excavations (struts), externally braced excavations (tieback excavations), Soil Nailing.	**10 Hours (L1-L3)**
Module -5	
Elements of Soil Dynamics and Design of Machine Foundations: IS 2974 Parts I to IV Machine- Foundation System , Block Foundations, Frame Foundations, Design Criteria, Tuning of Foundation, DOF of a Rigid Block Foundation, Linear Elastic Spring, Elastic Half Space Analog, Parameters influencing Dynamic Soil Parameters, Soil Mass Participation, Effect of Embedment, Soil Damping, Machine Parameters, Vibration Isolation System.	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to:

- Analyze the type of footing to be placed on the various soil
- Design the machine foundation
- Design the retaining walls

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Bowles J.E "Foundation Analysis and Design", McGraw Hill.
2. Swami, S. (1999). "Soil Dynamics and Machine Foundation", Galgotia Publications Pvt Ltd, New Delhi
3. Dr. B C Punmia, Soil Mechanics and Foundation Engineering

Reference Books:

1. Leonards. G.A, "Foundation Engineering", McGraw Hil l.
2. Tschebotoriff. G.P "Foundations, Retaining and Eart h Structures, McGraw Hill.
3. Srinivasulu. P. and Vaidyanathan, V. (1980). "Handbook of Machine Foundations", Tata McGraw-Hill Publishing Company, New Delhi

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject:	**ACTION AND RESPONSE OF STRUCTURAL SYSTEMS**		
Subject Code	**18CCS 242**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the importance of appropriate code provisions.
2. Familiarize with procedures for calculating action effects for different types of structures frequently encountered in practice
3. Assess the basic need, concepts and procedures of different types of analysis
4. Characterize the response of different types of structural systems for Tall buildings .

Modules	**Teaching Hours**
Module -1	
IS 875 PART 1, 2, 4, 5 Sources, Nature and Magnitude, Probabilistic assessment, Characteristic and Design values. IS 875 PART 1 and 2 code provisions. Load combination rules for design. Load path for gravity loads- Tributary Area and Stiffness based approaches. Estimation of DL and LL on structural elements such as Slab, Beams, Columns, in different types of structural systems, Joint Loads on Trusses, Distributed load on Purlins- Numerical examples.	**10 Hours (L1-L3)**
Module -2	
Wind Load - IS 875 PART 3: Buildings Nature and Magnitude, Factors influencing wind loads, Internal and External pressure distribution, Design Wind Speeds and Pressure, Numerical Examples to calculate external and internal pressure for different types of buildings and regions – Flat roof, Pitched Roof, Sign board, Structural glazing, Water tank on shaft staging, Multi storey Frames - Load path for Lateral loads.	**10 Hours (L1-L3)**
Module -3	
Seismic Loads: IS 1893: Buildings Nature and Magnitude, Centre of mass and rigidity, Calculation of Design Seismic Force by Static Analysis Method, Dynamic Analysis Method, Location of Centre of Mass, Location of Centre of Stiffness, and Lateral Force Distribution as per code provisions. - Load path for Lateral loads – Floor diaphragm action.	**10 Hours (L1-L3)**
Module -4	

Vehicles Loads as per IRC 6 - 2010 on Road Bridges – Class 70 R, Class AA, Class A ,Class B , Tracked Vehicle, Wheeled Vehicle, Load Combinations, Impact, Wind, Water Currents, Longitudinal Forces: acceleration, breaking and frictional resistance, Centrifugal forces, temperature, Seismic forces, Snow Load, Collision Loads. Load Combinations – Simple Numerical examples.	**10 Hours (L1-L2)**
Module -5	
Types of Analysis and Structural forms of Tall Buildings: Linear, Nonlinear behavior, Material nonlinearity, Geometric nonlinearity, Rigid and Elastic Supports, First Order Elastic Analysis, Second Order Elastic Analysis, First order Inelastic Analysis, Second order Inelastic Analysis – Concepts and Brief descriptions. Structural forms in Tall buildings – Rigid frame, Braced Frames, Shear Walls, Core walls, Tubular, Belt truss, Outrigger.	**10 Hours (L1-L2)**

Course outcomes:

After studying this course, students will be able to:

- Learn the design of structures as per IS code
- Analyze the structures for linear and non-linear behaviour of structures

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 16 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

IS Codes

1. IS 875 Parts (1 to 5), IS 1893, IRC 6,

Reference Books:

Bdn, New Delhi Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co Ltd, New Delhi

1. An explanatory Handbook on IS 875 (PART 3); Wind Load on Building and Structures, Document No: IITK-GSDMA Wind 07 V1.0 - IITK-GSDMA Project on Building Codes
2. Explanatory Examples on Indian Seismic Code IS 1893 (Part I): Document No. :: IITK-GSDMA-EQ21-V2.0 - IITK-GSDMA Project on Building Codes.
3. Matrix Analysis of Structures, Aslam Kassimali, Cengage Learning,2012.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject:	**RELIABILITY ANALYSIS AND DESIGN OF STRUCTURAL ELEMENTS**		
Subject Code	**18CCS243**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the concepts and techniques of reliability and probability distributions
2. Define safety format or failure surface for a given actions and response along with their statistics.
3. Use simulation techniques to arrive at the statistics of design variables.

Modules	**Teaching Hours**
Module -1	
Concept of variability: Applications of Statistical principles to deal with randomness in basicvariables, statistical parameters and their significance, Description of various probability distributions – Binomial, Poisson, Normal, Log-Normal, Beta, Gama, distributions. Testing of goodness– of – fit of distributions to the actual data using chi-square method and K.S Method.	**10 Hours (L1-L3)**
Module -2	
Statistical regression and correlation: Least – square and chi – square methods, Operation on one Random variable, expectation, multiple random variables, reliability distributions – basic formulation, the hazard function, Weibull distribution.	**10 Hours (L1-L3)**
Module -3	
Statistical Quality control in Civil Engineering: Characteristic strength and characteristic load, probability modeling of strength, geometrical dimensions, material properties and loading. Application problems Mean value method and its applications in structural designs, statistical inference, Comparison of various acceptance and rejection testing.	**10 Hours (L1-L3)**
Module -4	
Safety assessment of structures: Reliability analysis using mean value theorem – I, II and III order Reliability formats.	**10 Hours (L1-L3)**
Module -5	

Simulation techniques: Reliability index - reliability formulation in various limit states, reliability based design, application to design of RC, PSC and steel structural elements – LRFD Concept.	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to:

- Compute reliability index, for the given design details
- Arrive at mean value of a dominant design parameter for the target reliability index

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Ang A.H.S and W.H. Tang, Probability concepts in Engineering planning andDesign, John Wiley and sons, New York, Vol.I and II.
2. Ranganthan R, Reliability Analysis and Design of Structures, Tata McGraw Hillpublishing Co. Ltd., New Delhi.

Reference Books:

Ed, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co

1. John B. Kennedy and Adam M.Neville, Basic Statstical Methods for Engineers and Scientists,
2. Harperand Row Publishers, New York. Robert E. Melchers, Structural Reliability Analysis and Prediction, Wiley
3. Haldar, A., and Mahadevan, S. (2000). Probability, reliability and statistical methods in engineering design. John Wiley and Sons, New York.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject	**DESIGN OF PRECAST CONCRETE AND COMPOSITE STRUCTURES**		
Subject Code	**18CCS251**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

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

Modules	**Teaching Hours**
Module -1	
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 Hours (L1-L4)**
Module -2	
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 Hours (L1-L4)**
Module -3	
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.	**10 Hours (L1-L3)**
Module -4	
Design of Precast Connections and Structural Integrity Beam bearing, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties.	**10 Hours (L1-L3)**
Module -5	

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 behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams.	**10 Hours (L1-L4)**

Course outcomes:

After studying this course, students will be able to:

- To design and execute the prestressed elements
- design of prestressed concrete structures

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Design of Precast Concrete Structures, Kim S. Elliot , Butterworth Heinemann, 2002
2. Precast Concrete Structures. First Edition. Hubert Bachmann, Alfred Steinle, c 2011 Ernst &Sohn GmbH & Co. KG. Published by Ernst &Sohn GmbH & Co. KG.

Reference Books:

1. Structural Precast Concrete Handbook, CIDB, Singapore
2. INSDAG Teaching Resource Chapter 21 to 24: www.steel-insdag.org
3. IS 15916 (2011): Building Design and Erection Using Prefabricated Concrete - Code of Practice [CED 51: Planning, Housing and pre-fabricated construction]
4. IS 1343-2012, IS 456-2000, IS 800-2007
5. IS 11384 (1985):Code of Practice for Composite Construction in Structural Steel and Concrete [CED 38: Special Structures]

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject:	**DESIGN OF STRUCTURAL SYSTEMS FOR BRIDGES**		
Subject Code	**18 CCS252**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Understand and use the basic concepts in proportioning and design of bridges in terms of aesthetics, geographical location and functionality.
2. Develop an intuitive feeling about the sizing of bridge elements and the conceptual design part
3. Assess the load flow mechanism and loads on bridges.
4. Design of bridge starting from conceptual design, selecting suitable bridge, geometry to sizing of its elements.

Modules	**Teaching Hours**
Module -1	
Introduction to bridge engineering Historical background of bridges and types. Bridge aesthetics and proportioning..Bridge geometry. Conceptual design of various structural forms. Foundations with or without piles; abutments, retaining walls and wing walls; columns and cap beams; bearings.	**10 Hours (L1-L3)**
Module -2	
Loads on bridges (IRC6-2010) Class 70 R, Class AA, Class A , Class B , Tracked Vehicle, Wheeled Vehicle, Load Combinations, Impact, Wind, Water Currents, Longitudinal Forces: acceleration, breaking and frictional resistance, Centrifugal forces, temperature, Seismic forces, Snow Load, Collision Loads. Load Combinations.	**10 Hours (L1-L3)**
Module -3	
Design of Elevated Bridges: Solid slab bridges, Simple Girder bridges, PSC Girder Bridges	**10 Hours (L1-L4)**
Module -4	
Design of Underpass and Box culverts	**10 Hours (L1-L4)**
Module -5	
FE Concepts: Discrete and Continuum models of Bridge Deck – Spline, Grillage, Surface models, Bridge Piers, Support and Loading conditions, Soil-Structure Interaction.	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to:

- Design the superstructure of bridge using different methods.
- Design girder bridges and cable stayed bridges.

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Krishna Raju N " Design of Bridges," Oxford, IBH Pu blications New Delhi.
2. JohnsonVictor, " Essential of Bridge Engineering," Oxford, IBH Publications, New Delhi
3. Ponnuswamy, S., "Bridge Engineering", Tata McGraw H ill, 2008.

Reference Books:

1. IRC112 - 2011 Code of Practice for Concrete Road Bridges and Railway Board Codes
2. Jagadeesh. T.R. and Jayaram. M.A., "Design of Bridg e Structures", Prentice Hall of India ,2004.
3. Raina V.K." Concrete Bridge Practice" Tata McGraw H ill Publishing Company, New Delhi, 1991.
4. IITK-RDSO Guidelines On Seismicdesign Of Railway Bridges- Provisions with Commentary and Explanatory Examples , 2010.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject:	**COMPOSITE AND SMART MATERIALS**		
Subject Code	**18 CCS253**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives:

This course will enable students to

1. Understand the basic properties and manufacturing process along with their application in various industries for different types of composites.
2. Familiarize with different classes of ceramic and polymeric smart materials; development of actuators and sensors and their integration into a smart structure
3. Generate controllable force and response of a system.
4. Monitor the response of the system

Modules	**Teaching Hours**
Module -1	
Introduction to Composite materials Classifications and applications. of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance & stiffness matrices, coupling.	**10 Hours (L1-L3)**
Module -2	
Anisotropic elasticity Unidirectional and anisotropic lamina, thermo-mechanical properties, micro- mechanical analysis, classical composite lamination theory, Cross and angle–play laminates, symmetric, anti-symmetric and general asymmetric laminates, mechanical coupling, laminate stacking,	**10 Hours (L1-L3)**
Module -3	
Analysis of simple laminated structural elements Ply-stress and strain, lamina failure theories - first fly failure, environmental effects, manufacturing of composites.	**10 Hours (L1-L3)**
Module -4	
Smart materials Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation.	**10 Hours (L1-L3)**
Module -5	
Beam modeling with strain actuator, bending extension relation	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to indentify the type of failure in the structure and which type of new materials can be usable

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Robart M Jones, "Mechanic of Composite Materials", McGraw Hill Publishing Co.
2. Bhagwan D Agaraval, and Lawrence J Brutman, "Ana lysis and Performance ofFiber Composites", John Willy and Sons.
3. Lecture notes on "Smart Structures", by Inderjit h Chopra, Department of Aerospace Engg., University of Maryland

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject:	**CAD LAB – FE ANALYSIS OF 2D AND 3D CONTINUUM**		
Subject Code	**18 CCS L26**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**42**	Exam Hours	**03**

CREDITS – 02

Course objectives: This course will enable students to

1. Use industry standard software in a professional set up.
2. understand the elements of finite element modeling, specification of loads and boundary condition, performing analysis and interpretation of results for final design.

Practical Problems	**Hours**
1. FE Analysis of Plane Stress and Plane Strain Problems	*6 hours* **(L1-L3)**
2. Flexural Behaviour of Slab Panels with different aspect ratio and boundary conditions	*6 hours* **(L1-L3)**
3. FE Analysis of Slab panel resting on column supports- Drop Panels, Capitals	*6 hours* **(L1-L3)**
4. FE Analysis of Slab on Grade (Raft), Underpass, Bridge Structures	*6 hours* **(L1-L3)**
5. FE Analysis of Framed structures due to Seismic forces using modal superposition method	*6 hours* **(L1-L3)**
6. Program Development for design of structural steel elements, using any programming (Tension member, Compression member and Bending)	*12 hours* **(L1-L3)**

Exercises on Structural Analysis are aimed at using Finite element analysis based on Industry Standard Softwares.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject:	**ANALYSIS AND DESIGN OF SHELL ROOF STRUCTURES – CLASSICAL AND FE APPROACH**		
Subject Code	**18CCS31**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. apply knowledge of mathematics, science, and engineering related to shell theory
2. use finite element methods in shell analysis and design, ability to design special and long span roofs

Modules	**Teaching Hours**
Module -1	
Shapes and Forms: Geometry of Quadric Surfaces, Surface definitions- Line, Surface, Principal Curvature, mean and Gaussian curvature. Classification of Shell Surfaces – Geometry, Shell Curvature, Geometrical developability. Thick and Thin Shells, Historical developments of shell theory, Load carrying Mechanism, Weakness of shells.	**10 Hours (L1-L3)**
Module -2	
Membrane Theory of Cylindrical Shells and Spherical Domes: Cylindrical Shells: Elements, IS 2210 specifications, equations of equilibrium, Stresses in a Simply Supported Shell, Stress Resultants under Dead Load and Live Load for circular, cycloid, catenary, parabola and semi ellipse directrix. Spherical Domes: Notations, equations of equilibrium, expressions for stress resultants and ring tension for Dead, Live and Concentrated Load in domes with and without skylight, Proportioning and general detailing rules. Design Examples with and without skylight.	**10 Hours (L1-L4)**
Module -3	
Membrane Theory of Conical Shells, Hyperbolic Paraboloid: Conical Shells: Stress resultants for Dead, Live loads. Design Example, Hyperbolic Paraboloid: Structural Elements and behaviour in Umbrella and Inverted umbrella roof, Stress	**10 Hours (L1-L4)**

resultants, Shallow and Deep Shells, Design Examples.	
Module -4	
Bending Theory of Cylindrical Shells: Deficiency in Membrane theory, Incompatible loading, geometry and boundary conditions. General bending theory, equations of equilibrium, Stress-Strain and Moment – Curvature relations. Schorer's and Beam bending theory. Analysis and Design of Cylindrical shells as per ASCE Manual No. 31. Design of Edge beams and Traverses. Rebar Detailing.	**10 Hours (L1-L3)**
Module -5	
Folded Plates: Types, Structural behaviour- Slab and Plate Action**,** Analysis of Folded Plates: Resolution of ridge loads, Edge Shears- Theorem of Three Edge Shears, Stress distribution, Winter and Pei, Whitney and Simpsons method for analysis. Design Example: V Type and Trough Type, Detailing of Rebars. **FE approach**: Shell elements, four and eight noded shell element and finite elements formulation	**10 Hours (L1-L2)**

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. G. S. Ramaswamy, "Design and Construction of Concrete Shell Roofs", CBS.
2. P.C. Varghese, "Design of Reinforced Concrete Shells and Folded Plates, PHI.

Reference Books:

1. Timoshenko and Krieger, "Theory of Plates and Shell s", McGraw-Hill .
2. Chandrashekara K, "Theory of Plates", University Press
3. IS 2210, SP 34.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject:	**STRUCTURAL OPTIMIZATION - THEORY & COMPUTATIONS**		
Subject Code	**18CCS321**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to
1. Understand the need and concepts of design optimization
2. To use conventional and modern optimization methods in structural applications.

Modules	**Teaching Hours**
Module -1	
Classical Optimization Techniques: Engineering applications, Statement of optimization problem, Classification of optimization problems, Optimization techniques. Single variable optimization, Multivariable optimization with no constrains, with equality constraints - Lagrange multiplier - method, constrained variation method - and with inequality constraints Kuhn Tucker conditions.	**10 Hours (L1-L3)**
Module -2	
Linear Programming: Standard form of Linear programming problem, simplex method, revised simplex Method.	**10 Hours (L1-L3)**
Module -3	
Non-Linear Programming: One dimensional minimization methods, Elimination and Interpolation methods, unconstrained Optimization Techniques, Direct Search methods, Descent Methods, Constrained Optimization Techniques, Direct methods. Indirect methods.	**10 Hours**
Module -4	
Stochastic Programming: For optimization of design of structural elements with randomvariables. Application Problems: Optimum design RC, PSC, Steel structural elements. Algorithms for optimum designs.	**10 Hours (L1-L3)**
Module -5	
Genetic Algorithms: Introduction – fitness function including the effect of constraints crossover, mutation. **Ant colony optimization:** Basic concepts, Ant searching behavior, path retracing and pheromone updating, pheromone	**10 Hours (L1-L3)**

trail evaporation algorithm.	

Course outcomes:

After studying this course, students will be able to:

- Learn the design optimization of structures
- Adopt these methods in the field

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Rao.S.S - Optimization Theory and Applications, Wiley Eastern Limited,1978.
2. Fox.R.L. - Optimization Methods for Engineering Design, Addison Wesley, 1971.

Reference Books:

1. Stark. R.M. Nicholls.R.L., Mathematical Foundations for Design, McGraw Hill Book Company.
2. NarsingkDeo – System simulation with digital computer, Prentice – Hall of India Pvt, Ltd. New Delhi – 1989.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject	**DESIGN OF MASONRY STRUCTURES**		
Subject Code	**18CCS322**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course Objectives:

The objectives of this course are to make students to learn performance of masonry structures, To design the masonry structures for earthquake resistance. To evaluate the strength and stability of the masonry structures.

Modules	**Teaching Hours**
Module -1	
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.	**10 Hours (L1-L4)**
Module -2	
Strength of Masonry in Compression: Behavior of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength of masonry in Indian context, Failure theories of masonry under compression. Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength.	**10 Hours (L1-L4)**
Module -3	
Flexural and shear bond, flexural strength and shear strength: Bond between masonry unit and mortar, tests for determining flexural and shear bond strengths, factors affecting bond strength, effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shear strength.	**10 Hours (L1-L4)**
Module -4	

Design of load bearing masonry buildings: Permissible compressive stress, 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 code provisions.	**10 Hours (L1-L4)**
Module -5	
Earthquake resistant masonry buildings: Behaviour of masonry during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS code provisions. Masonry arches, domes and vaults: Components and classification of masonry arches, domes and vaults, historical buildings, construction procedure.	**10 Hours (L1-L4)**

Course outcomes:

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the principles of design and construction of masonry structures
3. Design and develop analytical skills.
4. Summarize the masonry Characteristics.
5. Evaluate the strength and stability of the masonry structures.

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books

1. Sven Sahlin, “Structural Masonry”-Prentice Hall
2. Jagadish K S, Venkatarama Reddy B V and Nanjunda Rao K S, “Alternative Building Materials and Technologies”- New Age International, New Delhi & Bangalore

Reference Books:

Ed, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co

1. Hendry A.W., “Structural masonry”- Macmillan Education Ltd., 2nd edition
2. Sinha B.P & Davis S.R., “Design of Masonry structures”- E & FN Spon
3. Dayaratnam P, “Brick and Reinforced Brick Structures”- Oxford & IBH
4. Curtin, “Design of Reinforced and Prestressed Masonry”- Thomas Telford
5. IS 1905, BIS, New Delhi and SP20(S&T),New Delhi

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject	**ADVANCED MECHANICS OF MATERIALS**		
Subject Code	**18CCS323**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. apply knowledge of mathematics, science, and engineering related to shell theory
2. use finite element methods in shell analysis and design, ability to design special and long span roofs

Modules	**Teaching Hours**
Module -1	
Torsion: Torsion of straight bars of Elliptic Cross section – St.Venants semi-inverse method and Prandtl's function Approach – Membrane analogy – Torsion of a bar of narrow rectangular cross section. Torsion of thin walled open cross sections – Torsion of thin walled tubes.	**10 Hours (L1-L3)**
Module -2	
Curved Beams: Introduction, Circumferential stress in a curved beam, Radial stresses incurved beams, Correction for circumferential stresses in curved beams having I, T, or similar cross sections, Deflections of curved beams, Statically indeterminate curved beams, Closed ring subjected to a concentrated load.	**10 Hours (L1-L3)**
Module -3	
Shear Center for Thin-Wall Beam Cross Sections: Definition of shear center in bending Approximations employed for shear in thin-wall beam cross sections, Shear flow in thin-walled beam cross sections, Shear center for singly symmetric and unsymmetrical sections. **Non-symmetrical Bending of Straight Beams:,** Symmetrical and non-symmetrical bending, Bending stresses in beams subjected to non-symmetrical bending, Deflections of straight beams subjected to non-symmetrical bending.	**10 Hours (L1-L3)**
Module -4	

Beams on Elastic Foundations: General theory, Infinite beam subjected to concentrated load, Boundary conditions, Infinite beam subjected to a distributed load segment, Semi-infinite beam with different end conditions subjected to concentrated load and moment at its end - Short beams.	**10 Hours (L1-L3)**
Module -5	
Structures subjected to out of plane loading: Analysis of simple bents, frames, grids and beams circular in plan – Cantilever beams, semicircular continuous beams with three equally spaced supports, circular beams with different number of equally spaced supports.	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to:

- know the behaviour of the structural elements using exact method
- know the effect of curved beams

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 16 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Arthur P. Boresi and Omar M. Sidebottom: "Advanced Mechanics of Materials", Fourth Edition, John Wiley & Sons, 1985
2. James M. Gere and S. P. Thimoshenko: "Advanced Mechanics of Materials", Second Edition, CBS Publishers, New Delhi, 2000.

Reference Books:

1. Ugural.A.C. andFenster.S.K "Advanced Strength of material and Applied Elasticity", Arnold Publishers, 1981.
2. Junnarkar.S.B., "Mechanics of Structures", Volume - III, Charotar Publications, Anand,

Ltd.,Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject:	**DESIGN OF STACK , TOWER AND WATER STORAGE STRUCTURAL SYSTEMS**		
Subject Code	**18CCS331**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives:

To illustrate the quintessential differences in the design of stack, tower and water storage structural systems vis-à-vis other structural systems.

Modules	**Teaching Hours**
Module -1	
Steel Chimneys Lining for chimneys – breach opening – Forces acting on steel chimneys including seismic forces. Analysis Design and Detailing of RC chimneys for different load combinations. Design of thickness of steel plate – Design of base plate – Design of anchor bolts – Design of foundation.	**10 Hours (L1-L4)**
Module -2	
Transmission line towers of various shapes and member types Loads on towers – Analysis and Design of Steel transmission line towers. Design of Foundations.	**10 Hours (L1-L3)**
Module -3	
Trestles Analysis and design of Steel Trestles for vertical and horizontal loads.	**10 Hours (L1-L3)**
Module -4	
Water Storage structures Properties of un-cracked section – Calculation of thickness and reinforcement for Liquid retaining structure, Design and Detailing of underground, Ground Level reservoirs.	**10 Hours (L1-L3)**
Module -5	
Overhead water tanks Circular, Rectangular on framed and Shaft type of Staging sytems as per IS 3370 Parts 1 to 4.	**10 Hours (L1-L3)**

Course outcomes:

On successful completion of this course, students are able to

1. Learn techniques for quantifying load induced actions on these structural systems.
2. Calculate load induced Response of these systems and proportion them for structural adequacy in
terms of strength, stiffness and functional as well as durability requirements
3. Envision the general approach for the design of structural systems intended for special purposes

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 12 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Ramachandra, Design of Steel structures Vo1 and Vo12.
2. S.K. Duggal, Design of Steel structures.
3. Vazirani & Ratwani, Steel structures, Vo1.III

Reference Books:

1. IS: 6533. Code of Practice for Design and Construction of steel chimneys.
2. IS 802: Use Of Structural Steel In Overhead Transmission Line
3. IS :4091, Code Towers
4. Code Of Practice - Part 1 Material, Loads And Permissible Stresses Of Practice For Design And Construction Of Foundations For Transmission Line Towers And Poles
5. IS 3370 Part 1 to 4

Timoshenko, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject:	**SEISMIC RESISTANT DESIGN OF STRUCTURAL SYSTEMS FOR BUILDINGS**		
Subject Code	**18CCS332**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Establish a performance-based framework to assess seismic response
2. Select appropriate structural systems, configurations and proportions,
3. Use design procedures capable of reliably achieving specified performance goals.

Modules	**Teaching Hours**
Module -1	
Seismic Hazard Assessment Engineering Seismology – Definitions, Introduction to Seismic hazard, Earthquake phenomenon – Seismotectonics and seismic zoning of India – Earth quake monitoring and seismic instrumentation – Characteristics of strong Earthquake motion - Estimation of Earthquake parameters – Microzonation	**10 Hours (L1-L3)**
Module -2	
Earthquake Effects on Structures: Response to ground acceleration – response analysis by mode superposition – torsional response of buildings -response spectrum analysis – selection o f design earthquake – earthquake response of base isolated buildings – earthquake response of inelastic structures, allowable ductility demand Response Spectra / Average response Spectra - Design Response Spectra - Evaluation of earthquake forces – (IS 1893 – 2002). – Effect of earthquake on different types of structures – Lessons learnt from past earthquakes.	**10 Hours (L1-L3)**
Module -3	
Concepts of Earthquake Resistant Design: Structural Systems / Types of buildings – Causes of damage – Planning consideration / Architectural Concept (IS 4326 – 1993) (Do's and Dont's for protection of life and property) – Philosophy and principle of earthquake resistant design – Guidelines for Earthquake Resistant Design.	**10 Hours (L1-L3)**
Module -4	

Earthquake Resistant Earthen and Masonry Buildings Earthquake Resistant low strength masonry buildings, Strength and Structural properties of masonry – Lateral load - Design considerations	**10 Hours (L1-L3)**
Module -5	
Earthquake Resistant Design of RCC Buildings – Material properties – lateral load analysis – design and detailing. Basic concepts of seismic base isolation and Seismic Isolation systems.	**10 Hours (L1-L3)**

Course outcomes:
After studying this course, students will be able to:

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 16 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Pankaj Agarwal and Manish Shrikhande, "Earthquake R esistant Design of Structures", Prentice Hall of India, 2006.
2. S K Duggal, "Earthquake Resistant Design of Structu res", Oxford University Press, 2007.

Reference Books:

1. Chopra, A.K. "Dynamics of structures", Prentice-Hal l of India Pvt. Ltd. New Delhi.
2. Ghose, S.K. "Earthquake Resistance Design of Concrete Structures", SDCPL –R&D Center – New Mumbai 73.
3. Jaikrishna et al. "Elements of Earthquake Engineeri ng", South Asia

Publishers, New Delhi

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject:	**AI AND EXPERT SYSTEMS IN STRUCTURAL ENGINEERING**		
Subject Code	**18CCS333**	IA Marks	**40**
Number of Lecture Hours/Week	**04**	Exam Marks	**60**
Total Number of Lecture Hours	**50**	Exam Hours	**03**

CREDITS – 04

Course objectives: This course will enable students to

1. Use expert systems to achieve fairly high levels of performance in task areas which require a good deal of specialized knowledge and training.
2. Develop expert systems to perform tasks which are physically difficult, tedious, or expensive to have a human perform**.**

Modules	**Teaching Hours**
Module -1	
Artificial Intelligence: Introduction: AI – Applications fields, defining the problems – state space representation – problem characteristics – production system – production system characteristics. Knowledge Representation: Formal logic – predicate logic – logic programming – forward v/s backward reasoning – matching control knowledge.	**10 Hours (L1-L3)**
Module -2	
Search and Control: Concepts – uninformed / blind search: depth first search – breadth first search - bi-directional search – informed search – heuristic graph search – generate and test - hill climbing – best–first search – AND OR graph search. Non-formal Knowledge Representation – semantic networks – frames – scripts – production systems. Programming in LISP.	**10 Hours (L1-L3)**
Module -3	
Expert Systems: Their superiority over conventional software – components of an expert system – expert system life cycle – expert system development process – nature of expert knowledge – techniques of soliciting and encoding expert knowledge. Inference: Forward chaining – backward chaining – rule value approach.	**10 Hours (L1-L3)**
Module -4	
Uncertainty Symbolic reasoning under uncertainty: logic for non-monotonic reasoning. Statistical reasoning: Probability and Bayes' theorem – certainty factor and rule based systems – Bayesian network - Dempster– Shafer theory.	**10 Hours (L1-L3)**

Module -5

Fuzzy reasoning and Neural Networks: Features of rule-based, network- based and frame -based expert systems – examples of expert systems in Construction Management and Structural engineering, Expert system shells. Neural Networks: An introduction– their possible applications in Civil Engineering.	**10 Hours (L1-L3)**

Course outcomes:

After studying this course, students will be able to:

- To identify the logical reasons in the system
- Knowledge on the entire system of neural networks and application in the structural system

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 16 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

Text Books:

1. Adeli, H., "Expert Systems in Constructions and Structural Engg", Chapman &Hall, New York
2. Patterson D W, "Artificial Intelligence and Expert Systems", Prentice-Hall, New Jersy.

Reference Books:

1. Rich, E. and Knight K. "Artificial Intelligence", T MH, New Delhi.
2. Rolston ,D.W., "Artificial Intelligence and Expert Systems" McGraw Hill, NewYork.
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