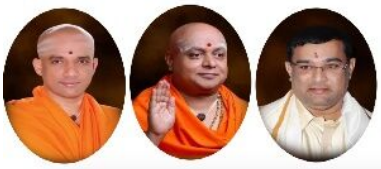

|| Jai Sri Gurudev ||
Sri Adichunchanagiri Shikshana Trust (R)

SJB Institute of Technology

An AUTONOMOUS INSTITUTION UNDER VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Approved by AICTE, 2(f) and 12(B) recognized by UGC, New Delhi
Accredited by NAAC, Accredited by NBA, Certified by ISO 9001 - 2015

PG Autonomous Scheme & Syllabus

Programme: M.Tech

Civil Engineering: Computer Aided Design of Structures

SCHEME
2023

I to IV Semester

SERVICE TO MANKIND IS SERVICE TO GOD

His Divine Soul Padmabhushana

Sri Sri Sri Dr. Balagangadharanath MahaSwamiji

Founder President, Sri Adichunchanagiri Shikshana Trust®

Belief in God is not ignorance or illusion. It is a belief that there is an unseen, ineffable Power that transcends all our

His Holiness Parama Pujya

Sri Sri Sri Dr. Nirmalanandanatha MahaSwamiji

President, Sri Adichunchanagiri Shikshana Trust ®

True richness is the generosity of heart. Cultivate it and work to help the less fortunate ones in life.

Revered Sri Sri Dr. Prakashanatha Swamiji

Managing Director, BGS & SJB Group of Institutions & Hospitals

People and prosperity follow the path which the leaders take. So, the elders and leaders should make sure that they give the right lead and take.

Syllabus Book for M.Tech (CAD Structure)		
Syllabus for 1st to 4th Semester		
The syllabus, scheme and guidelines are provided in detail. The syllabus, scheme and guidelines are subjected to changes if any needed. The updates will be done and intimated timely.		
The Syllabus book is available on	www.sjbit.edu.in	
For any queries, please write to	academicdean@sjbit.edu.in	
UPDATES		
Release / Revision	**Date**	**Remarks**
Release	06/02/2024	First uploading, Version 1
Version 2	15/03/2024	Correction of Teaching hours per week

|| Jai Sri Gurudev ||
Sri Adichunchanagiri Shikshana Trust (R)

SJB Institute of Technology

BGS Health and Education City, Dr. Vishnuvardhana Road, Kengeri, Bengaluru-560060
Approved by AICTE, New Delhi.
Autonomous Institute affiliated to Visvesvaraya Technological University, Belagavi
Accredited by NAAC with 'A+'grade, Certified by ISO 9001 - 2015
Recognized by UGC, New Delhi with 2(f) & 12 (B)

AUTONOMOUS SCHEME - MTech CAD Structures First Year CCS

SCHEME: 2023 **Aca. Year.: 2023-24**

SL No	Course Type	Course type series	Course Code	Course Title	Teaching Dept.	QP setting dept	Credits	Teaching Hrs/Week				Examinations				
								L	T	P	S	CIE Marks	SEE			Tot. Marks
								Lecture	Tutorial	Practical	PBL/ABL/ SL/othrs.		Dur.	Th. Mrks	Lab. Mrks.	
SEM: I																
1	BSC	1	23CCST11	Numerical Methods and programming	CV	CV	**3**	3	0	0		50	3	50	-	100
2	IPCC	2	23CCSI12	Finite Element Analysis of Structural Systems - Concepts and Procedures	CV	CV	**4**	3	0	2		50	3	50	-	100
3	PCC	3	23CCST13	Computational Structural mechanics - Classical and FE approach	CV	CV	**3**	3	0	0		50	3	50	-	100
4	PCC	4	23CCST14	Continuum mechanics –Classical and FE approach	CV	CV	**3**	3	0	0		50	3	50	-	100
5	PCC	5	23CCST15	Structural Dynamics- Theory and Computations	CV	CV	**3**	3	0	0	2	50	3	50	-	100
6	PCC	6	23CCST16	Research Methodology and IPR	CV	CV	**3**	3	0	0		50	3	50	-	100
7	PCCL	7	23CCSL17	CAD Lab – FE Programming	CV	CV	**2**	1	0	2		50	3	-	50	100
						SEM-I Total	**21**	**19**	**0**	**4**	**2**	**350**		**300**	**50**	**700**
SEM: II																
1	IPCC	1	23CCSI21	Analysis of Plates and shells – Classical and FE Approach	CV	CV	**4**	3	0	2		50	3	50	-	100
2	PCC	2	23CCST22	Structural stability analysis - Classical and FE approach	CV	CV	**3**	3	0	0	2	50	3	50	-	100
3	PEC	3	23CCSP21y	Professional elective- 1	CV	CV	**3**	3	0	0		50	3	50	-	100
4	PEC	4	23CCSP22y	Professional elective- 2	CV	CV	**3**	3	0	0		50	3	50	-	100
5	PRJ	5	23CCSP25	Mini Project with seminar	CV	CV	**4**	0	0	0	@PBL	50	3	50	-	100
6	PCCL	6	23CCSL26	CAD Lab – FE Modelling and Analysis	CV	CV	**2**	1	0	2		50	-	-	50	100
						SEM-II Total	**19**	**13**	**0**	**4**	**2**	**300**		**250**	**50**	**600**
						FIRST YEAR TOTAL	**40**									

BSC: Basic science course,PCC: Professional core. IPCC-Integrated Professional Core Courses, PCCL-Professional Core Course lab, PEC: Professional elective course,PRJ:Project,INT:Internship(G),SLC: Self learning course,L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities(Hours are for Interaction between faculty and students)

PEC-1

Course Code	Course Title
23CCSP211	Advanced Design of Steel Structures
23CCSP212	Design of Bridges
23CCSP213	Advanced Design of RC Structural Elements
23CCSP214	Design of Offshore Structures

PEC-2

Course Code	Course Title
23CCSP221	Structural Optimization
23CCSP222	Mechanics of Composites
23CCSP223	Structural Health Monitoring
23CCSP224	Reliability Analysis of Structures

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AUTONOMOUS SCHEME - MTech CAD Structures Second Year CCS

SCHEME: 2023 **Aca. Year.: 2024-25**

SL No	Course Type	Course type series	Course Code	Course Title	Teaching Dept.	QP setting dept	Credits	Teaching Hrs/Week				Examinations				
								L	T	P	S	CIE Marks	SEE			Tot. Marks
								Lecture	Tutorial	Practical	PBL/ABL/ SL/othrs.		Dur.	Th. Mrks	Lab. Mrks.	
SEM: III																
1	PCC	1	23CCST31	Advanced structural analysis	CV	CV	**4**	3	2	0		50	3	50	-	100
2	PEC	2	23CCSP33X	Professional elective- 3	CV	CV	**3**	3	0	2		50	3	50	-	100
3	PEC	3	23CCSP34X	Professional elective- 4	CV	CV	**3**	3	0	0		50	3	50	-	100
4	PRJ	4	23CCSPR34	Project Work phase -1	CV	CV	**3**	0	0	0	@PBL	50	3	50	-	100
5	PRJ	5	23CCSPR35	Societal Project	CV	CV	**3**	0	0	0	6	50	3	50	-	100
6	INT	6	23CCSG36	Internship			**6**	(06 weeks between of II and III semesters.)				50	3	-	50	100
						SEM-I Total	**22**	**9**	**2**	**2**	**6**	**300**		**250**	**50**	**600**

PEC-3

Course Code	Course Title	Course Code	Course Title
23CCSP331	Design Concepts of Substructures	23CCSP341	Admixtures and Special Concretes
23CCSP332	Advanced Design of Prestressed Concrete Structures	23CCSP342	Earthquake Geotechnical Engineering
23CCSP333	Design of Industrial Structures	23CCSP343	Fracture Mechanics
23CCSP334	Design of Precast and Composite Structures	23CCSP344	Action and Response of Structural Systems

PEC-4

SEM: IV			Course Code	Course Title	Teaching Dept.	QP setting dept	Credits	Teaching Hrs/Week				Examinations				
1	PRJ	2	23CCSPR41	Project work phase 2			18	-	-	-	@PBL	100	03	-	100	200
2	SLC	1	23CCSS1y	Self learning course- 1	NPTEL	NPTEL	**PP/NP**	0	0	0						
3	SLC	2	23CCSS2y	Self learning course- 2	NPTEL	NPTEL	**PP/NP**	0	0	0						
						SEM-II Total	**18**	**-**	**-**			**100**		**-**	**100**	**200**
						SECOND YEAR TOTAL	**40**									

BSC: Basic science course,PCC: Professional core. IPCC-Integrated Professional Core Courses, PCCL-Professional Core Course lab, PEC: Professional elective course,PRJ:Project,INT:Internship(G),SLC: Self learning course,L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities(Hours are for Interaction between faculty and students)

Table content

M. Tech. In CAD Structures

Semester:	**1**	**Course Type:**	BSC		
Course Title: NUMERICAL METHODS AND PROGRAMMING					
Course Code:	23CCST11			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3 Hours

I. Course Objectives:

- To understand techniques of numerical computation
- To effectively use MATLAB programming for numerical computation

II. Teaching-Learning Process:

The course will be covered in five modules. Various aspects of MATLAB programming for numerical computation will be covered in these modules, with each module dedicated to on equivalent numerical topic along with dedicated lab sessions. There will be self-study problems at the end of several of these lectures. Assignments will also be posted periodically.

III. COURSE CONTENT

III Theory PART

Module-1: Introduction to MATLAB Programming — 8 Hours

Introduction to MATLAB Programming:
Basics of MATLAB programming, Array operations in MATLAB, Loops and execution control, Working with files: Scripts and Functions, Plotting and program output.
Approximations and Errors:
Defining errors and precision in numerical methods, Truncation and round-off errors, Error propagation, Global and local truncation errors. (Taylor's / Maclaurin series expansion of some functions are used to introduce approximations and errors in computational methods)
RBT Levels: L1 L2

Module-2: Numerical Differentiation and Integration — 8 Hours

Numerical Differentiation: Numerical Differentiation in single variable, Numerical differentiation: Higher derivatives, Differentiation in multiple variables.
Numerical Integration: Newton-Cotes integration formulae, Multi-step application of Trapezoidal rule, MATLAB functions for integration.

RBT Levels: L2 L3

Module-3: Linear Equations	8 Hours

Linear Equations: Linear algebra in MATLAB, Gauss Elimination, LU decomposition and partial pivoting, Iterative methods: Gauss Siedel, Special Matrices: Tri-diagonal matrix algorithm
Nonlinear Equations: Nonlinear equations in single variable, MATLAB function fzero in single variable, Fixed-point iteration in single variable, Newton-Raphson in single variable, MATLAB function fsolve in single and multiple variables, Newton-Raphson in multiple variables

RBT Levels: L2 L3

Module-4: Ordinary Differential Equations	8 Hours

methods, Second-Order Runge-Kutta Methods, MATLAB ode45 algorithm in single variable, Higher order Runge-Kutta methods, Error analysis of Runge-Kutta method
ODE solving in multiple variables, stiff systems, and practical problems: MATLAB ode45 algorithm in multiple variables, Stiff ODEs and MATLAB ode15s algorithm, Practical example for ODE-IVP, solving transient PDE using Method of Lines

RBT Levels: L2 L3

Module-5: Matrices, Eigenvalues and Optimization	8 Hours

Matrices and Eigenvalues: Eigenvalues and Eigenvectors, Similarity Transformation and Diagonalization, Power Method, Jacobi Method
MATLAB Built-In Routines for Optimization: Unconstrained Optimization, Constrained Optimization, Linear Programming (LP)

RBT Levels: L2 L3

IV. COURSE OUTCOMES

CO1	Obtain solutions to linear equations by various methods.
CO2	Carry out higher order interpolation of polynomials using finite difference method.
CO3	Apply finite difference method and find numerical solutions to spatial differential equations.
CO4	Carry out numerical integration to find solutions to engineering applications.
CO5	Find out solutions to ordinary differential equations using different methods.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3		3									3			
CO2	3	3		3									3			
CO3	3	3		3									3			
CO4	3	3		3									3			
CO5	3	3		3									3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): 1 Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII: Reference Books:

1	Applied Numerical Analysis	Gerald, C.F. and Wheatley, P. O	6 and 1999	Pearson Education
2	Numerical Methods for Engineers with Programming and Software Applications,	Chapra, S.C. and Canale, R. P	3 and 1998	Tata McGraw Hill, New Delhi
3	Applied Numerical Methods for Engineers using Matlab and C	Schilling, R.J. and Harries, S. L	2000	Thomson Brooks/Cole

VII(c): Web links and Video Lectures (e-Resources):

Numerical methods - Course (nptel.ac.in)
Matlab Programming for Numerical Computation - Course (nptel.ac.in)
Applied Numerical Methods - Course (nptel.ac.in)

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Conduction of technical seminars on recent research activities
- Group Discussion

M. Tech. CAD Structures

Semester:	1	**Course Type:**	IPCC		
Course Title: Finite Element Analysis of Structural Systems - Concepts and Procedures					
Course Code:	23CCSI12			**Credits:**	4
Teaching Hours/Week (L:T:P:O)			3-0-2-0	**Total Hours:**	60
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3 Hours

I.Course Objectives:

1) To provide the fundamental concepts of theory of the finite element method.
2) To develop proficiency in the application of the finite element method (modeling, analysis and interpretation of results) to practical engineering problems.

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III.COURSE CONTENT

III(a). Theory PART

Module-1: Introduction	8 Hours

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.

RBT Levels: L3

Module-2: Interpolation (shape) functions of Bar, Beam and Triangular elements	8 Hours

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.

RBT Levels: L3

Module-3: Interpolation (shape) functions of Rectangular and Solid elements	8 Hours

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

RBT Levels: L3

Module-4: Mapping techniques | 8 Hours

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

RBT Levels: L3

Module-5: Numerical integration | 8 Hours

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.

RBT Levels: L3

III(b). PRACTICAL PART

Sl. No.	Experiments / Programs / Problems
1	Excel programming for computation of Axial Deformation of Bars with uniform cross section
2	Excel programming for computation of Axial Deformation of Bars with uniform cross section
3	Excel programming for Analysis of two nodded beam element
4	Excel programming for Analysis of three nodded beam element
5	Programming for analysis of serendipity element
6	Programming for analysis of Lagrange element
7	Programming for Mapping a Straight Line
8	Programming for quadrilateral areas
9	Programming for Numerical integration - Line or one-Dimensional Integrals
10	Programming for Numerical integration - quadrilateral areas

IV.COURSE OUTCOMES

CO1	Explain the basic theory behind the finite element method
CO2	Formulate and analyze shape functions for line, beam and triangular elements used in FEA.
CO3	Formulate and analyze shape functions for rectangular and brick elements used in FEA
CO4	Use the mapping techniques for different element shapes
CO5	Implement numerical integration techniques to solve FEA problems

V.CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3		2	3							2	3			
CO2	3	3		2	3							2	3			
CO3	3	3		2	3							2	3			
CO4	3	3		2	3							2	3			
CO5	3	3		2	3							2	3			

VI.Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 2

Continuous Internal Evaluation (CIE): 1 Refer Annexure section 2

Semester End Examination (SEE): Refer Annexure section 2

VII. Learning Resources

VII.(a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	The finite element method for solid and structural mechanics	Zeinkiewicz, O. C. and Taylor R.L.,	2013	Butterworh – Heinemann
2	Finite Element Analysis: Theory and programming	Krishnamoorthy C. S.,	2017	Tata McGraw Hill Publishing Co. Ltd.,
3	Fundamental finite element analysis and applications	M. Asghar Bhatti	2005	John Wiley & Sons
4	Concepts and Applications of Finite Element Analysis	Robert D Cook, Malkas, D. S. and Plesha., M. E.,	2007	John Wiley and Sons

VII(b): Web links and Video Lectures (e-Resources):

https://www.digimat.in/nptel/courses/video/112104193/L01.html
http://www.digimat.in/nptel/courses/video/112104205/L24.html

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

• Conduction of technical seminars on recent research activities
• Group Discussion

M. Tech. In CAD Structures

Semester:	1	**Course Type:**	PCC		
Course Title: Computational Structural Mechanics - Classical and FE approach					
Course Code:	**23CCST13**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3-0-0-0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

III. 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.
IV. Achieve problem solving skills using computer aided methods.
V. Implementation procedures of such methods in computer programs

II.Teaching-Learning Process:

Chalk and talk, power point presentation

III. COURSE CONTENT

III. Theory PART

Module-1: Introduction — 08 Hrs

Direct Stiffness Method – Trusses

Degrees of Static and Kinematic indeterminacies, Concepts of Stiffness 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.

RBT Levels: L3

Module-2: — 08 Hrs

Direct Stiffness Method - Continuous Beam, and Frames. Analysis of Continuous beams, for different 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).

RBT Levels: L3

Module-3: — 08 Hrs

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.

RBT Levels: L3

Module-4:	08 Hrs

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.
RBT Levels: L3

Module-5:	08 Hrs

FE Analysis using Beam Element. Element Stiffness matrix, Consistent Nodal loads, Concept of Reduced or Lumped Loads, Examples. Cantilever and Simply Supported beams.
RBT Levels: L3

IV. COURSE OUTCOMES

CO1	Apply direct stiffness method and analyse 2-D truss and frame structures
CO2	Formulate Finite Element method with respect to structures.
CO3	Formulate and apply FEM to bar and beam elements.
CO4	Apply knowledge of problem-solving skills using computer aided methods.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3		2								2	3			
CO2	3	3		2								2	3			
CO3	3	3		2								2	3			
CO4	3	3		2								2	3			
CO5	3	3		2								2	3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): 1 Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII.(a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	, Computational Structural Mechanics	Rajasekaran, S. and Shankarsubramanian	2001	PHI
2	Matrix analysis of framed structures	Weaver, W. and Gere, J. M.	2004	CBS Publishers and Distributors Pvt. Ltd. 2
3	Basic Structural Analysis	Reddy. C. S	2001	TMH
4	Concepts and Applications of Finite Element Analysis	Robert D Cook, Malkas, D. S. and Plesha., M. E.,	3, 2007	John Wiley and Sons

VII(b): Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/105/107/105107209/

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:
• Conduction of technical seminars on recent research activities • Group Discussion

Semester:	I	**Course Type:**	PCC		
Course Title: Continuum mechanics –Classical and FE approach					
Course Code:	**23CCST14**		**Credits:**		3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

This course will enable students to

1. 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. Carry out the formulation of and implementation of Iso-parametric 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.

II. Teaching-Learning Process (General Instructions):

The question paper will have ten questions, carrying equal marks. There will be two full questions with a maximum four sub questions from each module. Students shall answer five full questions selecting one full question from each module.

III. COURSE CONTENT

III(a). Theory PART

Module-1: **8 Hrs**

Basic Concepts

Definition of stress and strain at a point, components of stress and strain at a point, 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.

Pre-requisites (Self Learning)

1. Strength of Materials

RBT Levels: L1,L3

Module-2: **8 Hrs**

Two-dimensional problems in Rectangular Coordinates: Airy's stress function approach to 2-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.

Pre-requisites

1. Strength of Materials

RBT Levels: L1,L5

Module-3:	**8 Hrs**

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 symmetrical 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.

Pre-requisites

1. Theory of Elasticity

RBT Levels: L1,L5

Module-4:	**8 Hrs**

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.

Pre-requisites

1. Strength of Materials

RBT Levels: L1,L3

Module-5:	**8 Hrs**

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.

Pre-requisites

1. Structural analysis
2. Matrix method of Analysis.

RBT Levels: L1,L3

IV. COURSE OUTCOMES

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

CO1	Formulate equilibrium equations for simple structures.
CO2	Describe the continuum in 2 and 3-dimensions with rectangular and polar coordinate systems.
CO3	Analyse the principles of stress-strain behaviour of continuum with classical approach.
CO4	Formulation and implementation of isoparametric finite element models for 2 and 3- dimensional deforming bodies.
CO5	Use finite element method for solving continuum mechanics problems.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2	1								1	2					
CO2	3	2	1							2	2					
CO3	3	3	2	1						2	2					
CO4	3	2	1							2	2					
CO5	2	2	1							2	2					

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): 1 Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII.(a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Theory of elasticity	Timoshenko and Goodier	III Edition, 1983	McGraw Hill Book Company
2	Continuum Mechanics fundamentals	Valliappan. S,	1981	Oxford and IBH
3	Advanced Mechanics of solids	Srinath L. S.,	10th Print 1994	Tata McGraw Hill Publishing Co.
4	Theory of Elasticity	Verma P. D. S	1997	Khanna Publishers
5	Finite element procedures in Engineering Analysis	Bathe. K.J,	2007	PHI. NewDelhi

VII(b): Web links and Video Lectures (e-Resources):

Mention the links of the online resources, video materials, etc.

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Conduction of technical seminars on recent research activities
- Group Discussion

M. Tech. In CAD Structures

Semester:	**I**	**Course Type:**	PCC		
Course Title: STRUCTURAL DYNAMICS- THEORY AND COMPUTATIONS					
Course Code:	**23CCST15**			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:2	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

1. Understand effect of structural vibrations on safety and reliability of structural systems (L2).
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 (L3).
3. Apply modal methods to calculate the forced response of these systems(L3).
4. Use finite element methods for the analysis of the vibrations of structures(L4).

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: (Introduction) — 8 Hrs

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

RBT Levels: L1 L2

Module-2: (SDOF) — 8 Hrs

Response of Single-degree-of-freedom systems to harmonic loading including support motion, vibration isolation, transmissibility. Numerical methods applied to Single- degree-of-freedom systems – Duhamel's integral. Principle of vibration measuring instruments– seismometer and accelerometer.

RBT Levels: L2 L3

Module-3: (MDOF) — 8 Hrs

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

RBT Levels: L2 L3	
Module-4: (Shear Building)	8 Hrs
Response of Shear buildings for harmonic loading without damping using normal mode approach. Response of Shear buildings for forced vibration for harmonic loading with damping using normal mode approach.	
RBT Levels: L2 L3	
Module-5: (Numerical methods)	8 Hrs
Approximate methods: Rayleigh's method, Dun Karley's method, Stodola's method, Dynamics of Continuous systems: Flexural vibration of beams with different end conditions. Stiffness matrix, mass matrix (lumped and consistent).	
RBT Levels: L2 L3	

IV. COURSE OUTCOMES

CO1	Evaluate the effect of structural vibrations on safety and reliability of structural systems.
CO2	Develop and solve equations of motion for free and forced response of structural systems.
CO3	Analyse damping and its influence on structural response.
CO4	Apply modal method to compute forced response of SDOF and MDOF systems.
CO5	Carry out dynamic analysis of beams using FEM.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3											3			
CO2	3	3											3			
CO3	3	3											3			
CO4	3	3											3			
CO5	3	3											3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): 1 Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII(a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Dynamics of structures – Theory and Applications	Anil K. Chopra	2 and 2012	Pearson Education
2	Structural dynamics -	Mario Paz	2 and 2004	CBS Publisher and Distributors

	Theory and computations			
3	Earthquake Resistant Design of Building Structures	Vinod Hosur	2012	Wiley

VII(c): Web links and Video Lectures (e-Resources):

NPTEL :: Civil Engineering - NOC:Structural Dynamics
NPTEL :: Civil Engineering - NOC:Structural Dynamics for Civil Engineers - SDOF systems
Dynamics of Structures - Course (nptel.ac.in)

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Conduction of technical seminars on recent research activities
- Group Discussion

Semester:	**I**	**Course Type:**	PCC		
Course Title: Research methodology and IPR					
Course Code:	**23CCST16**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	3
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

1.To understand the process of research & identify good research and the problems encountered by researchers.

2. To collect various research design & features of a good design in order to apply in design of experiments.

3. To test the hypotheses, interpret and writing research reports.

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1:	8 hrs

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.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration

RBT Levels: L1, L2

Module-2:	8 hrs

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.

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.

RBT Levels: L1, L2

Module-3:	8 hrs

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.
Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method

RBT Levels: L1,L2

Module-4:	8 hrs

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis

RBT Levels: L1 L2

Module-5:	8 hrs

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports**.**

Intellectual Property: The Concept, Intellectual Property System in India**, 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 Rights, UNSECO**.**

RBT Levels: L1 L2

IV. COURSE OUTCOMES After studying this course, students will be able to:

CO1	Discuss research methodology and the technique of defining a research problem
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
CO4	Explain several parametric tests of hypotheses, art of interpretation and writing research reports & discuss various forms of the intellectual property & its relevance

V. CO-PO-PSO MAPPING

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	2										1	2			
CO2	3	2	2						2	3		1	2			
CO3	3	2	3	3	2							1	2			
CO4	3	2	3	3	2					3		1	2			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): 1 Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII.(a): Reference Books:

1	Research Methodology: Methods and Techniques	C.R. Kothari, Gaurav Garg	Edition 4 & 2013	New Age International
2	Research Methodology a step-by-step guide for beginners	Ranjit Kumar	Edition 3 & 2011	SAGE
3	Research Methods: the concise knowledge base	Trochim,	Edition 1 &2005	Atomic Dog Publishing
4	Conducting Research Literature Reviews	Fink A	Edition 1 &2009	SAGE

VII(b): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=E2gGF1rburw
https://www.youtube.com/watch?
=5fvpsqPWZac&list=PLyqSpQzTE6M8PuzP1p2hNPXgpbOBhFgja
https://www.youtube.com/watch?v=yplWZs3dqNQ
https://www.youtube.com/watch?v=51HnRTt4KeQ
https://www.youtube.com/watch?v=WvduZOWoft0&t=100
https://www.youtube.com/watch?v=WvduZOWoft0&t=316
https://www.youtube.com/watch?v=WvduZOWoft0&t=603
https://www.youtube.com/watch?v=WvduZOWoft0&t=729
https://www.youtube.com/watch?v=WvduZOWoft0&t=831

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Conduction of technical seminars on recent research activities
- Group Discussion

Semester:	1	**Course Type:**	PCCL		
Course Title: CAD LAB – FE PROGRAMMING					
Course Code:	23CCSL17			**Credits:**	1
Teaching Hours/Week (L:T:P:O)			0:2:0:2	**Total Hours:**	50
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Practical			**Exam Hours:**	03

I. Course Objectives:

To develop programs using concept of finite element method to solve practical engineering problems.

II. COURSE CONTENT

PRACTICAL PART

Sl. No.	Experiments / Programs / Problems
1	Programming to generate element mesh using 6 nodded triangular elements
2	Programming to generate element mesh using serendipity elements
3	Programming to generate element mesh using Legrange elements
4	Programming to solve a static beam deflection using Hermitian beam elements
5	Programming for linear static analysis of a truss structure
6	Programming for linear static analysis of a truss structure
7	Programming for linear static analysis of a continuous beam
8	Programming for linear static analysis of a continuous beam
9	Programming for linear static analysis of a rigid jointed frame
10	Programming for linear static analysis of a rigid jointed frame

Instructions for conduction of practical part:

III. COURSE OUTCOMES

CO1	Explain the basic theory behind the finite element method.
CO2	Formulate and analyze shape functions for line, beam and triangular elements used in FEA.
CO3	Formulate and analyze shape functions for rectangular and brick elements used in FEA.

CO4	Use the mapping techniques for different element shapes
CO5	Implement numerical integration techniques to solve FEA problems

IV. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3		3	3							3	3			
CO2	3	3		3	3							3	3			
CO3	3	3		3	3							3	3			
CO4	3	3		3	3							3	3			
CO5	3	3		3	3							3	3			

V. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 3

Continuous Internal Evaluation (CIE): Refer Annexure section 3

Semester End Examination (SEE): Refer Annexure section 3

VI. Learning Resources

VII: Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	The finite element method for solid and structural mechanics	Zeinkiewicz, O. C. and Taylor R.L.,	2013	Butterworh – Heinemann
2	Finite Element Analysis: Theory and programming	Krishnamoorthy C. S.,	2017	Tata McGraw Hill Publishing Co. Ltd.,
3	Fundamental finite element analysis and applications	M. Asghar Bhatti	2005	John Wiley & Sons
4	Concepts and Applications of Finite Element Analysis	Robert D Cook, Malkas, D. S. and Plesha., M. E.,	2007	John Wiley and Sons

VII(c): Web links and Video Lectures (e-Resources):

https://www.digimat.in/nptel/courses/video/112104193/L01.html
http://www.digimat.in/nptel/courses/video/112104205/L24.html

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Conduction of technical seminars on recent research activities
- Group Discussion

Semester:	II	**Course Type:**	IPCC		
Course Title: Analysis of Plates and shells – Classical and FE Approach					
Course Code:	**23CCSI21**			**Credits:**	4
Teaching Hours/Week (L:T:P:O)			3:0:2:0	**Total Hours:**	60
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- Apply knowledge of mathematics, science, and engineering related to plate theory
- Analyse the structural elements consisting of curved surfaces
- Use finite element methods in plate analysis.

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

III(a). THEORY PART

Module-1: Introduction	08 Hrs
Introduction to plate theory, Small deflection of laterally loaded thin rectangular plates for pure bending. Navier's and Levy's solution for various lateral loading and boundary conditions (No derivation), Numerical examples	
RBT Levels: L3	
Module-2:	08 Hrs
Introduction to curved surfaces and classification of shells, Membrane theory of spherical shells, cylindrical shells, hyperbolic paraboloids, elliptic paraboloid and conoids	
RBT Levels: L3	
Module-3:	08 Hrs
Axially symmetric bending of shells of revolution, closed cylindrical shells, water tanks, spherical shells and Geckler's approximation. Bending theory of doubly curved shallow shells.	
RBT Levels: L3	
Module-4:	08 Hrs
Design and detailing of folded plates with numerical examples Design and Detailing of simple shell problems – spherical domes, water tanks, barrel vaults and hyperbolic paraboloid roofs	
RBT Levels: L3	
Module-5:	08 Hrs

FE approach: Finite Element Analysis of Thin Plate: Triangular Plate Bending Element, Rectangular Plate Bending Element, Finite Element Analysis of Thick Plate.

RBT Levels: L3

III(b). PRACTICAL PART

Sl. No.	**Experiments / Programs / Problems** (insert rows as many required)
1	Programming for analysis of simply supported plate using Navier's technique.
2	Programming for analysis of fixed plate using Lavy's technique.
3	Programming for analysis of plate with opposite ends fixed and others simply supported using Lavy's technique.
4	Programming for analysis of spherical shells using membrane theory.
5	Programming for analysis of cylindrical shells using membrane theory.
6	Programming for design of folded plates
7	Programming for design of spherical domes
8	Programming for design of hyperbolic paraboloid roofs
9	Programming for FE analysis of thin plates
10	Programming for FE analysis of thick plates

IV. COURSE OUTCOMES

CO1	Analysis of plates using closed form solution techniques
CO2	Explain the classification of curved surfaces and explain the membrane theory for the analysis
CO3	Solve the shell problems for axisymmetric bending
CO4	Design folded plates and shells
CO5	Make use of FE approach for the analysis of thin and thick plates

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3		2	3							2	3			
CO2	3	3		2	3							2	3			
CO3	3	3		2	3							2	3			
CO4	3	3		2	3							2	3			
CO5	3	3		2	3							2	3			

VI.Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 2

Continuous Internal Evaluation (CIE): Refer Annexure section 2

Semester End Examination (SEE): Refer Annexure section 2

VII. Learning Resources

VI(a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Theory of Plates and Shells	Timoshenko and Krieger	1959	McGraw-Hill

2	Theory of Plates	Chandrashekara K	2000	University Press
3	Concepts and Applications of Finite Element Analysis	Robert D Cook, Malkas, D. S. and Plesha., M. E.	3, 2007	John Wiley and Sons
4	Theory and analysis of plates - Classical and numerical methods	Szilard. R	1974	Prentice Hall,
5	Stress in Plates and shell	Ugural A C	1999	McGraw-H ill

VI(b): Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/105/103/105103209/
https://onlinecourses.nptel.ac.in/noc23_ce103/preview

VII: Activity Based Learning / Practical Based Learning/Experiential learning:

• Conduction of technical seminars on recent research activities
• Group Discussion

M.Tech Computer Aided Design of Structures

Semester:	II	**Course Type:**	PCC		
Course Title: Structural Stability Analysis – Classical and FE Approach					
Course Code:	23CCST22			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:2	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

This course will enable students to

1. Learn the concepts of stability of structures
2. Analyse various structural elements for their stability.
3. Compute buckling loads of columns; elastic buckling of frames and Plates.

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: **8 Hrs**

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.

Pre-requisites (Self Learning)

2. Strength of Materials

RBT Levels: L1, L2

Module-2: **8 Hrs**

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 pulsating forces.

Pre-requisites

2. Strength of Materials

RBT Levels: K1, K2

Module-3: **8 Hrs**

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.

Pre-requisites

2. Matrix method of Analysis
3. Finite Element Method

RBT Levels: L2, L3, L4

Module-4:	**8 Hrs**

Lateral buckling of beams: Differential equation –pure bending – cantilever beam with tip load – simply supported beam of I section subjected to central concentrated load. Pure Torsion of thin – walled bars of open cross section. Non – uniform Torsion of thin – walled bars of open cross section

Pre-requisites

2. Strength of Materials

RBT Levels: L1, L2, L3

Module-5:	**8 Hrs**

Expression for strain energy in plate bending with in plate forces (linear and non – linear): Buckling of simply supported rectangular plate– uniaxial load and biaxial load. 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.

Pre-requisites

3. Strength of Materials.

RBT Levels: L1, L2, L3

IV. COURSE OUTCOMES

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

CO1	Formulate differential equations for beam column elements with various combinations of loads and end conditions.
CO2	Analyse buckling of frames and continuous beams.
CO3	Carry out stability analysis of structures using Finite Element Method.
CO4	Analyse buckling of beams and torsion in beams.
CO5	Apply strain energy method for buckling of plates.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2	2									1					
CO2	3	3	1	1						2	2					
CO3	3	2	1	1						2	2					
CO4	3	3	1	1						2	2					
CO5	3	2	1	1						2	2					

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VI(a): Textbooks: (Insert or delete rows as per requirement)

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Theory of elasticity Stability	Timoshenko and Gere J	II Edition	McGraw Hill Book Company
2	Fundamentals of Structural Stability	Simitses, G.J. and Hodges, D.H.	2006	Butterworth & Heinemann
3	Stability Analysis and Design of Structures	Gambhir, M.L	2009	Springer
VI(b): Reference Books: (Insert or delete rows as per requirement)				
1	Advanced Mechanics of Solids	Srinath, L.S.	2017	Tata McGraw-Hill Publishing Co
2	Computational Structural Mechanic	Rajashekaran. S	2001	Prentice-Hall
VI(c): Web links and Video Lectures (e-Resources):				
https://archive.nptel.ac.in/courses/105/105/105105217/ https://onlinecourses.nptel.ac.in/noc22_ce91/preview http://www.infocobuild.com/education/audio-video-courses/architectural-and-civil-engineering/FEM-for-StructuralDynamic-IISc-Bangalore/lecture-02.html				
VII: Activity Based Learning / Practical Based Learning/Experiential learning:				
• Conduction of technical seminars on recent research activities • Group Discussion				

Semester:	II	**Course Type:**	PEC		
Course Title: ADVANCED DESIGN OF STEEL STRUCTURES					
Course Code:	23CCSP211			**Credits:**	03
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

This course will enable students to

- Carry out the designs of steel structures made from hot-rolled and cold-formed structural steel.
- Become Proficient in applying the code provisions for design of columns, beams, beam-columns junctions, etc.

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1:	8 hrs

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-symmetricandnon-uniformbeams–DesignExamples.Conceptsof-ShearCenter, Warping, Uniform and Non-Uniform torsion.

RBT Levels: L1, L2, L3 L4, L5

Module-2:	8 hrs

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.

RBT Levels: L1, L2, L3 L4, L5

Module-3:	8 hrs

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)

RBT Levels: L1, L2, L3 L4, L5

Module-4:	8 hrs

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.

RBT Levels: L1 L2 L3

Module-5:	8 hrs

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.

RBT Levels: L1 L2 L3

IV. COURSE OUTCOMES

CO1	Analyse the laterally unrestrained beams as per Codal provisions.
CO2	Carry out designs of steel columns and beam-column joints in frames.
CO3	Design castellated beams for given sectional properties.
CO4	Design of beams and columns made up of cold formed steel sections.
CO5	Learn different aspects of fire resistance in steel structures.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3											3			
CO2	3	3											3			
CO3	3	3											3			
CO4	3	3											3			
CO5	3	3											3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VI (a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Design of Steel Structures	N. Subramanian	2008	Oxford, IBH
2	Design of Steel Structures	Duggal, S. K	2000.	Tata McGraw-Hill
3	IS 800: 2007, IS 801-2010, IS 811-1987			
4	BS 5950 Part- 8, SP 6 (5)-1980			

VI(b): Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=qJV5zdx7NJs
- https://www.youtube.com/watch?v=5eZneS83pBg&list=PLyqSpQzTE6M_nweVk5N8okOAVl0BNPUXX
- INSDAG Teaching Resource Chapter 11 to 20: www.steel-insdag.org

VII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Conduction of technical seminars on recent research activities
- Group Discussion

Semester:	II	**Course Type:**	PEC		
Course Title: DESIGN OF BRIDGES					
Course Code:	23CCSP212			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

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

II. Teaching-Learning Process:

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: 8hrs

Introduction & Design of Slab Culvert: Bridge Engineering and its development in past, Ideal site selection for Bridges, Bridge classifications, Forces acting on Bridge. Analysis for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of slab culvert using limit state method with reinforcement details.
RBT Levels: L1, L2, L3.

Module-2: 8hrs

Box Culvert: Introduction to box culvert, advantage of structural continuity, Analysis for maximum BM and SF at critical sections using moment distribution method for various load combinations such as Dead, Surcharge, Soil, Water and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of box culvert using limit state method with reinforcement details.
RBT Levels: L1, L2, L3.

Module-3: 8hrs

T Beam Bridge: Components of T Beam Bridge, Load transfer mechanism, Proportioning the of Components, Analysis of Slab using Pigeauds Method for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of Slab using limit state method with reinforcement details. Analysis of Cross Girder for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of slab using limit state method with reinforcement details. Analysis

of Main Girder using Courbon's Method for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of Main Girder using limit state method with reinforcement details.

RBT Levels: L1, L2, L3.

Module-4:	8hrs

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

RBT Levels: L1, L2, L3.

Module-5:	8hrs

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

RBT Levels: L1, L2, L3.

IV. COURSE OUTCOMES

CO1	Describe historical growth, select ideal site and bridge, calculate values of design parameters of slab culvert at critical section as per IRC, design and detailing required for the execution of the project
CO2	Carry out analysis of box culvert as per IRC to obtain the values of design parameters and to design and detail the components following IS code procedure.
CO3	Demonstrate the use of Pigeauds Method and Courbon's Method in the analysis of T beam bridge as per IRC, design to obtain the safe dimensions various components, optimum reinforcement required following IS code procedure.
CO4	Display the use of Courbon's Method in the analysis of PSC bridge as per IRC, design to obtain the safe value of prestressing force, obtain the dimensions of various components to keep the stresses within codal provisions following IS code procedure
CO5	Analysis a balanced cantilever bridge as per IRC and to obtain the safe values of design parameters and to design and detail the components as per IS code procedure

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3			3			3					3			
CO2	3	3			3			3					3			
CO3	3	3			3			3					3			
CO4	3	3			3			3					3			
CO5	3	3			3			3					3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Essentials of Bridge Engineering	Dr D Johnson Victor	2019	Oxford & IBH Publishing Co New Delhi

2	Design of Bridges	Dr N Krishna Raju	**2019**	Oxford & IBH Publishing Co New Delhi
3	Principles and Practice of Bridge Engineering	S P Bindra	**2012**	Dhanpat Rai & Sons New Delhi

VII(c): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=RB2k5hSYO3U&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28
https://www.youtube.com/watch?v=5k8vdDSK6jU&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28&index=2
https://www.youtube.com/watch?v=pWecDpoJd9E&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28&index=3
https://www.youtube.com/watch?v=U4a0q4hYUWw&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28&index=4
https://www.youtube.com/watch?v=rAH6eP1G4N0&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28&index=5
https://www.youtube.com/watch?v=zIfrR2J154w&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28&index=7
https://www.youtube.com/watch?v=SCWNDk2Sfk0&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28&index=8

VIII : Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of technical seminars on recent research activities
Group Discussion
Site visit

Semester:	II	**Course Type:**	PEC		
Course Title: Advanced Design of RC Structural Elements					
Course Code:	23CCSP213			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:2:0	**Total Hours:**	60
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3hrs

I. Course Objectives:

This course will enable students to analyse the behaviour of elements subjected to shear and torsion. And concept of redistribution of moments in design.

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: 8 hrs

Introduction:

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

Lab Experiment: Excel programming to compute Concrete Mix Design, Excel programming to compute singly and doubly reinforced beam

RBT Levels: L1 L2 L3

Module-2: 8 hrs

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

Lab Experiment: Excel programming to compute continuous beam

RBT Levels: L1 L2 L3

Module-3: 8 hrs

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

Lab Experiment: Excel programming to compute Deep beams

RBT Levels: L1 L2 L3

Module-4:	8 hrs

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, Moment Interaction equation, Interaction surface for a biaxial loaded column, concept of equilibrium approach and application to nonrectangular columns. Slender Column: Braced and Unbraced, Design examples

Lab Experiment: Excel programming to compute Short columns, Excel programming to compute slender column

RBT Levels: L1 L2 L3

Module-5:	8 hrs

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

Lab Experiment : Excel programming to compute simple Flat Slab

RBT Levels: L1 L2 L3

IV. COURSE OUTCOMES

CO1	Analyse the behaviour of RC beams.
CO2	Apply redistribution of moments in the analysis of RC beams
CO3	Analyse and design RC deep beams
CO4	Design compression members.
CO5	Design flat slabs

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2	2	2				2	3				1	2			
CO2	2	2	2				2	3				1	2			
CO3	2	2	2					3				1	2			
CO4	2	2	2					3				1	2			
CO5	2	2	2					3				1				

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII (a): Reference Books:

1	Krishna Raju	Advanced R.C. Design	1986	CBS Publishers and Distributors
2	S. Pillai, Devdas Menon	Reinforced Concrete Design	1999	Tata McGraw-Hill, 3rd Edition
3	Varghese. P.C	Advanced Reinforced Concrete design	2007	Prentice, Hall of India
4	Gambhir M. L	Design of Reinforced Concrete Structures	2008	, PHI Pvt. Ltd. New Delhi

VII(b): Web links and Video Lectures (e-Resources):
https://onlinecourses.nptel.ac.in/noc23_ce109/preview https://onlinecourses.nptel.ac.in/noc22_ce65/preview https://archive.nptel.ac.in/courses/105/105/105105105/ https://www.youtube.com/watch?v=undsd92MM8w http://www.digimat.in/nptel/courses/video/105105105/L10.html
VIII : Activity Based Learning / Practical Based Learning/Experiential learning:
Conduction of technical seminars on recent research activities Group Discussion Site visit

Semester:	II	**Course Type:**	PEC		
Course Title: Design of Offshore Structures					
Course Code:	23CCSP214			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To explain the different types of loads acting on offshore structures
- To design steel tubular members against static and cyclic loads
- To design offshore structural elements against Accidental loads

II. Teaching-Learning Process:

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: Loads on Offshore Structures — 8 Hrs

Wind Loads; Wave and Current Loads; Calculation based on Maximum base Shear and Overturning Moments; Design Wave heights and Spectral Definition; Hydrodynamic Coefficients and Marine growth; Fatigue Load Definition and Joint Probability distribution; Seismic Loads.
Concepts of Fixed Platform Jacket and Deck:
Jacket concepts, redundant framing arrangement; Launch and Lift jackets; Simple Deck configurations for Lift and float-over installations; In-service and Pre-service Loads and analysis.

RBT Levels: L2

Module-2: Steel Tubular Member Design — 8 Hrs

Principles of WSD and LRFD; Allowable stresses and Partial Safety Factors; Tubular Members, Slenderness effects; Column Buckling, Design for Hydrostatic pressure; Design for combined axial and bending stresses (API RP 2A guidelines).

RBT Levels: L3

Module-3: Tubular Joint Design for Static and Cyclic Loads — 8 Hrs

Simple tubular joints, design using allowable loads; stress concentration factors; S-N curves and fatigue damage calculations.

Self-study problems

RBT Levels: L3

Module-4: Submarine Pipelines and Risers	8 Hrs
Route selection and Diameter / wall thickness calculations; Pipeline stability, free span calculations; Concrete coated pipelines and pipe-in-pipe insulated pipelines; Design using DNV 81 code.	
RBT Levels: L3	
Module-5: Design against Accidental Loads (Fire, Blast and Collision)	8 Hrs
Behaviour of steel at elevated temperature; Fire Rating for Hydrocarbon fire; Design of structures for high temperature; Blast Mitigation-Blast walls; Collision of Boats and energy absorption; Platform survival capacity and Plastic design methods. Self-study problems	
RBT Levels: L3	

IV. COURSE OUTCOMES

CO1	Explain the different types of load on offshore structures.
CO2	Obtain Steel Tubular Member size for the given loading condition
CO3	Design Tubular Joint for Static and Cyclic Loads
CO4	Propose design configuration for Submarine Pipelines and Risers
CO5	Analyse and design offshore structural elements against Fire, Blast and Collision

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3							3					3			
CO2	3	3						3					3			
CO3	3	3						3					3			
CO4	3	3						3					3			
CO5	3	3						3					3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII (a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Hydrodynamics of Offshore Structures	S. K. Chakrabarti	2010	Springer Verlag
2	Handbook of Offshore Engineering	S.K. Chakrabarti	2005	Elseviers
3	Offshore pipelines	B. Gou, S. Song, J. Chacko and A. Ghalambor	2006	GPP Publishers
4	Structural Stability - Theory and Implementation	W. F. Chen and E.M.Lui	1999	Elsevier

VII(b): Web links and Video Lectures (e-Resources):
https://archive.nptel.ac.in/courses/114/106/114106011/ https://archive.nptel.ac.in/courses/114/106/114106035/
VIII: Activity Based Learning / Practical Based Learning/Experiential learning:
• Conduction of technical seminars on recent research activities • Group Discussion • Site visit

Semester:	II	**Course Type:**	PEC		
Course Title: STRUCTURAL OPTIMIZATION					
Course Code:	23CCSP221			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3hrs

I. Course Objectives:

Learn the need and concepts of design optimization.
Implement optimization concepts in structural engineering problems.
Evaluate different methods of optimization.

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1:	**8 hrs**

Introduction to optimization: Engineering applications of optimization, Formulation of structural optimization problems as programming problems. Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.

RBT Levels: L1 L2 L3

Module-2:	**8 hrs**

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

RBT Levels: L1 L2 L3

Module-3:	**8 hrs**

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

RBT Levels: L1 L2 L3

Module-4:	**8 hrs**

Constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems. Formulation and solution of structural optimization problems by different technique

RBT Levels: L1 L2 L3

Module-5:	**8 hrs**

Geometric programming & Dynamic programming: conversion of NLP as a sequence of LP / geometric programming. Dynamic programming: Dynamic programming conversion of NLP as a sequence of LP/ Dynamic programming**.**

RBT Levels: L1 L2 L3

IV. COURSE OUTCOMES

CO1	Formulate structural optimization problems.
CO2	Carry out linear programming by solving a system of linear simultaneous equations.
CO3	Apply different non-linear programming methods
CO4	Apply constrained optimization techniques for structural engineering problems.
CO5	Undertake geometric and dynamic programming techniques to structural engg. problems.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2	2	2										2			
CO2	2	2	2										2			
CO3	2	2	2										2			
CO4	2	2	2										2			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII (a) Reference Books:

1	Optimum Structural Design	Spunt L	1971	Prentice Hall
2	Optimization – Theory and Practice	Rao S. S.	1978	Wiley Eastern Ltd
3	Optimum Structural Design,	Uri Kirsch	1981	McGraw Hill, New York
4	Operation Research	Bronson R. and, Govind sami N	2017	Schaum's Outline Series
5	Structural optimization using sequential linear programming	Bhavikatti S. S	2003	Vikas publishing

VII(b): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=wEdZLKMMZ8o&list=PLwdnzlV3ogoXKKb9nABDWYltTDgi37lYD
https://www.youtube.com/watch?v=GMTvoKRfxQw&list=PLGbjwqYC00hsy6XGalOBAphm2tdeLbgK0
https://www.youtube.com/watch?v=fszNBvdfKrY

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of technical seminars on recent research activities
Group Discussion

Semester:	II	**Course Type:**	PEC		
Course Title: Mechanics of Composites					
Course Code:	23CCSP222			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To compute the mechanical properties of fiber reinforced composites by knowing the properties of constituent materials.
- To analyse and design composite laminates with different configuration.

II. Teaching-Learning Process :

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: Introduction to Composite Materials	8 Hrs

Introduction to composite materials: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites. Constituents of composite materials: Reinforcements, Matrix, Coupling agents, coatings & fillers.
Reinforcements: Introduction, Glass Fibers, Boron Fibers, Carbon Fibers, Organic Fibers, Ceramic Fibers, Whiskers, Other Non-oxide Reinforcements, Comparison of Fibers
Matrix Materials: Polymers, Metals and Ceramic Matrix Materials.

RBT Levels: L2

Module-2: Macromechanical Analysis of a Lamina	8 Hrs

Hooke's Law for Different Types of Materials: Anisotropic Material, Monoclinic Material, Orthotropic Material (Orthogonally Anisotropic)/Specially Orthotropic, Transversely Isotropic Material, Isotropic Material, Hooke's Law for a Two-Dimensional Unidirectional Lamina: Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina, Hooke's Law for a Two-Dimensional Angle Lamina, Engineering Constants of an Angle Lamina, Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina,

RBT Levels: L3

Module-3: Micromechanical Analysis of a Lamina	8 Hrs

Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi-Empirical Models, Elasticity Approach, Ultimate Strengths of a Unidirectional Lamina, Longitudinal Tensile Strength, Longitudinal Compressive Strength, Transverse

Tensile Strength, Transverse Compressive Strength, In-Plane Shear Strength, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion. Numerical examples

Self-study problems

RBT Levels: L3

Module-4: Macromechanical Analysis of Laminates	8 Hrs

Macromechanical Analysis of Laminates, Laminate Code, Stress-Strain Relations for a Laminate: One-Dimensional Isotropic Beam Stress-Strain Relation, Strain-Displacement Equations, Strain and Stress in a Laminate, Force and Moment Resultants Related to Midplane Strains and Curvatures, In-Plane and Flexural Modulus of a Laminate, In-Plane Engineering Constants of a Laminate, Flexural Engineering Constants of a Laminate, Hygrothermal Effects in a Laminate, Hygrothermal Stresses and Strains, Coefficients of Thermal and Moisture Expansion of Laminates, Warpage of Laminates. Numerical examples.

RBT Levels: L3

Module-5: Failure, Analysis, and Design of Laminates	8 Hrs

Special Cases of Laminates: Symmetric Laminates, Cross-Ply Laminates, Angle Ply Laminates, Antisymmetric Laminates, Balanced Laminate, Quasi-Isotropic Laminates. Failure Criterion for a Laminate.
Design of a Laminated Composite, Design of a Laminated Composite, Sandwich Composites: Long-Term Environmental Effects, Interlaminar Stresses, Impact Resistance, Fracture Resistance, Fatigue Resistance.

RBT Levels: L3

IV. COURSE OUTCOMES

CO1	Explain the classification of composite materials
CO2	Compute the mechanical properties of composite lamina
CO3	Obtain the strength of an arbitrarily oriented lamina.
CO4	Calculate the stresses and strains in a laminate
CO5	Analyse and design laminates configuration for the given load

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3												3			
CO2	3	3											3			
CO3	3	3											3			
CO4	3	3											3			
CO5	3	3											3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII(a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher

1	Mechanics of composite materials	Robert M. Jones	2, 1999	Taylor & Francis
2	Mechanics of Composite Materials	Autar K. Kaw	2, 2006	CRC Press
3	Engineering Mechanics of Composite Materials	Isaac M. Daniel, Ori Ishai	3, 2007	Oxford University Press
4	Mechanics of Composite Materials and Structures	Madhujit Mukhopadhyay	2, 2005	Universities Press,India
5	Composite Science and Engineering	`K. K. Chawla	3, 2012	Springer Verlag

VII(b): Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/112/103/112103308/#
https://archive.nptel.ac.in/courses/112/104/112104229/
https://onlinecourses.nptel.ac.in/noc22_me40/preview
https://onlinecourses.nptel.ac.in/noc23_me139/preview

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Conduction of technical seminars on recent research activities
- Group Discussion
- Site visit

Semester:	II	**Course Type:**	PEC		
Course Title: Structural Health Monitoring					
Course Code:	**23CCSP223**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- Study fundamentals of structural health monitoring.
- Study various vibration-based techniques for structural health monitoring.
- Use fibre-optic methods for monitoring of structural health.
- Adopt electrical resistance and Capacitive Methods for structural health monitoring.

II. Teaching-Learning Process :

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: Introduction to Structural Health Monitoring	8 Hrs

Introduction to Structural Health Monitoring Definition of structural health monitoring (SHM), Motivation for SHM, SHM as a way of making materials and structures smart, SHM and biomimetics, Process and pre-usage monitoring as a part of SHM, SHM as a part of system management, Passive and active SHM, NDE, SHM and NDECS, Variety and multi disciplinarity: the most remarkable characters of SHM, Birth of the SHM Community.

RBT Levels: L2

Module-2: Vibration-Based Techniques for Structural Health Monitoring	8 Hrs

Basic vibration concepts for SHM, Mathematical description of structural systems with damage, Linking experimental and analytical data, Damage localization and quantification, Solution of the equation system, Neural network approach to SHM, A simulation example, Time-domain damage detection methods for linear systems, Damage identification in non-linear systems, Applications.

RBT Levels: L2

Module-3: Fiber-Optic Sensors	8 Hrs

Classification of fiber-optic sensors, The fiber Bragg grating as a strain and temperature sensor, Structures with embedded fiber Bragg gratings, Fiber Bragg gratings as damage sensors for composites, Examples of applications in aeronautics and civil engineering

RBT Levels: L2

Module-4: Structural Health Monitoring with Piezoelectric Sensors	8 Hrs
The use of embedded sensors as acoustic emission (AE) detectors, State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research, Electromechanical impedance,	
RBT Levels: L2	
Module-5: Electrical Resistance and Capacitive Methods	8 Hrs
Composite damage, Electrical resistance of unloaded composite, Composite strain and damage monitoring by electrical resistance, Damage localization. Capacitance probe for cover concrete, Application for external post-tensioned cables	
RBT Levels: L2	

IV. COURSE OUTCOMES

CO1	Emphasize the importance of structural health monitoring as part of system management
CO2	Adopt vibration-based techniques for health monitoring of a few structural elements and components
CO3	Use fibre-optic and other types of sensors for estimating damage in a structural element
CO4	Characterise the defect or damage in a structural element using piezo-electric sensors or acoustic emission methods
CO5	Apply general principles of structural health monitoring using Electrical Resistance and Capacitive Methods

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3												3			
CO2	3	3											3			
CO3	3	3											3			
CO4	3	3											3			
CO5	3	3											3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VI(a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Structural Health Monitoring	Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes	1, 2006	Wiley ISTE
2	Continuum Mechanics Fundamentals	Health monitoring of structural materials and components-Methods with Applications	1, 2007	John Wiley and Sons
3	Structural Health Monitoring and Intelligent Infrastructure	J. P. Ou, H. Li and Z. D. Duan	1, 2006	Taylor and Francis Group

4	Structural Health Monitoring with Wafer Active sensors, smart materials and structures	Victor Giurglutiu	1, 2007	Gandhi and Thomson
5	Structural Health Monitoring: current status and perspective	Fu Kuo Chang	1, 1997	CRC Press, Inc.

VI(b): Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/114/106/114106046/
https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-oe05/
https://nptel.ac.in/courses/112104160

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Conduction of technical seminars on recent research activities
- Group Discussion
- Site visit

Semester:	II	**Course Type:**	**PEC**		
Course Title: RELIABILITY ANALYSIS OF STRUCTURES					
Course Code:	23CCSP224			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3hrs

I. Course Objectives:

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

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1:	8 hrs

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

RBT Levels: L1 L2 L3

Module-2:	8 hrs

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

RBT Levels: L1 L2 L3

Module-3:	**8 hrs**

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

RBT Levels: L1 L2 L3

Module-4:	**8 hrs**

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

RBT Levels: L1 L2 L3

Module-5:	**8 hrs**

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

RBT Levels: L1 L2 L3

IV. COURSE OUTCOMES

CO1	Understand the concepts of statistics for probabilistic analysis and importance of uncertainty in structural analysis and design.
CO2	Apply the theoretical principles of randomness of variables in structural engineering through density functions.
CO3	Analyze components of structure to assess safety using concepts related to structural reliability by various methods
CO4	Evaluate the safety reliability index at system level.

V. CO-PO-PSO MAPPING

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2	2	2										2			
CO2	2	2	2										2			
CO3	2	2	2										2			
CO4	2	2	2										2			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII (a) Reference Books:

1	Structural Reliability Analysis and design	Ranganathan R	1999	Jaico publishing house
2	Reliability based Analysis and Design for Civil Engineers	Devaraj & Ravindra. R	2017	I.K. International
3	Probability concepts in engineering planning and design, Volume –I, II	Ang, A. H. S., and Tang, W. H.	1984	John Wiley and sons, Inc, New York.
4	Reliability based design in civil engineering.	Milton, E. Harr	1987	Mc Graw Hill education Pvt. Ltd
5	Statistics, "Probability and reliability for Civil and	Nathabandu, T., Kottegoda, and Renzo Rosso	1998	Mc Graw Hill international edition, Singapore

	Environmental Engineers			

VII(b): Web links and Video Lectures (e-Resources):

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

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

- Conduction of technical seminars on recent research activities
- Group Discussion
- Site visit

Semester:	II	**Course Type:**	**PCCL**		
Course Title: Cad Lab – FE Modelling and Analysis					
Course Code:	23CCSL26			**Credits:**	02
Teaching Hours/Week (L:T:P:O)			1:0:2:0	**Total Hours:**	Lab sessions
CIE Marks:	**50**	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Practical			**Exam Hours:**	03

I. Course Objectives:

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

II. Teaching-Learning Process (General Instructions): Chalk and talk, videos, Power Point presentation, animations

III(b). PRACTICAL PART

Sl. No.	Experiments / Programs / Problems
1	FE Analysis of Plane Stress and Plane Strain Problems
2	Flexural Behaviour of Slab Panels with different aspect ratio and boundary conditions
3	FE Analysis of Slab panel resting on column supports- Drop Panels, Capitals
4	FE Analysis of Slab on Grade (Raft), Underpass, Bridge Structures
5	FE Analysis of Framed structures due to Seismic forces using modal superposition method
6	Program Development for design of structural steel elements, using any programming (Tension member, Compression member and bending)

III. COURSE OUTCOMES

CO1	Carry out FE analysis of Plane Stress and Plane Strain Problems
CO2	Analyse and interpret Flexural Behaviour of Slab Panels.
CO3	Conduct FE analysis of structural elements like slab panels, drop panels and capitals.
CO4	Analyse Slab on Raft, Underpass and Bridge etc using FE method.
CO5	Carry out dynamic analysis using mode superposition method
CO6	Develop programs for the analysis structural steel elements in tension, compression and bending.

IV. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)																
PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3		3	3								3			
CO2	3	3		3	3								3			
CO3	3	3		3	3								3			
CO4	3	3		3	3								3			
CO5	3	3		3	3								3			
CO6	3	3		3	3								3			

V. Assessment Details (CIE & SEE)
General Rules: Refer Annexure section 3
Continuous Internal Evaluation (CIE): Refer Annexure section 3
Semester End Examination (SEE): Refer Annexure section 3

VI. References
1.Krishna Raju. N., "Advanced Reinforced Concrete Design", CBS Publishers & Distributors
2. Pillai S. U. and Menon D., "Reinforced Concrete Design", Tata McGraw-Hill,3rd Ed, 1999
3.Relevant IS Code Books
4. Shah.H.J, "Reinforced Concrete", Vol-1 and Vol-2, Charotar, 8th Edition –2009 and 6th Edition – 2012 respectively.

Semester:	III	**Course Type:**	**PCC**		
Course Title: ADVANCED STRUCTURAL ANALYSIS					
Course Code:	23CCST31			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3hrs

I. Course Objectives:

Analysis of curved beams, Beams on elastic foundation, shear centre and unsymmetrical bending and buckling of non-prismatic columns and beam columns.

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: **8 hrs**

Curved Beams: Curved beams, Introduction, assumptions, derivation of Winkler Bach equation, Radius to the neutral surface of simple geometric figures, Limitation, Stress distribution in open curved members such as Hooks and chain links, Stress distribution in closed rings and chain links. Deformations of open and closed rings.

RBT Levels: L1 L2 L3

Module-2: **8 hrs**

Beams on Elastic Foundations: Governing differential equation for elastic line, Interpretation of constants, Infinite beam with point load, moment & UDL with problems. Semi- infinite beams with point load and moment UDL with problems over fixed and hinged support conditions.

RBT Levels: L1 L2 L3

Module-3: **8 hrs**

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

RBT Levels: L1 L2 L3

Module-4: **8 hrs**

Unsymmetrical Bending: Theory behind unsymmetrical bending, Assumptions, obtaining the stresses in beams, simply supported and cantilever unsymmetrical beams subjected to inclined loading, Deflections of unsymmetrical simply supported and cantilever beams with numerical problems.

RBT Levels: L1 L2 L3

Module-5: **8 hrs**

Buckling of Non Prismatic Columns and Beam-Column: Principle behind Euler's theory of buckling, Governing differential equation applied to buckling of columns and evaluation of constants for various boundary conditions, Obtaining the characteristic equation for the buckling load of non-prismatic compound columns, Analysis of Beam- column, conceptual theory of magnification stresses and deformations subjected to axial and different types of lateral loads with numerical problems..

RBT Levels: L1 L2 L3

IV. COURSE OUTCOMES

CO1	Apply Winkler Bach and Strain Energy principles to obtain stresses and deformation in curved members.
CO2	Derive the expressions to Foundation pressure, Deflection, Slope, BM and SF of infinite and semi-infinite Beams resting on Elastic Foundation.
CO3	Obtain the equations for the shear centre for symmetrical and unsymmetrical from fundamentals.
CO4	Extrapolate the bending theory to calculate the stresses and deformations in unsymmetrical bending
CO5	Develop the characteristic equation for the buckling load of compound column and stresses and deformations in beam-column.

V. CO-PO-PSO MAPPING

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2	2	2										2			
CO2	2	2	2										2			
CO3	2	2	2										2			
CO4	2	2	2										2			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII.(a): Reference Books:

1	Advanced mechanics of solids and structures	Krishna Raju N & Gururaj D R	1998	NAROSA Publishers Company Delhi.
2	Advanced Mechanics of Solids", Tenth Print, ,.	Srinath L. S	1992	Tata McGraw Hill publishing company. New Delhi
3	Optimum Structural Design	Uri Kirsch	1994	McGraw Hill, New York
4	Advanced theory of structures and Matrix Method	Vazirani V N and Ratwani M M	1995	Khanna publishers
5	Indeterminate Structural Analysis	Sterling Kinney	1996	Oxford & IBH publishers

VII.(b): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=s4CN6aVKhPo&list=PLEE5D02698EAAF2C0

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of technical seminars on recent research activities
Group Discussion
Site visit

Semester:	III	**Course Type:**	PEC		
Course Title: DESIGN CONCEPTS OF SUBSTRUCTURES					
Course Code:	23CCSP331			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3hrs

I. Course Objectives:

The objective of this course is to make students to learn principles of subsoil exploration, To design the sub structures. To evaluate the soil shear strength parameters. .

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: **8 hrs**

Introduction, Site investigation, Insitu testing of soils, Subsoil exploration, Classification of foundations systems. General requirement of foundations, Selection of foundations, Computations of Loads, Design concepts.

RBT Levels: L1 L2 L3

Module-2: **8 hrs**

Concept of soil shear strength parameters Settlement Analysis of footings, Shallow foundations in clay, Shallow foundation in sand & C Φ soils, Footings on layered soils and sloping ground, Design for Eccentric or Moment Loads.

RBT Levels: L1 L2 L3

Module-3: **8 hrs**

Types of rafts, bearing capacity & settlements of raft foundation, Rigid methods, Flexible methods, soil structure interaction, different methods of modeling the soil. Combined footings (rectangular & trapezoidal), strap footings & wall footings, Raft – super structure interaction effects & general concepts of structural design, Basement slabs

RBT Levels: L1 L2 L3

Module-4: **8 hrs**

Deep Foundations: Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different types of piles in different soil conditions, laterally loaded piles, tension piles & batter piles, Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles, Proportioning and design concepts of piles.

RBT Levels: L1 L2 L3

Module-5:	**8 hrs**
Types of caissons, Analysis of well foundations, Design principles, well construction and sinking. Foundations for tower structures: Introduction, Forces on tower foundations, Selection of foundation type, Stability and design considerations, Ring foundations – general concepts. **RBT Levels: L1 L2 L3**	

IV. COURSE OUTCOMES

CO1	Achieve Knowledge of site investigation and design concepts of foundation.
CO2	Understand the concepts of Settlement analysis.
CO3	Design various types of shallow foundation
CO4	Design pile foundation
CO5	Understand design concept of caisson, tower foundation and ring foundation.

V. CO-PO-PSO MAPPING

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2	2	2										2			
CO2	2	2	2										2			
CO3	2	2	2										2			
CO4	2	2	2										2			
CO5	2	2	2										2			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII (a): Reference Books:

1	Analysis & Design of Substructures	Swami Saran	1998	Oxford & IBH Pub. Co. Pvt. Ltd.
2	Design of Foundation Systems	Nainan P Kurian	1992	Narosa Publishing House
3	Optimum Structural Design	Uri Kirsch	1981	McGraw Hill, New York
4	Foundation Engineering	R.B. Peck, W.E. Hanson & T.H. Thorburn	1984	Wiley Eastern Ltd
5	Foundation Analysis and Design	J.E. Bowles	1996	McGraw-Hill Int. Editions

VII(b): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=lsYFtwwlHIw&list=PLbRMhDVUMngeiZjKPTPEFl1CByXmYX3Kv

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of technical seminars on recent research activities
Group Discussion
Site visit

Semester:	III	**Course Type:**	PEC		
Course Title: Advanced Design of Prestressed Concrete Structures					
Course Code:	23CCSP332			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3-0-0-0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- Develop an advanced system of prestressed concrete members.
- Analyze and design the statically determinate prestressed concrete members.
- Demonstrate the stresses with anchorage system in prestressed concrete members.

II. Teaching-Learning Process:

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1:	8 Hrs

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 l-beam - Design of shear reinforcement - Indian code provisions, Importance of modulus of elasticity of Prestressing tendons, failures of prestressed concrete.

RBT Levels: L2

Module-2:	8 Hrs

Shear and Torsional resistance- ultimate shear resistance- Design of shear reinforcement in torsion.

RBT Levels: L3

Module-3:	8 Hrs

Transfer of Prestress in Pretensioned Members: Transmission of prestressing force by bond Transmission length, Flexural bond stresses - lS code provisions - Anchorage zone stresses in post tensioned members - stress distribution in End block - Analysis by approximate, Guyon and Magnel methods -Anchorage zone reinforcement.

RBT Levels: L3

Module-4:	8 Hrs

Transfer of Prestress in Pretensioned Members: Transmission of prestressing force by bond Transmission length, Flexural bond stresses - lS code provisions - Anchorage zone stresses in

post tensioned members - stress distribution in End block - Analysis by approximate, Guyon and Magnel methods -Anchorage zone reinforcement.

RBT Levels: L3

Module-5:	8 Hrs

Statically indeterminate Structures: Advantages & disadvantages of continuous Prestressed beams - Primary and secondary moments - P and C lines - Linear transformation concordant and non- concordant cable profiles -Analysis of continuous beams and simple portal frames (single bay and single story)

RBT Levels: L3

IV. COURSE OUTCOMES

CO1	Identify various prestressed structural elements.
CO2	Apply analytical skills to evaluate performance of prestressed structural elements
CO3	Analyse prestressed structural elements with various considerations.
CO4	Design and detail prestressed structural elements for various loading conditions.

V. CO-PO-PSO MAPPING

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3												3			
CO2	3	3											3			
CO3	3	3	3										3			
CO4	3	3											3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII.(a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Prestressed Concrete	N Krishnaraju	2, 1999	Tata McGraw-Hill Education
2	Prestressed Concrete structures	LinT. Y and H. Burns	2, 2008	WileyPublication
3	Prestressed Concrete	N. Rajagopalan	3, 2005	Narosa Publishing House
4	Design of Prestressed Concrete	A. Nilson	2, 2005	John Willey & Sons

VII(b): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=PcZpOexe5hI
https://archive.nptel.ac.in/courses/105/106/105106118/

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of technical seminars on recent research activities
Group Discussion
Site visit

Recognized by UGC, New Delhi with 2(f) & 12 (B)

M. Tech. In CAD Structures

Semester:	III	**Course Type:**	**PEC**		
Course Title: DESIGN OF INDUSTRIAL STRUCTURES					
Course Code:	23CCSP333			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3hrs

I. Course Objectives:

To learn principles of Design of industrial building,
To design different components of industrial structures and to detail the structures.
To evaluate the performance of the Pre-engineered buildings

II. Teaching-Learning Process (General Instructions):

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1:	8 hrs

Analysis of industrial building for Gravity and Wind load. Analysis and design of framing components namely, girders, trusses, gable frames

RBT Levels: L2 L3 L4

Module-2:	8 hrs

Analysis and design of gantry column (stepped column / column with bracket), purlins, girts, bracings including all connections.

RBT Levels: L2 L3 L4

Module-3:	8 hrs

Analysis of transmission line towers for wind load and design of towers including all connections.

RBT Levels: L2 L3 L4

Module-4:	8 hrs

Forms of light gauge sections, Effective width computation of unstiffened, stiffened, multiple stiffened compression elements of cold formed light gauge sections. Concept of local buckling of thin elements. Limiting width to thickness ratio. Post buckling strength.

RBT Levels: L2 L3 L4

Module-5:	8 hrs

Concept of Pre- engineered buildings, Design of compression and tension members of cold formed light gauge sections, Design of flexural members (Laterally restrained / laterally unrestrained).

RBT Levels: L1 L2 L3

IV. COURSE OUTCOMES

CO1	Achieve Knowledge of design and development of problem-solving skills.
CO2	design of gantry column

CO3	Analysis of transmission line towers and light gauge sections
CO4	Understands the concept of pre-engineered buildings.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	2	2	2					2					2			
CO2	2	2	2					2					2			
CO3	2	2	2					2					2			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII.(a): Reference Books:

1	Design of Steel Structures	N Subramanian	1999	oxford University Press
2	Design of Steel Structures	B.C. Punmia, A.K. Jain	2017	Laxmi Publications
3	Design of Steel Structures " Vol 1 and Vol.2,	Ramchandra and Virendra Gehlot.	1984	Scientific Publishers
4	Limit State Design of Steel Structures	Duggal	1987	TMH
5	IS800-2007, IS875-1987, IS-801-1975. Steel Tables, SP 6(1)	-	-	BIS

VII.(b): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=qJV5zdx7NJs
https://www.youtube.com/watch?v=5nLJHnCUMRI

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of technical seminars on recent research activities
Group Discussion
Site visit

Semester:	**III**	**Course Type:**	**PEC**		
Course Title: Design of Precast & Composite Structures					
Course Code:	23CCSP334			**Credits:**	3
Teaching Hours/Week (L: T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

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

II. Teaching-Learning Process:

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1:	8 hrs

Introduction: 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.

RBT Levels: L1, L2

Module-2:	8 hrs

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

RBT Levels: L3, L4

Module-3:	8 hrs

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.

RBT Levels: L3, L4

Module-4:	8 hrs
Design of Precast Connections and Structural Integrity Beam bearing, Beam half Joint, Steel Inserts, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties. **RBT Levels: L3, L4**	
Module-5:	8 hrs
Design of Steel Concrete Composite Floors and Beams Composite Floors: Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, Design Example **Composite Beams:** Elastic Behaviour, Ultimate Load behaviour of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams. **RBT Levels: L3, L4**	

IV. COURSE OUTCOMES

CO1	Explain the need for precast elements in building construction.
CO2	Design precast reinforced and prestressed concrete beams for different conditions.
CO3	Design precast concrete columns and walls.
CO4	Analyse and design composite floors and beams

V. CO-PO-PSO MAPPING

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3						3					3			
CO2	3	3						3					3			
CO3	3	3						3					3			
CO4	3	3						3					3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII.(a): Reference Books:

1	Precast Concrete – Design and applications	Hass A.M.	1983	Applied Science
2	Plant cast, Precast and Prestressed concrete	David Sheppard	1989	McGraw Hill
3	Composite Structure of Steel and Concrete (Volume 1)	R.P. Johnson	1994	Blackwell Scientific Publication (Second Edition)
4	NBC – 2005 (Part I to Part VII)		IS 15916- 2011, IS 11447, IS6061 – I and III	BIS Publications

VII.(b): Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc20_ar04/preview.
https://www.youtube.com/watch?v=fRqxXkxApSY.

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of technical seminars on recent research activities
Group Discussion
Site visit

M. Tech. In CAD Structures

Semester:	III	**Course Type:**	PEC		
Course Title: Admixtures and Special Concretes					
Course Code:	**23CCSP341**			**Credits:**	3
Teaching Hours/Week (L: T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- Understand the materials science of concrete
- Develop an ability to link the behaviour of concrete with the fundamental interactions between the ingredients
- Develop a fundamental understanding of the mechanisms governing concrete performance

II. Teaching-Learning Process:

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: 8 hrs

Overview of cement chemistry and concrete performance: Cement history and production, Quality control and composition, Overview of Cement Chemistry: Composition of Cement and Classification of Cement, Hydration of Cement, Overview of Concrete Performance: Curing & Hardened Concrete, Basics of Hardened Concrete.

Chemical Admixtures: Introduction, characteristics, classification, Water reducers: Classification, Mechanism of action, Applications, Superplasticizers

Module-2: 8 hrs

Chemical Admixtures: Set controllers – Accelerators and Retarders, Air entrainers, Concrete Rheology, Viscosity Modifying Agents (VMA), Mechanism of corrosion, Corrosion inhibitors, Shrinkage reducing admixtures, Other specialty admixtures, Curing compounds

Module-3: 8 hrs

Mineral Admixtures : Types, Composition and Particle size distribution, Microstructure of SCMs and Pozzolonic reactions, Pozzolonic activity, Electrical Conductivity method, Frattini test & Lime saturation method, Strength Activity test, Lime reactivity test, Mixture Proportioning and R3 test.

Flyash: Uses, Classification, structure, effect on fresh and hardened concrete. Sugarcane Bagasse Ash: effect on fresh and hardened concrete . Silica fume: Availability, Properties, benefits, effects on fresh and hardened concrete. GGBFS: Formation of Slag, Types, properties, hydration, effects concrete properties, Rice husk ash, Metakaolin,

Module-4:	8 hrs

HPC: Mixture Proportioning. Topics in Fresh Concrete: Workability, Rheology, Rheological models, Rheological measurements. Design of SCC combining (i) Particle Packing and (ii) Rheology. Pumping of Concrete: Need, concrete pumps, pipes for pumping, Requirements of pumped concrete, Other factors.

Topics in Hardened Concrete: Mechanical Properties, Factors Affecting Strength, Cracking in concrete, Failure Modes in Concrete, Compressive Strength and Factors Affecting It, Behavior of Concrete Under Various Stress States,

Module-5:	8 hrs

Creep: Definition, nature, effects. Factors affecting creep. Shrinkage: Definition, Sources of restraint, plastic shrinkage, carbonation shrinkage, Combined Effect of Shrinkage and Creep. Shrinkage and creep Testing

Durability: Water as an Agent of Deterioration, Permeability, Chemical attack: Sulphate attack, Acid attack, Chloride attack and Carbonation. Corrosion of rebars: Mechanism and control. Alkali Silica Reaction: Manifestation, Freezing and thawing damage

IV. COURSE OUTCOMES

CO1	Discuss the cement chemistry and concrete performance
CO2	Explain about the role and mechanism of chemical admixtures in concrete
CO3	Emphasize on use of various types of mineral admixtures in concrete
CO4	Discuss about factors related to high performance concrete
CO5	Outline the durability aspects of concrete

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3											3			
CO2	3	3											3			
CO3	3	3											3			
CO4	3	3											3			
CO5	3	3											3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII(a): Reference Books:

1	Concrete: Microstructure, Properties, and Materials	Mehta, P. K., and Monteiro, P. J. M	4, 2014	McGraw Hill,
2	Properties of Concrete	Neville, A. M.	2013	Pitman Publishing, Inc., MA
3	Supplementary Cementing Materials in Concrete	Thomas M.D.A.	1997	Blackwell Scientific Publication (Second Edition)
4	Steel Corrosion in Concrete	Bentur, A., Diamond, S., and Berke, N.S.,	1990	E&FN Spon

5	The Chemistry of Cement and Concrete	Lea, F. M.	1970	Chemical Publishing Company, Inc.,
VII(b): Web links and Video Lectures (e-Resources):				
https://onlinecourses.nptel.ac.in/noc23_ce61/preview				
VIII: Activity Based Learning / Practical Based Learning/Experiential learning:				
Conduction of technical seminar and group discussion				

Semester:	III	**Course Type:**	PEC		
Course Title:	EARTHQUAKE GEOTECHNICAL ENGINEERING				
Course Code:	23CCSP342			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

3. Plan a subsurface exploration
4. Evaluate appropriate bearing capacity correction factors to use in design
5. Select the appropriate deep foundation type for different soil profiles.
6. Compute earth pressure and implement the design procedure for earth retaining structures.

II. Teaching-Learning Process:

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1:	**8 hr**

INTRODUCTION TO GEOTECHNICAL EARTHQUAKE ENGINEERING: Seismic hazards – Ground Shaking, Structural hazards, Liquefaction, Landslides, Retaining structure failures, Lifeline Hazards, Tsunami and Seismic Hazards; Mitigation of Seismic Hazards, Significant Historical Earthquakes.

DYNAMIC SOIL PROPERTIES: Representation of Stress conditions by Mohr Circle – Principal stresses and stress path; measurement of dynamic soil properties: Field test, lab tests, interpretation of observed ground response.

RBT Levels: L1, L2, L3.

Module-2:	**8 hr**

LIQUEFACTION: Liquefaction related phenomenon – flow liquefaction,Cyclic Mobility; Evaluation of liquefaction hazards; liquefaction Susceptibility historical criteria. Geologic criteria. Compositional criteria. State criteria: initiation of liquefaction- flow liquefaction surface, Influence of excess pore pressure. Evaluation of Initiation of liquefaction – effects of liquefaction.

RBT Levels: L1, L2, L3.

Module-3:	**8 hr**

SOIL IMPROVEMENT FOR REMEDIATION OF SEISMIC HAZARDS: densification techniques - Vibro techniques. Dynamic compaction, Blasting. Compaction grouting, Arial extent of Densification-; Reinforcement techniques – stone columns. Compaction piles. Drilled inclusions; grouting and mixing techniques-drainage techniques. Verification of soil improvement – lab testing techniques.; In-situ testing techniques, Geophysical testing techniques; Other considerations.

RBT Levels: L1, L2, L3.

Module-4:	8 hr

GENERAL PRINCIPLE OF MACHINE FOUNDATION **DESIGN**: Types of machine and foundation,General requirements of machine foundations; permissible amplitude, Allowable soil pressure. Permissible stresses of concrete and steel., Permissible stresses of timber. **FOUNDATION OF RECIPROCATING MACHINE**; Modes of vibration of a rigid foundation block. Methods of analysis, Linear elastic weight less spring method, Elastic half space method. Effect of footing shape on vibratory response, Dynamic response of embedded block foundation. Soil mass participating in vibrations, Design procedure for a block foundation.

RBT Levels: L1, L2, L3.

Module-5:	8 hr

FOUNDATION OF IMPACT TYPE MACHINE: Dynamic analysis. Design procedure for a hammer foundation **FOUNDATION OF ROTARY MACHINES**: Special considerations. Design criteria. Loads on a T.G. Foundations, Method of analysis and design, Resonance method. Amplitude method, Combined method

RBT Levels: L1, L2, L3.

IV. COURSE OUTCOMES

CO1	Achieve Knowledge of design and development of problem-solving skills.
CO2	Understand the principles of engineering seismology.
CO3	Design and develop analytical skills.
CO4	Summarize the Seismic evaluation and retrofitting of structures.
CO5	Understand the concepts of earthquake resistance of reinforced concrete buildings.

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3											3			
CO2	3	3											3			
CO3	3	3											3			
CO4	3	3											3			
CO5	3	3											3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII(a) Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Dynamics of Structures – Theory and Application to Earthquake Engineering	Anil K. Chopra	2007	Pearson Education.
2	Earthquake resistant design of structures	Pankaj Agarwal, Manish Shrikande	2011	PHI India.
3	Geotechnical Earthquake Engineering	Steven L Kramer	1996	PHI series

VII(b): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=SwY7-hKL8FI&list=PLLy_2iUCG87CjkEM3IgTlehqzXSJeJUQL
https://www.youtube.com/watch?v=eOS7Uk4S-JA&list=PLLy_2iUCG87CjkEM3IgTlehqzXSJeJUQL&index=2
https://www.youtube.com/watch?v=CxlTg8GOuTs&list=PLLy_2iUCG87CjkEM3IgTlehqzXSJeJUQL&index=3
https://www.youtube.com/watch?v=Aa_7tELKYYk&list=PLLy_2iUCG87CjkEM3IgTlehqzXSJeJUQL&index=4

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of technical seminar and group discussion

Semester:	3	**Course Type:**	PEC		
Course Title: Fracture Mechanics					
Course Code:	**23CCSP343**			**Credits:**	3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	03

I. Course Objectives:

- To compute the stress intensity factor, strain energy release rate and the stress and strain fields around a crack tip for linear and nonlinear materials.
- Know experimental methods to determine the fracture toughness.
- Use the design principles of materials and structures using fracture mechanics approach.

II. Teaching-Learning Process:

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: Stress concentration in elastic materials	**8 Hrs**

Theory of stress concentration in elastic materials, stress concentration factors around circular and elliptic holes. Influence of ratio of radii on stress concentration factor in elliptic hole.

RBT Levels: L3

Module-2: Linear Elastic Fracture mechanics	**8 Hrs**

Modelling a crack as a flat elliptic hole by Inglis and the limitations of the model, Griffith theory of brittle fracture

Theories of linear elastic fracture mechanics, stress intensity factors, Irwin's definition. Fracture toughness KIc, KIIc, KIIIc & corresponding values of GC.

RBT Levels: L3

Module-3: Elasto-plastic fracture mechanics	**8 Hrs**

Crack-tip plasticity in metals. Irwin's modification for elasto-plastic material.

J integral, CMOD, CTOD. Mixed mode problems and evaluation of critical fracture parameters.

RBT Levels: L3

Module-4: Fracture of Concrete	**8 Hrs**

Limitations of theories of linear elastic fracture mechanics in concrete, Review of concrete behaviour in tension and compression.

Kaplan's experiments, concept of fracture energy, definition of a quasi-brittle material, concept of softening.

RBT Levels: L3

Module-5: Advanced concepts in fracture behavior of concrete	8 Hrs

Definition of fracture energy by RILEM, Influence of size on fracture behavior, Bazant's size effect law. Size dependent & independent fracture energies.
Application of fracture mechanics in design of concrete structures.
RBT Levels: L3

IV. COURSE OUTCOMES

CO1	Discuss the stress concentration effects in elastic materials
CO2	Adopt Linear Elastic Fracture mechanics for crack modeling.
CO3	Make use of Elasto-plastic fracture mechanics
CO4	Discuss about fracture behaviour of concrete
CO5	Outline the Advanced concepts in fracture behavior of concrete.

V. CO-PO-PSO MAPPING

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3											3			
CO2	3	3											3			
CO3	3	3											3			
CO4	3	3											3			
CO5	3	3											3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII(a): Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
01	Theory of Elasticity	Timoshenko & Goodier	3, 1970	McGrawHill
02	Continuum Mechanics Fundamentals	Valliappan S.	1982	Oxford IBH, ND. New Delhi
03	Elementary Engineering Fracture Mechanics	Broek, D.	4, 1987	Martinus Nijhoff
04	Fracture Mechanics-Fundamentals and Applications	T. L. Anderson	2, 1995	CRC press
05	Advanced Mechanics of Solids	Srinath L.S.	10, 1994	Tata McGraw Hill

VII(b): Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/112/106/112106065/

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:

Conduction of technical seminar and group discussion

Semester:	III	**Course Type:**	PEC		
Course Title: ACTION AND RESPONSE OF STRUCTURAL SYSTEMS					
Course Code:	**23CCSP344**		**Credits:**		3
Teaching Hours/Week (L:T:P:O)			3:0:0:0	**Total Hours:**	40
CIE Marks:	50	**SEE Marks:**	50	**Total Marks:**	100
SEE Type:	Theory			**Exam Hours:**	3

I. Course Objectives:

1. Familiarize with procedures for calculating action effects for different types of structures frequently encountered in practice
2. Understand the importance of appropriate code provisions
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.

II. Teaching-Learning Process :

Chalk and talk, videos, Power Point presentation, animations.

III. COURSE CONTENT

Module-1: **8 Hrs**

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.

RBT Levels: L1, L2, L3.

Module-2: **8 Hrs**

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

RBT Levels: L1, L2, L3.

Module-3: **8 Hrs**

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.

RBT Levels: L1, L2, L3.

Module-4:	**8 Hrs**

Vehicles Loads as per IRC 6 - 2014 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.

RBT Levels: L1, L2, L3.

Module-5:	**8 Hrs**

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.

RBT Levels: L1, L2, L3.

IV. COURSE OUTCOMES

CO1	Apply the load combination for design of structural elements.
CO2	Apply wind loads to different types of buildings and structures.
CO3	Design buildings for seismic loads
CO4	Compute appropriate vehicle loads on bridge structure.
CO5	Analyse structural elements of tall buildings

V. CO-PO-PSO MAPPING (mark H=3; M=2; L=1)

PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	S1	S2	S3	S4
CO1	3	3						3					3			
CO2	3	3						3					3			
CO3	3	3						3					3			
CO4	3	3						3					3			
CO5	3	3						3					3			

VI. Assessment Details (CIE & SEE)

General Rules: Refer Annexure section 1

Continuous Internal Evaluation (CIE): Refer Annexure section 1

Semester End Examination (SEE): Refer Annexure section 1

VII. Learning Resources

VII(a) Reference Books:

Sl. No.	Title of the Book	Name of the author	Edition and Year	Name of the publisher
1	Advanced Mechanics of Solids	L. S. Srinath	2019	Tata McGraw-Hill Publishing Co
2	Matrix Analysis of Structures	Aslam Kassimali	2012	Cengage Learning
3	IS 875 Parts (1 to 5), IS 1893, IRC 6-2014,			

VII(b): Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=RB2k5hSYO3U&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28
https://www.youtube.com/watch?v=5k8vdDSK6jU&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28&index=2
https://www.youtube.com/watch?v=pWecDpoJd9E&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28&index=3
https://www.youtube.com/watch?v=U4a0q4hYUWw&list=PLH9QdGLzps2GOHlqEQpSBBLJha0eGNb28&index=4

VIII: Activity Based Learning / Practical Based Learning/Experiential learning:
Conduction of technical seminar and group discussion

CIE & SEE Evaluation strategy for Autonomous Scheme MTech 2023

Sl. No.	Course Type /Credits	Continuous Internal Evaluation (CIE)																Semester End Examination (SEE)								Total Marks (CIE+SEE)
		Total CIE marks	Min. Eligty.	I. Theory Component							II. Practical Component								Total CIE marks	Dur. In hrs.	Theory			Practical			Total SEE marks	
				Marks	Min. Eligty.	A. Unit test		B. Formative Assessments		Tot. Theory marks (I)	Marks	Min. Eligty.	C. Weekly Evaluation		D. Internal Test			Tot. marks (II)				Max. cond. marks	Max. considered marks	min. pass %	Max. cond. marks	Max. considered marks	min. pass %		
						Nos.	Marks/ Each	Nos.	Marks/ Each				Each week	Tot. marks	Nos.	Marks/ Each	Total marks											
1	**BSC/PCC/PEC (3/4 Credit courses)**	50	50%	50	50%	2	50	1	50	50 (avg. of 3)	--	--	--	--	--	--	--	--	50 (I)	03	100	50	40 %	--	--	--	50	100
2	**IPCC (4 Credit courses)**	50	50%	50	50%	2	50	--	--	50 (avg. of 2)	50	50%	50	50 (Avg. of all)	1	50	50	50 (Avg. of C & D)	50 (Avg. of I & II)	03	100	50	40 %	--	--	--	50	100
4	**PCCL (2 Credit courses)**	50	50%	--	--	--	--	--	--	--	50	50%	50	50 (Avg. of all)	1	50	50	50 (Avg. of C & D)	50 (II)	03	--	--	--	100	50	50 %	50	100

Formative (Successive) Assessments: Assignments/quiz/ seminars/field survey and report presentation/course project/etc. based on the faculty & dept. planning

Practical Conduction: The conduction of each experiment/program per week should evaluate for 50 Marks and average of all shall be taken.

In case of Integrated course, minimum eligibility shall be attained as prescribed in both the theory and practical components.

Self Learning Courses (SLC) Courses, Internship, Mini project & Major Project: Rubrics & Methodology shall be defined seperately

CIE and SEE guidelines based on course Type for M.Tech Autonomous Scheme 2023

Note:

- **The CIE conduction coordination will be done by the office of Controller of Examination (COE).**
- **The SEE will be conducted by the office of Controller of Examination (COE).**

Continuous Internal Evaluation (CIE)	Semester End Examination (SEE)	Final Passing requirement
1. BSC/PCC/ PEC– Theory Course (03/04 Credit courses)		
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.		
The minimum passing mark for the CIE is 50% of the maximum marks (25 marks out of 50). **Continuous Internal Evaluation:** CIE will be conducted by the department and it will have only 01 component: **I. Theory component.** Theory Component will consist of A. Internal Assessment Test B. Formative assessments **A. Internal Assessment Test:** • There are 02 tests each of 50 marks conducted during 9th week & 15th week, respectively.	The minimum passing mark for SEE is 40% of the maximum marks (20 out of 50 marks). **Semester-End Examination:** Duration of 03 hours and total marks of 100. • The question paper will have ten questions. Each question is set for 20 marks. • There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.	The student is declared as a pass in the course if he/she secures a minimum of 50% (50 marks out of 100) in the sum total of the CIE and SEE taken together.

• The question paper will have four questions (max of 3 sub questions) from the notified syllabus. Each question is set for 25 marks. • The student have to answer 2 full questions (one from 1st & 2nd questions and another from 3rd & 4th question). • Internal Assessment Test question paper shall be designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course. **B. Formative assessments:** • 01 formative assessment for 50 marks shall be conducted by the course coordinator based on the dept. planning during random times. • One formative assessment shall be completed before 12th week. • The syllabus content for the formative assessment shall be defined by the course coordinator. • The formative assessments include Assignments/ Quiz/ seminars/case study/field survey/ report presentation/ course project/etc. • The assignment QP or Quiz QP shall indicate marks of each question and the relevant COs & RBT levels. • The rubrics required for the other formal assessments shall be defined by the departments along with mapping of relevant COs & POs. **The final CIE marks will be 50:** Average of all 03 events of Internal Assessment test and formative assessments. **The documents of all the assessments shall be maintained meticulously.**	• The students have to answer 5 full questions, selecting one full question from each module. • Marks scored shall be proportionally reduced to 50 marks.	
2. IPCC – Integrated with Theory & Practical (04 credit courses)		
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.		
The minimum passing mark for the CIE is 50% of the maximum marks (25 marks out of 50). Minimum eligibility of 50% marks shall be attained separately in both the theory component and practical component.	The minimum passing mark for SEE is 40% of the maximum marks (20 out of 50 marks). **Semester-End Examination:**	The student is declared as a pass in the course if he/she secures a minimum of 50% (50 marks out of 100) in

Continuous Internal Evaluation: CIE will be conducted by the department and it will have 02 components: I. Theory Component. II. Practical Component. I. Theory Component will consist of A. Internal Assessment Test B. Formative assessments (Not required for Integrated courses) **A. Internal Assessment Test:** • There are 02 tests each of 50 marks conducted during 9th week & 15th week, respectively. • The question paper will have four questions (max of 3 sub questions) from the notified syllabus. Each question is set for 25 marks. • It is suggested to include questions on laboratory content in the Internal Assessment test Question papers. • The student have to answer 2 full questions (one from 1st & 2nd questions and another from 3rd & 4th question). • Internal Assessment Test question paper shall be designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course. **B. Formative assessments:** • Not required for Integrated courses. **II. Practical Component:** **C.** Conduction of each experiment/program should be evaluated for 50 marks and average of all the experiments/programs shall be taken. (rubrics will be published by the lab conduction committee) **D.** One laboratory Internal Assessment test will be conducted during the 14th week for 50 marks. (rubrics will be published by the lab conduction committee) **The final CIE marks will be 50 =** Avg. {**I** [Avg. of 02 Internal assessment tests] + **II** [Avg. of (C & D)]} **The documents of all the assessments shall be maintained meticulously.**	Only theory SEE for duration of 03 hours and total marks of 100. • The question paper will have ten questions. Each question is set for 20 marks. • There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module. • The laboratory content must be included in framing the theory question papers. • The students have to answer 5 full questions, selecting one full question from each module. • Marks scored shall be proportionally reduced to 50 marks. **No Practical SEE for Integrated Course.**	the sum total of the CIE and SEE taken together.
3. PCCL: Laboratory course (01 credit course)		

<table>
<tr><td colspan="3">The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.</td></tr>
<tr>
<td>The minimum passing mark for the CIE is 50% of the maximum marks (25 marks out of 50).
Continuous Internal Evaluation:
CIE will be conducted by the department and it will have only 01 component:
I. Theory Component. (Not required for Laboratory course)
II. Practical Component.

II. Practical Component:
C. Conduction of each experiment/program should be evaluated for 50 marks and average of all the experiments/program shall be taken (rubrics will be published by the lab conduction committee).
D. One laboratory Internal Assessment test will be conducted for 50 marks (rubrics will be published by the lab conduction committee).

The final CIE marks will be 50 = Avg. of (C & D)

The documents of all the assessments shall be maintained meticulously.</td>
<td>The minimum passing mark for SEE is 50% of the maximum marks (25 out of 50 marks).
Semester-End Examination:
Only laboratory SEE will be conducted jointly by the internal examiner and external examiner appointed by COE as per the scheduled timetable for duration of 03 hours.
• The examination shall be conducted for 100 marks and shall be reduced to 50 marks proportionately.
• All laboratory experiments/programs are to be included for practical examination.
• Breakup of marks (Rubrics) and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners (OR) based on the course requirement evaluation rubrics shall be decided jointly by examiners.
• Students can pick one question (experiment/program) from the questions lot prepared by the internal /external examiners jointly.
• Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
• General rubrics suggested for SEE: writeup-20%, Conduction procedure and results -60%, Viva-voce 20% of maximum marks.
• Change of experiment is allowed only once and shall be assessed only for 85% of the maximum marks.</td>
<td>The student is declared as a pass in the course if he/she secures a minimum of 50% (50 marks out of 100) in the sum total of the CIE and SEE taken together.</td>
</tr>
</table>

|| Jai Shree Gurudev ||
Sri Adichunchanagiri Shikshana Trust ®

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Approved by AICTE, New Delhi

Affiliated to
Visvesvaraya Technological University, Belagavi

Accredited by NBA

Accredited by NAAC with A+

Recognized by UGC, New Delhi with 2(f) and 12(B)

Certified by ISO 9001 – 2015

ATAL Ranking:
Band Performer

Band of 151 to 300 in
Innovation Category