SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject: STRUCTURAL OPTIMIZATION - Concepts&Applications			
Subject Code	**16CCS11**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
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**
Module -2	
Linear Programming: Standard form of Linear programming problem, simplex method, revised simplex Method.	**10 Hours**
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 random variables. Application Problems: Optimum design RC, PSC, Steel structural elements. Algorithms for optimum designs.. .	**10 Hours**
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 trail evaporation algorithm	**10 Hours**

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 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.

Reference 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.
3. Srinath L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co. Ltd., New Delhi
3. Stark. R.M. Nicholls. R.L., Mathematical Foundations for Design, McGraw Hill Book Company.
4. Narsing k Deo – 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 – I			
Subject: Computational Structural Mechanics- Classical and FE Approach			
Subject Code	**16CCS12**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
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.	**10 Hours**
Module -2	
Direct Stiffness Method - Continuous Beam, 2D Frames Analysis of Continuous beams, fordifferent types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports, support settlement. Analysis of Simple 2D Frames with and without sway, Element stiffness matrix for 3D frames and Grids	**10 Hours**
Module -3	
Basic Concept of Finite Element Method Concept of FEM, Formulation using principle ofvirtual work, Principles minimum potential energy, Method of Weighted Residuals(Galerkin's), Choice of displacement function, Degree of continuity. Generalized and Natural coordinates.	**10 Hours**
Module -4	

FE Analysis using Bar Elements Derivation of Shape Function for Linear and Higher order elements using Inverse and Lagrange Interpolation formula, Element Stiffness matrix 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. Isoparametric formulation	**10 Hours**
Module -5	
FE Analysis using Beam Element Derivation of Shape Function for two noded beam element, Hermitian Interpolation, Element Stiffness matrix, Consistent Nodal loads,, Concept of Reduced or Lumped Loads, Examples : Cantilever and Simply Supported beams.	**10 Hours**

Course outcomes:

After studying this course, students will be able to:

Draw response of SDOF, MDOF systems and conduct modal analysis of MDOF systems.

Understand the effects of system/model parameters on dynamic response

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.

Reference 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
4. Beaufait.F.W. et al., Computer Methods of Structural Analysis, Prentice Hall, 1970.
5. Weaver.W and Gere.J.H., Matrix Analysis of Framed Structures, Van Nastran, 1980.
6. Rubinstein M.F, Matrix Computer Methods of Structural Analysis Prentice-Hall.
7. 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 – I			
Subject: Structural Dynamics –Theory and Computations			
Subject Code	**16CCS13**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
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**
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**
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.	**10 Hours**

Multistory Shear Building. *Free vibration* – natural frequencies 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	
<u>Discretization of Continuous Systems</u> 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**
Module -5	
<u>Dynamic Analysis of Beams</u> Stiffness matrix, mass matrix (lumped and consistent); equations of motion for the discretiesed beam in matrix form and its solutions.	**10 Hours**

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 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.

Reference Books:

1. Mario Paz, “Structural dynamics, Theory and computation”, 2 nd Edition, CBS Publisher and Distributors, New Delhi.
2. Mukhopadyaya, “Vibration, Dynamics and structural problems,” Oxford IBH Publishers
3. Clough, Ray W and Penzien J, “Dynamics of Structure s”, 2nd Edition, McGraw-Hill, New Delhi.
4. Roy R. Craig, Andrew J. Kurdila, “Fundamentals of Structural Dynamics”, 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	**16CCS14**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
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**
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**
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**
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**
Module -5	
FE APPROACH: 2D and 3D Elements - CST, LST, Rectangular family, Tetrahedra andHexahedra : Shape functions, Element Stiffness matrix, Equivalent Loads, Isoparametric formulation of Triangular and General quadrilateral elements, Axisymmetric elements, Gauss Quadrature.	**10 Hours**

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 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.

Reference 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
4. Srinath L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co Ltd., New Delhi
5. Roy R. Craig, Andrew J. Kurdila, "Fundamentals of Structural Dynamics", John Wiley & Sons
6. Bathe. K.J, Finite element procedures in Engineering Analysis. PHI. New Delhi
7. Zienkiewicz. O.C, "The Finite Element Method", Tata -McGraw-Hill PublishingCompany
8. Krishnamoorthy C.S, "Finite Element Analysis", Tata -McGraw-Hill PublishingCompany

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

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

SEMESTER – I

Subject: Design of Stack, Tower and Water Storage Structural Systems

Subject Code	**16CCS151**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students 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

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.	**8 Hours**
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	**8Hours**
Module -3	
Trestles Analysis and design of Steel Trestles for vertical and horizontal loads	**8Hours**
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	**8 Hours**
Module -5	
Overhead water tanks Circular, Rectangular on framed and Shaft type of Staging systems as per IS 3370 Parts 1 to 4.	**8 Hours**

Course outcomes:

After studying this course, students will be able to:

- Analysis of the super structure and sub structure
- Analyze and execute the steel trestles

- Analyze and execute the steel trestles

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.

Reference 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
Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co ltd., New
4. IS : 6533. Code of Practice for Design and Construction of steel chimneys.
5. IS 802: USE OF STRUCTURAL STEEL IN OVERHEAD TRANSMISSION LINE TOWERS — CODE OF PRACTICE - PART 1 MATERIAL, LOADS AND PERMISSIBLE STRESSES
6. IS :4091, CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF FOUNDATIONS FOR TRANSMISSION LINE TOWERS AND POLES
7. IS 3370 Part 1 to 4

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject: Composite and Smart Materials			
Subject Code	**16 CCS152**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

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	**8 Hours**
Module -2	
Anisotropic elasticity Unidirectional and anisotropic lamina, thermo-mechanical properties, micro- mechanical analysis, classical composite lamination theory, Cross and angle–play laminates, symmetric, antisymmetric and general asymmetric laminates, mechanical coupling, laminate stacking,	**8 Hours**
Module -3	
Analysis of simple laminated structural elements Ply-stress and strain, lamina failure theories - first fly failure, environmental effects, manufacturing of composites.	**8 Hours**
Module -4	
Smart materials, Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation.	**8 Hours**
Module -5	

Beam modeling with strain actuator, bending extension relation	**8 Hours**

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 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.

Reference Books:

1. Robart M Jones, “Mechanic of Composite Materials ”, McGraw Hill Publishing Co.
2. Bhagwan D Agaraval, and Lawrence J Brutman, “Analysis and Performance ofFiber Composites”, John
3. Willy and Sons.
4. 3.Lecture notes on “Smart Structures”, by Inderjith Chopra, Department ofAerospaceEngg., University of Maryland.
5. Srinath L S, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co., New Delhi
5. Crawley, E and de Luis, J., “Use of piezoelectric a ctuators as elements of intelligent structures”, AIAA Journal, Vol. 25 No 10, Oct 1987, PP 1373-1385.
6. Crawley, E and Anderson, E., “Detailed models of Pi ezoceramic actuation of beams”, Proc. of the 30th AIAA /ASME/ASCE/AHS/ASC-Structural dynamics and material conference, AIAA Washington DC, April 1989.

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject: Action and Response of Structural Systems			
Subject Code	**16CCS153**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

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. Accidental loads – Impact and collisions, Numerical examples	**8 Hours**
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 – Pitched Roof, Sign board,Structural glazing,Multistory Frames - Load path for Lateral loads	**8 Hours**
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	**8 Hours**
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	**8 Hours**
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	**8 Hours**

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.

Reference Books:

1. IS 875 Parts (1 to 5) , IS 1893, IRC 6,
2. Srinath L S, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co.Ltd., New Delhi
2. 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
3. Explanatory Examples on Indian Seismic Code IS 1893 (Part I): Document No. :: IITK-GSDMA-EQ21-V2.0 - IITK-GSDMA Project on Building Codes
4. 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 – I			
Subject: GEOTECHNICAL ASPECTS OF FOUNDATIONS AND EARTH RETAINING STRUCTURES			
Subject Code	**16CCS154**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

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.	**8 Hours**
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.	**8 Hours**
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.	**8 Hours**
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.	**8 Hours**
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.	**8 Hours**

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

Graduate Attributes (as per NBA)

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.

Reference 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
4. Srinath L S, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co Ltd., New Delhi
4. Leonards. G.A, “Foundation Engineering”, McGraw Hil l.
5. Tschebotoriff. G.P “Foundations, Retaining and Eart h Structures, McGraw Hill.
6. 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 – I

Subject: CAD Lab – Structural Analysis

Subject Code	**16CCSL16**	IA Marks	20
Number of Lecture Hours/Week	01 + 02	Exam Marks	80
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**
2. Structural Analysis of Continuous Beams using for different types of loadings and support conditions	**6 hours**
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**
4. Excel Spread Sheet for analysis of truss, beams and frames, using Direct Stiffness Method	**12 hours**
5. Program Development for Design of RC Structural Elements	**9 hours**

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 [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Subject: Analysis of Plates – Classical And FE Approach			
Subject Code	**16CCS21**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
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 toplate 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**
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**
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**

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**
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**

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 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.

Reference 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
4. Szilard. R, “Theory and analysis of plates-classica l and numerical methods”
5. Ugural A C, “Stress in Plates and shells”, McGraw-H ill International Book Company.
6. 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: Seismic Resistant Design of Structural Systems

Subject Code	**16CCS22**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
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**
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**
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**
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**
Module -5	

Earthquake Resistant Design of RCC Buildings – Material properties – lateral load analysis – design and detailing. Basic concepts of seismic b ase isolation and Seismic Isolation systems.	**10 Hours**

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.

Reference Books:

1. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India, 2006.
2. S K Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2007.
3. Chopra, A.K. "Dynamics of structures", Prentice-Hal l of India Pvt. Ltd. New Delhi.
4. Ghose, S.K. "Earthquake Resistance Design of Concrete Structures", SDCPL –R&D Center – New Mumbai 73.
5. Jaikrishna et al. "Elements of Earthquake Engineering", South Asia Publishers, New Delhi

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	**16CCS23**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
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**
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**
Module -3	
Stability analysis by finite element approach: Derivation of shape functions for a two nodedBernoulli-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**
Module -4	

Buckling of simply supported rectangular plate: Buckling of uniformly compressedrectangular 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**
Module -5	
Buckling of simply supported rectangular plate – Combined effects: Buckling of a SimplySupported 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**

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 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.

Reference Books:

1. Stephen P. Timoshenko, James M. Gere, "Theory of El astic 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
4. Srinath, L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing, New Delhi
4. Rajashekaran. S, "Computational Structural Mechanic s", Prentice-Hall, India.
5. Ray W Clough and J Penzien, "Dynamics of Structures ", 2nd 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: Advanced Design of RC Structural Elements			
Subject Code	**16CCS24**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
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	**10 Hours**
Module -2	
Redistribution of Moments in RC Beams: Conditions for Moment Redistribution – Final shape of redistributed bending moment diagram – Moment redistribution for a two-span continuous beam – 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. Curtailment of tension Reinforcement - code procedure – Numerical Example	**10 Hours**
Module -3	
Design of Reinforced Concrete Deep Beams: Introduction – Minimum thickness -Steps ofDesigning Deep beams – design by IS 456 - Detailing of Deep beams.	**10 Hours**
Module -4	

<table>
<tr><td>Behaviour and Analysis of Compression Members:
Effective Length Ratios of Columns inFrames, Code Charts – Numerical Examples,ShortColumns - Modes of Failure in Eccentric Compression, Axial Load - Moment Interaction equation, Interaction Surface for a Bi-axially Loaded Column, Concept of Equilibrium approach and application to Non rectangular columns. Slender Column: Braced and Unbraced, Design Methods as per IS 456 – Strength Reduction and Additional Moment Method</td><td>10 Hours</td></tr>
<tr><td colspan="2">Module -5</td></tr>
<tr><td>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.</td><td>10 Hours</td></tr>
<tr><td colspan="2">Course outcomes:
After studying this course, students will be able to:
• Design and execute the structural elements in different aspects</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td colspan="2">Reference Books:
1. S. Pillai, DevdasMenon- REINFORCED CONCRETE DESIGN 3/ED 3rd Edition
2. Varghese. P.C., Advanced Reinforced Concrete design, prentice, Hall of India, Neevpeth.
3. Srinath L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co.Ltd., New Delhi
3. Krishna Raju – “Advanced R.C. Design”, CBSRD,1986,
4. Park R. and Paulay, T., Reinforced Concrete Structures, John Wiley and Sons.
5. N. Subramanian , Design of Reinforced Concrete Structures, Oxford IBH</td></tr>
</table>

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	**16CCS251**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

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 probability distributions 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	**8 Hours**
Module -2	
Statistical regression and correlation: Least – square and chi – square methods, Operationon one Random variable, expectation, multiple random variables, reliability distributions – basic formulation	**8 Hours**
Module -3	
Statistical Quality control in Civil Engineering: Characteristic strength and characteristicload, probability modeling of strength, geometrical dimensions, material properties and loading.Application problems Mean value method and its applications in structural designs.	**8 Hours**
Module -4	
Safety assessment of structures: Reliability analysis using mean value theorem – I, II and IIIorder Reliability formats	**8 Hours**
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.	**8 Hours**

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 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.

Reference 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
3. John B. Kennedy and Adam M.Neville, Basic Statstical Methods for Engineers and Scientists,
4. Harperand Row Publishers, New York. Robert E. Melchers, Structural Reliability Analysis and Prediction, Wiley
5. 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: AI and Expert Systems in Structural Engineering

Subject Code	**16 CCS252**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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.	**8 Hours**
Module -2	
Search and Control: Concepts – uninformed / blind search: depth first s earch – breadth first search - bi-directional searc h – 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.	**8 Hours**
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.	**8 Hours**
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.	**8 Hours**
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 Engg. Expert system shells. Neural Networks: An introduction– their possible applications in Civil Engineering.	**8 Hours**

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.

Reference 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 Jersey.

Srinath L.S., New Delhi, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co

3. Rich, E. and Knight K. "Artificial Intelligence", T MH, New Delhi.
4. Rolston ,D.W., "Artificial Intelligence and Expert Systems" McGraw Hill, NewYork.
5. Nilsson, N.J., "Principals of Artificial Intelligence", Narosa., 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	**16CCS253**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

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.	**8 Hours**
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	**8 Hours**
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(Concepts), Design of laterally restrained castellated beams for given sectional properties, Structural behaviour of Vierendeel girders (Concepts).	**8 Hours**
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.	**8 Hours**
Module -5	

Fire resistance: Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members-Numerical Examples, Methods of fire protection, Fire resistance ratings.	**8 Hours**

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 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.

Reference Books:

1. N. Subramanian, "Design of Steel Structures", Oxford,IBHDuggal.S.K., Design of Steel structures. Srinath L.S., New Delhi, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co
2. IS 1641, 1642,1643
3. IS 800: 2007, IS 811, IS 801
4. 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: Design of Structural Systems for Bridges

Subject Code	**16 CCS254**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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 andproportioning..Bridge geometry. Conceptual design of various structural forms. Foundations with or without piles; abutments, retaining wallsand wing walls; columns and cap beams; bearings.	**8 Hours**
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	**8 Hours**
Module -3	
Design of Elevated Bridges: Solid slab bridges, Simple Girder bridges, PSC Girder Bridges	**8 Hours**
Module -4	
Design of Underpass and Box culverts	**8 Hours**
Module -5	
FE Concepts: Discrete and Continuum models of Bridge Deck – Spin e, Grillage, Surfacemodels, Bridge Piers, Support and Loading conditions, Soil-Structure Interaction	**8 Hours**

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 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.

Reference 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.
4. IRC112 - 2011 Code of Practice for Concrete Road Bridges and Railway Board Codes
5. Jagadeesh. T.R. and Jayaram. M.A., “Design of Bridg e Structures”, Prentice Hall of India ,2004.
6. Raina V.K.” Concrete Bridge Practice” Tata McGraw H ill Publishing Company, New Delhi, 1991.
7. IITK-RDSO GUIDELINES ON SEISMICDESIGN OF RAILWAY BRIDGES- Provisions with Commentary and Explanatory Examples , 2010

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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	**16CCSL26**	IA Marks	20
Number of Lecture Hours/Week	01 + 02	Exam Marks	80
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*
2. Flexural Behaviour of Slab Panels with different aspect ratio and boundary conditions	*6 hours*
3. FE Analysis of Slab panel resting on column supports- Drop Panels, Capitals	*6 hours*
4. FE Analysis of Slab on Grade (Raft), Underpass, Bridge Structures	*6 hours*
5. FE Analysis of Framed structures due to Seismic forces using modal superposition method	*6 hours*
6. Program Development for design of structural steel elements, using any programming (Tension member, Compression member and Bending)	*12 hours*

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 – IV

Subject: Analysis and Design of Shell Roof Structures – Classical and FE Approach

Subject Code	**16CCS41**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
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**
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**
Module -3	
Membrane Theory of Conical Shells, Hyperbolic Paraboloid: Conical Shells: Stressresultants for Dead, Live loads. Design Example, Hyperbolic Paraboloid: Structural Elements and behaviour in Umbrella and Inverted umbrella roof, Stress resultants, Shallow and Deep Shells, Design Examples	**10 Hours**
Module -4	
Bending Theory of Cylindrical Shells: Deficiency in Membrane theory, Incompatibleloading, 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	**10 Hours**

Cylindrical shells as per ASCE Manual No. 31. Design of Edge beams and Traverses. Rebar Detailing.	
Module -5	
Folded Plates: Types, Structural behavior- 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**

Course outcomes:

After studying this course, students will be able to:

- adopt better method to analyse the plate
- understand the behaviour of the plate

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.

Reference Books:

1. G. S. Ramaswamy, “Design and Construction of Concrete Shell Roofs”, CBS
2. P.C. Varghese, “Design of Reinforced Concrete Shell s and Folded Plates, PHI
3. Timoshenko and Krieger, “Theory of Plates and Shell s”, McGraw-Hill .
4. Chandrashekara K, “Theory of Plates”, University Press
5. IS 2210, SP 34

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES

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

SEMESTER – IV

Subject: Design of Precast and Composite Structures

Subject Code	**16 CCS421**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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, Precast elements- Floor, Beams, Columns and walls. Structural Systems and connections. **Design of precast Concrete Floors:**Theoretical and Design Examples of Hollow core slabs.	**8 Hours**
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	**8 Hours**
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.	**8 Hours**
Module -4	
Design of Precast Connections and Structural Integrity Beam bearing, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties.	**8 Hours**
Module -5	
Design of Steel Concrete Composite Floors and Beams **Composite Floors:** Profiled Sheeting with concrete topping, , Bending and Shear Resistance of Composite Slabs, Serviceability Criteria - Design principles only. **Composite Beams:** Elastic Behaviour, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams.	**8 Hours**

Course outcomes:

After studying this course, students will be able to:

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

Graduate Attributes (as per NBA)

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.

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

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

Subject: Advanced Mechanics of Materials

Subject Code	**16CCS422**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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 methodand 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.	**8 Hours**
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.	**8 Hours**
Module -3	
Shear Center for Thin-Wall Beam Cross Sections: Definition of shear center in bendingApproximations employed for shear in thin-wall beam cross sections, Shear flow in thin-walled beam cross sections, Shearcenter for singly symmetric and unsymmetrical sections. **Nonsymmetrical Bending of Straight Beams:,** Symmetrical and nonsymmetrical bending, Bending stresses in beams subjected to nonsymmetrical bending.	**8 Hours**
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.	**8 Hours**
Module -5	

Structures subjected to out of plane loading: Analysis of simple bents, frames, grids andbeams circular in plan – Cantilever beams, semicircular continuous beams with three equally spaced supports.	**8 Hours**

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.

Reference 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.

Srinath L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co ..., New Delhi

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

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

Advanced Design of Pre-stressed Concrete Structures

Subject Code	**16CCS423**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to

1. Design pre-stressed elements
2. Understand the behavior of pre-stressed elements.
3. Understand the behavior of pre-stressed sections

Modules	Teaching Hours
Module -1	
Losses of Prestress : Loss of prestress in pre-tensioned and post-tensioned members due to various causes like elastic shortening of concrete, shrinkage of concrete, creep of concrete, relaxation of steel, slip in anchorage, bending of member and frictional loss – Analysis of sections for flexure.	**8 Hours**
Module -2	
Design of Section for Flexure: Allowable stresses – Elastic design of simple beams having rectangular and I-section for flexure – kern lines – cable profile and cable layout. **Design of Sections for Shear** : Shear and Principal stresses – Improving shear resistance by different prestressing techniques – horizontal, sloping and vertical prestressing – Analysis of rectangular and I–beam – Design of shear reinforcement – Indian code provisions.	**8 Hours**
Module -3	
Deflections of Prestressed Concrete Beams: Short term deflections of uncracked members–Prediction of long-time deflections – load – deflection curve for a PSC beam – IS code requirements for max. deflections.	**8 Hours**
Module -4	
Transfer of Prestress in Pretensioned Members : Transmission of prestressing force by bond – Transmission length – Flexural bond stresses – IS code provisions – Anchorage zone stresses in post tensioned members – stress distribution in End block – anchorage zone reinforcements.	**8 Hours**
Module -5	
Statically Indeterminate Structures : Advantages & disadvantages of continuous PSC beams – Primary and secondary moments – P and C lines – Linear transformation concordant and non-concordant cable profiles – Analysis of continuous beams.	**8 Hours**

Course outcomes:

After studying this course, students will be able to:

1. Design and detailing of PSC elements

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.

Reference Books:

Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co ltd., New

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

SYLLABUS FOR M Tech., COMPUTER AIDED DESIGN OF STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – 4			
Subject: Dynamics of Soil-Structure Interaction			
Subject Code	**16CCS424**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students

- To impart knowledge of various numerical techniques to solve the problems of geotechnical engineering.
- To impart the knowledge on the propogation of waves

Modules	Teaching Hours
Module -1	
Introduction: Objectives and practical significance and importance of soil structure interaction (SSI); Fixed base structure, structures on soft ground; Modeling of unbounded media. **Fundamentals of Soil-Structure Interaction**: Direct and substructure methods of analysis; Equation of motion for flexible and rigid base; Kinematic interaction, inertial interaction and effect of embedment.	**8 Hours**
Module -2	
Modeling of Structure: Temporal and spatial variation of external loads (including seismic loads); Continuous models, discrete models (lumped mass) and finite element models. **Wave Propagation for SSI**: Waves in semi-infinite medium – one, two and three-dimensional wave propagation; Dynamic stiffness matrix for out-of plane and in-plane motion.	**8 Hours**
Module -3	
Free-Field Response of Site: Control point and control motion for seismic analysis; Dispersion and attenuation of waves; Half-space, single layer on half-space; Parametric studies. **Modeling of Boundaries**: Elementary, local, consistent and transmitting boundaries.	**8 Hours**
Module -4	
Modeling of Soil: Green's influence functions, boundary-element method, finite element model; Dynamic stiffness coefficients for different types of foundations – surface foundation, embedded foundation, shallow (strip) foundation and deep (piles) foundations. **Soil Structure Interaction in Time Domain**: Direct method; Substructure method (using dynamic stiffness and Green's functions of soil); Hybrid frequency-time domain approach.	**8 Hours**
Module -5	
Nonlinear Analysis: Material nonlinearity of soil (including plasticity and strain hardening), geometrical nonlinearity (slip and separation of foundation with soil); Nonlinear structure with linear soil considering both soil and structure nonlinearity.	**8 Hours**

Engineering Applications of Dynamic Soil-Structure Interaction: Low-rise residential buildings, multistory buildings, bridges, dams, nuclear power plants, offshore structures, soil-pile-structure interactions.

Course outcomes:

After studying this course, students will be able to:

- Predict type of waves and its movement
- Predict the behaviour of structures in such movements

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.

Reference Books:

Wolf, J. P., “Dynamic Soil-Structure Interaction”, Prentice-Hall.
1. Wolf, J. P., “Dynamic Soil-Structure Interaction”, Prentice-Hall.
2. Cakmak, A.S. – Editor, “Soil-Structure Interaction”, Developments in Geotechnical Engineering 43, Elsevier and Computational Mechanics Publications.
3. Wolf, J.P., “Soil-Structure Interaction in the Time-Domain”, Prentice-Hall.
4. Wolf, J.P. and Song C. “Finite Element Modelling of Unbounded Media”, John Wiley & Sons.
5. Kramer, S.L., “Geotechnical-Earthquake Engineering”, Pearson Education
6. Hall, W.S. and Oliveto G., “Boundary Element Method for Soil-Structure Interaction”, Kluwer Academic Publishers.
7. Chen, Wai-Fah and DuanLian, “Bridge Engineering (Seismic Design)”, CRC Press.