VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

Scheme of Teaching and Examinations and Syllabus

M.Tech Computer Aided Structural Engineering (CAS)

(Effective from Academic year 2021-22)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech COMPUTER AIDED STRUCTURAL ENGINEERING (CAS)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20CAS11	Computational Structural mechanics - Classical and FE approach	03	--	02	03	40	60	100	4
2	PCC	20 CAS 12	Structural Dynamics- Theory and Computations	03	--	02	03	40	60	100	4
3	PCC	20 CAS 13	Finite Element Analysis of Structural Systems – Concepts and Procedures	03	--	02	03	40	60	100	4
4	PCC	20 CAS 14	Advanced Design of RC Structural Elements	03	--	02	03	40	60	100	4
5	PCC	20 CAS 15	Mechanics of Deformable Bodies	03	--	02	03	40	60	100	4
6	PCC	20 CAS L16	Structural Laboratory –I (concrete lab)	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	02	--	02	03	40	60	100	2
			TOTAL	**17**	**04**	**12**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

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

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech COMPUTER AIDED STRUCTURAL ENGINEERING (CAS)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20 CAS21	Analysis of Plates and shells –Classical and FE Approach	03	--	02	03	40	60	100	4
2	PCC	20 CAS22	Python and its application in civil engineering	03	--	02	03	40	60	100	4
3	PCC	20 CAS23	Design of Industrial Structures	03	--	02	03	40	60	100	4
4	PEC	20 CAS24x	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20 CAS25x	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20 CASL26	Software Computation Laboratory –II	--	04	--	03	40	60	100	2
7	PCC	20 CAS27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20CAS24X	**Course title**	**Course Code under 20CAS25X**	**Course title**
20 CAS 241	Design of Masonry Structures	20 CAS 251	Seismic resistant design of structural systems
20 CAS 242	Design of Tall structures	20 CAS 252	Retrofitting and Rehabilitation of structures
20 CAS 243	Advanced Design of Pre-stressed Concrete Structures	20 CAS 253	Composite and smart materials
20 CAS 244	Design Concepts of Substructures	20 CAS 254	Green Building Technology

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech COMPUTER AIDED STRUCTURAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Skill Development activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20 CAS 31	MOOC/NPTL	03	--	02	03	40	60	100	4
2	PEC	20 CAS 32x	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20 CAS 33x	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20 CAS 34	Project Work phase -1	--	02	--	--	100	--	100	2
5	PCC	20 CAS35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20CASI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		**Professional elective 4**	
Course Code under 20 CAS **32X**	**Course title**	**Course Code under 20** CAS **33X**	**Course title**
20 CAS 321	Reliability analysis and design of structural elements	20 CAS 331	Applications of IoT in Civil Engineering
20 CAS 322	Structural Health Monitoring	20 CAS 332	Advances in Artificial Intelligence
20 CAS 323	Structural stability analysis - Classical and FE approach	20 CAS 333	Numerical Methods and programming
20 CAS 324	Action and Response of Structural Systems	20 CAS 334	Structural Optimization - Theory & Computations

Note:

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

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

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

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech COMPUTER AIDED STRUCTURAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical / Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	20 CAS 41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Work Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

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

COMPUTATIONAL STRUCTURAL MECHANICS - CLASSICAL AND FE APPROACH			
Course Code	20CAS11	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

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.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-2

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).

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-3

FE Analysis using Bar Elements:
Element Stiffness matrix of two and three noded elements. Examples with constant and varying cross sectional area subjected to concentrated loads, distributed body force and surface traction and Initial strains due to temperature.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-4

Isoparametric formulation of Bar Elements. Element stiffness matrix of two noded element with constant area, linear variation in area, Consistent Load due to body force, Surface traction. Element stiffness matrix of three noded bar Element, Consistent load due to UDL, Linearly Varying Load, and Quadratic Varying Load.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply,

Module-5

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

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply,

Course outcomes:
At the end of the course the student will be able to:
1. Apply direct stiffness method and analyse 2-D truss and frame structures
2. Formulate Finite Element method with respect to structures.
3. Formulate and apply FEM to bar and beam elements.
4. Apply knowledge of problem solving skills using computer aided methods.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

Textbook/ Textbooks

(1) Rajasekaran, S. and Shankarsubramanian, G., Computational Structural Mechanics, PHI New

(2)Weaver, W. and Gere, J. M., Matrix analysis of framed structures, CBS Publishers and Distributors Pvt. Ltd. 2004.

(3) Reddy. C. S, Basic Structural Analysis, TMH, New Delhi 2001

Reference Books

(1)Robert D Cook, Malkas, D. S. and Plesha., M. E., Concepts and Applications of Finite Element Analysis, 3rd Edition, John Wiley and Sons, New York. 2007

(2)Bathe. K. J., Finite element procedures in Engineering Analysis. PHI. NewDelhi, 2007.

(3) Rubinstein M.F, Matrix Computer Analysis of structures. Prentice-Hall, Eaglewood Cliffs, New Jersey, 1966.

(4) M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons, 2005

STRUCTURAL DYNAMICS –THEORY AND COMPUTATIONS			
Course Code	20CAS12	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

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.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-2

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.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-3

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.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-4

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.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-5

Approximate methods: Rayleigh's method, Dunkarley's method, Stodola's method. Dynamics of Continuous systems: Flexural vibration of beams with different end conditions. Stiffness matrix, mass matrix (lumped and consistent).

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Course outcomes:

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

1. Evaluate the effect of structural vibrations on safety and reliability of structural systems.
2. Develop and solve equations of motion for free and forced response of structural systems.
3. Analyse damping and its influence on structural response.
4. Apply modal method to compute forced response of SDOF and MDOF systems.
5. Carry out dynamic analysis of beams using FEM.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

Textbook/ Textbooks

(1) Anil K. Chopra, Dynamics of structures – Theory and Applications, Pearson Education, 2nd Edition,

(2)Mario Paz, Structural dynamics - Theory and computations, 2 nd Edition, CBS Publisher and Distributors, New Delhi, 2004.

(3) Mukhopadyaya, Vibration, Dynamics and structural problems, Oxford IBH Publishers, 2000.

Reference Books

(1)Clough, Ray W and Penzien J, Dynamics of Structures, 2nd Edition, McGraw-Hill, New York, 1993

(2)Roy R. Craig, Andrew J. Kurdila, Fundamentals of Structural Dynamics, John Wiley & Sons, 2006.

(3) Timoshenko, S., Vibration Problems in Engineering, 2nd Edition, Van Nostrand Co., New York, 1955.

FINITE ELEMENT ANALYSIS OF STRUCTURAL SYSTEMS - CONCEPTS AND PROCEDURES			
Course Code	20CAS13	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Approximate Solutions of differential equations Mathematical back ground, Need and importance of differential equations, Initial and boundary value problems, Differential equation for axial deformation of bars, exact solution for axial deformation of a uniform bar, tapered bar with linearly varying cross section (illustration about the difficulty). Axial Deformation of Bars with uniform cross section using Galerkin and Raleigh-Ritz Method.

Finite element method: Concept and basic procedure, Idealization of continuum using different types of elements (Bar, Beam, Membrane, Plate and Shell), Choice of displacement function, Generalized and Natural coordinates. Interpolation (shape) functions. Formulation using principle of virtual work.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand,

Module-2

Interpolation (shape) functions of Bar, Beam and Triangular elements, Bar elements: Generalized coordinate approach, Lagrange interpolation for Linear, quadratic and cubic variation in Generalized and natural coordinates. Beam elements: Two noded (Hermitian interpolation in generalized and natural coordinates). Triangular elements: Three nodes (Generalized and area coordinates), six nodes and transition elements with four and five nodes in area coordinates.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-3

Interpolation (shape) functions of Rectangular and Solid elements Rectangular elements: Four nodes (Cartesian, natural coordinates and Lagrange formula), eight nodes (serendipity element) in natural coordinates, Nine nodes (Lagrange element) using Lagrange formula and transition elements with seven nodes in natural coordinates. Tetrahedral element: Four nodes, ten nodes (volume coordinates), Hexahedron (Brick element): Lagrange formula in natural coordinates.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-4

Mapping techniques using interpolation functions. Mapping a Straight Line, Curve, and quadrilateral areas with straight and curved edges, Requirement for valid mapping Guidelines for Mapped Element Shapes. Numerical examples

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Module-5

Numerical integration- Gauss quadrature. Line or one-Dimensional Integrals: One point, Two point and Three point formula. Procedure and Numerical examples. Area or two-dimensional Integrals: procedure and Numerical examples. Volume or three dimensional Integrals: procedure and Numerical examples.

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Course outcomes:

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

1. Explain the basic theory behind the finite element method.
2. Formulate and analyse shape functions for different types of elements used in FEA.
3. Use the mapping techniques for different element shapes.
4. Solve numerical examples using finite element method for real structures.
5. Implement computer oriented procedures for FE based structural analysis.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbook/ Textbooks

(1)Zeinkiewicz, O. C. and Taylor R.L., The finite element method for solid and structural mechanics, Butterworh –Heinemann, 2013.

(2) Krishnamoorthy C. S., Finite Element Analysis: Theory and programming, Tata McGraw Hill Publishing Co. Ltd., 2017.

(3) M. Asghar Bhatti, Fundamental finite element analysis and applications, John Wiley & Sons, 2005

Reference Books

(1)Robert D Cook, Malkas, D. S. and Plesha., M. E., Concepts and Applications of Finite Element Analysis, 3rd Edition, John Wiley and Sons, New York. 2007.

(2) Bathe. K.. J., Finite element procedures in Engineering Analysis. PHI. NewDelhi, 2002.

(3) David V Hutton, Fundamentals of finite element analysis, McGraw Hill, 2003

(4)Reddy J., An Introduction to Finite Element Methods, McGraw Hill Co., 2013

ADVANCED DESIGN OF RC STRUCTURAL ELEMENTS			
Course Code	20CAS14	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Behaviour of RC Beams in Shear and Torsion: Modes of Cracking, Shear Transfer Mechanisms , Shear Failure Modes, Critical Sections for Shear Design , Influence of Axial Force on Design Shear Strength, Shear Resistance of Web Reinforcement, Compression Field Theory, Strut-and-Tie Model. Equilibrium Torsion and Compatibility Torsion, Design Strength in Torsion, Design Torsional Strength with Torsional Reinforcement- Space Truss Analogy and Skew Bending Theory- Numerical examples.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-2

Redistribution of Moments in RC Beams: Conditions for Moment Redistribution – Final shape of redistributed bending moment diagram. Advantages and disadvantages of Moment redistribution – Modification of clear distance between bars in beams (for limiting crack width) with redistribution, Moment – curvature Relations of Reinforced Concrete sections. Moment redistribution for a two-span continuous beam. Curtailment of tension Reinforcement – code procedure – Numerical Examples.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-3

Design of Reinforced Concrete Deep Beams: Introduction, definition, Types of deep beams, Minimum thickness - Steps for designing Deep beams as per IS 456 - Detailing of Deep beams. Design examples.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-4

Behaviour and Analysis of Compression Members: Effective Length Ratios of Columns in Frames, Code Charts – Numerical Examples, Short Columns - Modes of Failure in eccentric Compression, Axial Load, 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 Methods as per IS 456. Strength reduction and additional moment method. Design examples

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-5

Flat Slab Design: Behaviour of Slab supported on Stiff, Flexible and no beams, Equivalent Frame Concept, ,Proportioning of Slab Thickness, Drop Panel and Column Head, Transfer of Shear from Slab to column, Direct Design Method, Equivalent Frame Method – Design Examples. FE analysis and design of Slab Panels based on Wood- Armer equations.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Course outcomes:

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

1. Analyse the behaviour of RC beams.
2. Apply redistribution of moments in the analysis of RC beams
3. Analyse and design RC deep beams
4. Design compression members.
5. Design flat slabs.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

(1) Krishna Raju, Advanced R.C. Design, CBS Publishers and Distributors, 1986.

(2) S. Pillai, Devdas Menon, Reinforced Concrete Design, Tata McGraw-Hill, 3rd Edition, 1999

(3) Varghese. P.C., Advanced Reinforced Concrete design, prentice, Hall of India, 2007.

(4) Gambhir M. L., Design of Reinforced Concrete Structures, PHI Pvt. Ltd. New Delhi, 2008

Reference Books

(1) Purushothaman, P., Reinforced concrete structural elements: Behaviour, analysis and Design, Tata McGraw Hill, 1986.

(2) Park R. and Paulay, T., Reinforced Concrete Structures, John Wiley and Sons. 2004.

(3) N. Subramanian, Design of Reinforced Concrete Structures, Oxford IBH.

(4) Relevant IS Codes

MECHANICS OF DEFORMABLE BODIES			
Course Code	20CAS15	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Theory of Elasticity: Introduction: Definition of stress and strain and strain at a point, components of stress and strain at appoint of Cartesian and polar coordinates. Constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases.			
Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply		
Module-2			
Transformation of stress and strain at a point, Principal stresses and principal strains, invariants ofstress and strain, hydrostatic and deviatric stress, spherical and deviatric strains max. shear strain.			
Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply		
Module-3			
Plane stress and plane strain: Airy's stress function approach to 2-D problems of elasticity, simple problems of bending of beams. Solution of axisymmetric problems, stress concentration due to the presence of a circular hole in plates.			
Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply		
Module-4			
Elementary problems of elasticity in three dimensions, stretching of a prismatic bar by its own weight, twist of circular shafts, torsion of non-circular sections, membrane analogy, Propagation of waves in solid media. Applications of finite difference equations in elasticity.			
Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand, L_3 – Apply.,		
Module-5			
Theory of Plasticity: Stress – strain diagram in simpletension, perfectly elastic, Rigid – Perfectly plastic, Linear work – hardening, Elastic Perfectly plastic, Elastic Linear work hardening materials, Failure theories, yield conditions, stress – space representation of yield criteria through Westergard stress space,			

Tresca and Von-Mises criteria of yielding

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand, L_3 – Apply

Course outcomes:

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

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the principles of stress-strain behaviour of continuum
3. Design and develop analytical skills.
4. Describe the continuum in 2 and 3- dimensions
5. Understand the concepts of elasticity and plasticity

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

(1) Timoshenko &Goodier, "Theory of Elasticity", McGraw Hill

(2) Srinath L.S., Advanced Mechanics of Solids, 10th print, Tata McGraw Hill Publishing company, New Delhi, 1994.

(3) Sadhu Singh, "Theory of Elasticity", Khanna Publishers

Reference Books

(1) Valliappan C, "Continuum Mechanics Fundamentals", Oxford IBH Publishing Co.Ltd.

(2) Sadhu Singh, "Applied Stress Analysis", Khanna Publishers

(3) Xi Lu, "Theory of Elasticity", John Wiley

SOFTWARE COMPUTATION LABORATORY –I			
Course Code	20CASL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl.NO	**Experiments**	**RBT levels**
1	Structural Analysis of 2D and 3D Trusses.	L1,L2,L3, L4, L5
2	Structural Analysis of Continuous Beams using different types of loadings and support conditions.	L1,L2,L3, L4, L5
3	Structural Analysis of 2D and 3D Rigid and Braced Frames for different types of loadings , support conditions	L1,L2,L3, L4, L5
4	Modelling and stress analysis of Beams subjected to different loadings using FEA.	L1,L2,L3, L4, L5
5	Modelling and stress analysis of Trusses using FEA.	L1,L2, L3
6	Flexural Behaviour of Slab Panels with different aspect ratio and boundary conditions using FEA.	L1,L2, L3
Exercises on Structural Analysis are aimed at using Finite element analysis based on Industry Standard Software		

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

1. Carry out structural analysis of 2-D and 3-D trusses.
2. Apply different types of loading and end conditions for analysis of continuous beams.
3. Analyse 2-D and 3-D rigid and braced frames having different configurations
4. Carry out FE analysis of Plane Stress and Plane Strain Problems
5. Analyse and interpret Flexural Behaviour of Slab Panels.

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.
Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. ■

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand

Module-2

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. ■

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand

Module-3

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. ■

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand

Module-4

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.
Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. ■

Revised Bloom's Taxonomy Level	L_1 – Remember, L_2 – Understand

Module-5

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, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.

Revised Bloom's Taxonomy Level	L_1 – Remember,L_2 – Understand

Course outcomes:

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

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR. ■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Textbooks

(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.

(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,3rd Edition, 2011.

(3) Study Material (For the topic Intellectual Property under module 5),
Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books

(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.

(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

ANALYSIS OF PLATES AND SHELLS – CLASSICAL AND FE APPROACH			
Course Code	20CAS21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

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

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.

Module-2

Introduction to curved surfaces and classification of shells, Membrane theory of spherical shells, cylindrical shells, hyperbolic paraboloids, elliptic paraboloid and conoids

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.. L_3 – Apply

Module-3

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.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply, L_4 – Analyse.

Module-4

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

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-5

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

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.. L_3 – Apply

Course outcomes:

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

1. Analyse the laterally loaded thin plate or shell like structural elements.
2. Design structures with shell elements like water tank.
3. Carry out the design and detailing of folded plate or shell like structural elements.
4. Use FEM to analyse thin plate structures.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Timoshenko and Krieger, Theory of Plates and Shells, McGraw-Hill Int Book Co., New York, 1959.

(2) Chandrashekara K, Theory of Plates, University Press, 2000.

(3) Robert D Cook, Malkas, D. S. and Plesha., M. E., Concepts and Applications of Finite Element Analysis, 3rd Edition, John Wiley and Sons, New York. 2007.

Reference Books

(1)Szilard. R, Theory and analysis of plates - Classical and numerical methods, Prentice Hall, New Jercy, 1974.

(2)Ugural A C, Stress in Plates and shells, McGraw-H ill International Book Company. 1999.

(3) Bathe. K.J, Finite element procedures in Engineering Analysis. PHI. New Delhi, 2007

PYTHON AND ITS APPLICATION IN CIVIL ENGINEERING			
Course Code	20CAS22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1	
Introduction Python Basics, Entering Expressions into the Interactive Shell, The Integer, Floating-Point, and String Data Types, String Concatenation and Replication, Storing Values in Variables, Your First Program, Dissecting Your Program, Flow control, Boolean Values, Comparison Operators, Boolean Operators, Mixing Boolean and Comparison Operators, Elements of Flow Control, Program Execution, Flow Control Statements, Importing Modules, Ending a Program Early with sys.exit(), Functions, def Statements with Parameters, Return Values and return Statements, The None Value, Keyword Arguments and print(), Local and Global Scope, The global Statement, Exception Handling, A Short Program: Guess the Number.	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.

Module-2	
The Lists, The List Data Type, Working with Lists, Augmented Assignment Operators, Methods, Example Program: Magic 8 Ball with a List, List-like Types: Strings and Tuples, References, Dictionaries and Structuring Data, The Dictionary Data Type, Pretty Printing, Using Data Structures to Model Real-World Things, Manipulating Strings, Working with Strings, Useful String Methods, Project: Password Locker, Project: Adding Bullets to Wiki Markup.	
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-3	
Structural Pattern Matching with Regular Expressions, Finding Patterns of Text Without Regular Expressions, Finding Patterns of Text with Regular Expressions, More Pattern Matching with Regular Expressions, Greedy and Nongreedy Matching, The findall() Method, Character Classes, Making Your Own Character Classes, The Caret and Dollar Sign Characters, The Wildcard Character, Review of Regex Symbols, Case-Insensitive Matching, Substituting Strings with the sub() Method, Managing Complex Regexes, Combining re .IGNORECASE, re.DOTALL, and re.VERBOSE, Project: Phone Number and Email Address Extractor	
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-4	
Classes and objects, Programmer-defined types, Attributes, Rectangles, Instances as return values, Objects are mutable, Copying, Classes and functions, Time, Pure functions, Modifiers, Prototyping versus planning, Classes and methods, Object-oriented features, Printing objects, Another example, A more complicated example,The init method, The __str__ method, Operator overloading, Type-based dispatch, Polymorphism, Interface and implementation, Inheritance, Card objects, Class attributes, Comparing cards, Decks, Printing the deck, Add, remove, shuffle and sort, Inheritance, Class diagrams, Data encapsulation.	
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-5	
Implementation of python in analysis of s/s beam, cantilever beam, fixed, pin and rigid jointed frames; RCC design; design of beams, design of slabs; one way slab and two way slab, design of continuous beams; to find out shear strength of concrete for given grade of concrete using python (Theory and numerical problems)	
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_5 – Evaluate, L_6 - Create

Course outcomes:

1. At the end of the course the student will be able to:
2. Demonstrate proficiency in handling of loops and creation of functions.
3. Identify the methods to create and manipulate lists, tuples and dictionaries. Discover the commonly used operations involving regular expressions and file system.
4. Interpret the concepts of Object-Oriented Programming as used in Python
5. Enhancing skills of students to apply modern techniques like python in civil engineering

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Al Sweigart,"Automate the Boring Stuff with Python",1stEdition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/)

(2) Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015. (Available under CC-BY-NC license at http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Chapters 13, 15, 16, 17, 18) (Download pdf/html files from the above links).

Reference Books

(1) Gowrishankar S, Veena A, "Introduction to Python Programming", 1st Edition, CRC Press/Taylor & Francis, 2018. ISBN-13: 978-0815394372

(2) Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data", 1st Edition, O'Reilly Media, 2016. ISBN-13: 978-1491912058

(3) Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd, 2015. ISBN-13: 978-8126556014

(4) Wesley J Chun, "Core Python Applications Programming", 3rd Edition, Pearson Education India, 2015. ISBN-13: 978-9332555365

(5) Dr.B.C.Punmia, Ashok kumar jain,arun kumar Jain,"limit state design of reinforced concrete (As per IS 456:200), 1st Edition, Laxmi Publications (P) LtD, NEW Delhi-110002

DESIGN OF INDUSTRIAL STRUCTURES			
Course Code	20CAS23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

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

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse

Module-2

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

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse

Module-3

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

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse

Module-4

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.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_4 – Analyse

Module-5

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).

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse

Course outcomes:

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

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the industrial building and the components.
3. Design and develop analytical skills.
4. Summarize the principles of Structural Design and detailing
5. Understands the concept of Pre- engineered buildings.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

(1) N Subramanian- "Design of Steel Structure" oxford University Press

(2) B.C. Punmia, A.K. Jain "Design of Steel Structures", Laxmi Publications, New Delhi.

(3) Duggal "Limit State Design of Steel Structures" TMH

Reference Books

(1) Bureau of Indian Standards, IS800-2007, IS875-1987, IS-801-1975. Steel Tables, SP 6
(1) – 1984

(2) Ramchandra and Virendra Gehlot " Design of Steel Structures " Vol 1 and Vol.2,
Scientific Publishers, Jodhpur

DESIGN OF MASONRY STRUCTURES			
Course Code	20CAS241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction, Masonry units, materials and types:
History of masonry, Masonry units – Brick- Types of bricks,Tests conducted on bricks. Other masonry units - stone, clay block, concrete block, laterite block, stabilized mud blockmasonry units Masonry materials – Classification andproperties of mortars, selection of mortars. Cracks - Cracks inmasonry structures, Type of crack, causes and prevention ofcrack.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.

Module-2

Strength of Masonry in Compression:
Behaviour of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar Characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength of masonry in Indian context, Failure theories of masonry under Compression. Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength
Masonry Bond Strength and Masonry in Shear and Flexure Bond between masonry unit and mortar, tests for determiningflexural and shear bond strengths, factors affecting bondstrength, effect of bond strength on compressive strength,
orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shear strength

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply,

Module-3

Design of load bearing masonry wall
Permissible stresses: Types of walls, permissible compressive stress, stress reduction and shape modification factors, increase in permissible stresses for eccentric vertical and lateral load, permissible tensile stress and shear stresses.
Design Considerations: Effective height of walls and columns, openings in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action in lintels. Problems on design considerations for solid walls, cavity walls, wall with pillars.
Load considerations and design of Masonry subjected to axial loads: Design criteria, design examples of walls underUDL, solid walls, cavity walls, solid wall supported at the endsby cross wall, walls with piers.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-4

Design of walls subjected to concentrated axial loads: Solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers, design of wall with openings. Design of walls subjected to eccentric loads: Design criteria – stress distribution under eccentric loads – problems on eccentrically loaded solid walls, cavity walls, walls with piers.
Design of Laterally and transversely loaded walls: Design criteria, design of solid wall under wind loading, design of shear wall – design of compound walls.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-5

Earthquake resistant masonry buildings: Behaviour of masonry during earthquakes, concepts anddesign procedure for earthquake resistant masonry, BIS codalprovisions. In-filled frames: Types – modes of failures **Reinforced brick masonry** Methods of reinforcing Masonry, Analysis of reinforced Masonry under axial, flexural and shear loading

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

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

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

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

Textbook/ Textbooks

(1) K.S. Jagadish, "Structural masonry", I.K. International Publishing House Pvt.Ltd

(2) Dayaratnam P, "Brick and Reinforced Brick Structures", Oxford & IBH, 1987.

Reference Books

(1) Henry, A.W., "Structural Masonry", Macmillan Education Ltd., 1990.

(2) M. L. Gambhir, "Building and Construction Materials", Mc Graw Hilleducation Pvt. Ltd.

(3) IS 1905–1987 "Code of practice for structural use of un-reinforced masonry-

(4) SP 20 (S&T) – 1991, "Hand book on masonry design and construction (1st revision) BIS, New Delhi.

DESIGN OF TALL STRUCTURES			
Course Code	20CAS242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Design Criteria: Design philosophy, loading, sequential loading, and materials – high performance concrete, fiber reinforced concrete, lightweight concrete, design mixes. Loading and Movement: Gravity loading: Dead and live load, methods of live load reduction, Impact, Gravity loading, Construction loads

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.

Module-2

Wind loading: static and dynamic approach, Analytical and wind tunnel experimentation method. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading, working stress design, Limit state design, Plastic design.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Module-3

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

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply

Module-4

Analysis and Design: Modeling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift and twist, computerized general three dimensional analyses.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse

Module-5

Stability of Tall Buildings: Overall buckling analysis of frames, wall frames, approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first order and P-Delta analysis, Transnational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation. Structural elements: sectional shapes, properties and resisting capacities, design, deflection, cracking, pre-stressing, shear flow. Design for differential movement, creep and shrinkage effects, temperature effects and fire.

Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Apply, L_4 – Analyse., L_5 – Evaluate

Course outcomes:

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

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the principles of strength and stability
3. Design and develop analytical skills.
4. Summarize the behavior of various structural systems.
5. Understand the concepts of P-Delta analysis

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

Textbook/ Textbooks

(1) Taranath B.S, "Structural Analysis and Design of Tall Buildings"- McGraw Hill

(2) Dr. Y.P. Gupta – Editor, "Proceedings National Seminar on High Rise Structures- Design and Construction practices for middle level cities"- New Age International Limited

Reference Books

(1) Wilf gang Schuller, "High rise building structures"- John Wiley

(2) Bryan Stafford Smith & Alexcoull, "Tall building structures Analysis and Design"- John Wiley

(3) T.Y Lin & D.Stotes Burry, "Structural concepts and system for Architects and Engineers"-John Wiley

(4) Lynn S.Beedle, "Advances in Tall Buildings"- CBS Publishers and Distributors.

ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES			
Course Code	20CAS243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Shear and Torsional Resistance: Shear and principal stresses, ultimate shear resistance,design of shear reinforcement, Torsion, Design ofreinforcement for torsion.
Anchorage Zone Stresses in Post-Tensioned Members: Introduction, stress distribution in end block,investigations on Anchorage zone stresses, Magnel andGuyon's Methods, Comparative Analysis, Anchorage zonereinforcement

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.

Module-2

Tension Members: Introduction, Ties, Pressure pipes – fabrication process,analysis, design and specifications. Cylindrical containersconstruction techniques, analysis, design andspecifications. **Compression Members:** Introduction, Columns, short columns, long columns,biaxially loaded columns, Design specifications.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply

Module-3

Statically indeterminate Structures: Introduction, Advantages of continuous members, effect ofprestressing in indeterminate structures, methods ofanalysis for secondary moments, concordant cable profile,Guyon's theorem, Ultimate load analysis, Design ofcontinuous beams and portal frames.

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse

Module-4

Slab and Grid Floors: Types of floor slabs, Design of one way, two way and flat slabs. Distribution of prestressing tendons, Analysis and design of grid floors.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-5

Composite Beams: Introduction, types of composite beams, analysis forstresses, differential shrinkage, serviceability limit state.Design for flexural and shear strength.
Precast Elements: Introduction, Prestressed concrete poles-manufacturingtechniques, shapes and cross sectional properties, designloads, designs principles. Railway sleepers-classificationand Manufacturing techniques, design loads, analysis anddesign principles. Prestressed concrete pavements, slaband wall panels.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

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

- Analyse , Design and detail PSC elements

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

(1) Krishna Raju, "Prestressed concrete", Tata Mc Graw Hill Book – Co., New Delhi.

(2) T.Y. Lin and Burn, "Design of prestress concrete structures", John Wiley, New York.

Reference Books

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

(2) S. Ramamrutham, "Prestressed concrete", Dhanpat Rai & Sons, Delhi.

DESIGN CONCEPTS OF SUBSTRUCTURES			
Course Code	20CAS244	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction, Site investigation, In-situ testing of soils, Subsoil exploration, Classification of foundations systems. General requirement of foundations, Selection of foundations, Computations of Loads, Design concepts.			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_4 – Analyse., L_5 – Evaluate		
Module-2			
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			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_4 – Analyse., L_5 – Evaluate		
Module-3			
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			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_4 – Analyse., L_5 – Evaluate		
Module-4			
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.			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply L_4 – Analyse., L_5 – Evaluate		
Module-5			
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.			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply L_4 – Analyse., L_5 – Evaluate		

Course outcomes:

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

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the principles of subsoil exploration
3. Design and develop analytical skills.
4. Identify and evaluate the soil shear strength parameters.
5. Understand the concepts of Settlement analysis.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

(1) Swami Saran – "Analysis & Design of Substructures"- Oxford & IBH Pub. Co. Pvt. Ltd., 1998.
(2) Nainan P Kurian – "Design of Foundation Systems"- Narosa Publishing House, 1992.
Reference Books
(1) R.B. Peck, W.E. Hanson & T.H. Thornburn – "Foundation Engineering"- Wiley Eastern Ltd.,Second Edition, 1984.
(2) J.E. Bowles – "Foundation Analysis and Design"- McGraw-Hill Int. Editions, Fifth Ed., 1996.
(3) W.C. Teng – "Foundation Design"- Prentice Hall of India Pvt. Ltd., 1983.
Bureau of Indian Standards:IS-1498, IS-1892, IS-1904, IS-6403, IS-8009, IS-2950, IS-11089, IS-11233, IS-2911 and all other relevant codes

SIESMIC RESISTANT DESIGN OF STRUCTURES			
Course Code	20CAS251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03
Module-1			
Introduction to engineering seismology, Geological and tectonic features of India, Origin and propagation of seismic waves, characteristics of earthquake and its quantification – Magnitude and Intensity scales, seismic instruments. Earthquake Hazards in India, Earthquake Risk Evaluation and Mitigation. Structural behavior under gravity and seismic loads, Lateral load resisting structural systems, Requirements of efficient earthquake resistant structural system, damping devises, base isolation systems.			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.		
Module-2			
The Response history and strong motion characteristics. Response Spectrum – elastic and inelastic response spectra, tripartite (D-V-A) response spectrum, use of response spectrum in earthquake resistant design. Computation of seismic forces in multi-storied buildings – using procedures (Equivalent lateral force and dynamic analysis) as per IS- 1893.			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate		
Module-3			
Structural Configuration for earthquake resistant design, Concept of plan irregularities and vertical irregularities, Soft storey, Torsion in buildings. Design provisions for these in IS-1893. Effect of infill masonry walls on frames, modeling concepts of infill masonry walls. Behaviour of masonry buildings during earthquakes, failure patterns, strength of masonry in shear and flexure, Slenderness concept of masonry walls, concepts for earthquake resistant masonry buildings – codal provisions.			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate		
Module-4			
Design of Reinforced concrete buildings for earthquake resistance-Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS1893. Structural behavior, design and ductile detailing of shear walls.			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse., L_5 – Evaluate		
Module-5			

Seismic response control concepts – Seismic demand, seismic capacity, Overview of linear and nonlinear procedures of seismic analysis. Performance Based Seismic Engineering methodology, Seismic evaluation and retrofitting of structures

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_5 – Evaluate, L_6 - Create

Course outcomes:

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

1. Familiarise with the principles of engineering seismology.
2. Use the response spectrum principle in the earthquake resistant design of structures.
3. Analyse behaviour and performance of buildings during earthquakes.
4. Design RC buildings for different earthquake load combinations with ductile detailing of components.
5. Carry out performance based seismic evaluation and retrofitting of structures

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Anil K. Chopra, Dynamics of Structures – Theory and Application to Earthquake Engineering- 2nd edition,Prentice Hall, 2000.

(2) Vinod Hosur, Earthquake Resistant Design of Building Structures, , WILEY (india), 2012

(3) Duggal S. K., Earthquake Resistant Design of Structures, , Oxford University Press, 2013.

(4) Pankaj Agarwal, Manish Shrikande Earthquake resistant design of structures - PHI India, 2009.

Reference Books

(1) IS – 1893 (Part I): 2002, IS – 13920: 1993, IS – 4326: 1993, IS-13828: 1993

(2) Minoru Wakabayashi, Design of Earthquake Resistant Buildings, , McGraw Hill Pub 1985.

(3) T Paulay and M J N Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons, 1992.

RETROFITTING AND REHABILITATION OF STRUCTURES			
Course Code	20CAS252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Maintenance: Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration.
Repair Strategies: Causes of distress in concrete structures, Construction and design failures, Condition assessment and distress-diagnostic techniques, Assessment procedure for Inspection and evaluating a damaged structure,

Revised Bloom's Taxonomy Level	L_2 – Understanding. . L_3 – Apply

Module-2

Serviceability and Durability of Concrete: Quality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-3

Materials and Techniques for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, Sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Bacterial concrete, Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels,coating and cathodic protection

Revised Bloom's Taxonomy Level	L_2 – Understanding. . L_3 – Apply

Module-4

Repair, Rehabilitation and Retrofitting Techniques: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure, Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.

Revised Bloom's Taxonomy Level	L_2 – Understanding. . L_3 – Apply

Module-5

Health Monitoring and Demolition Techniques: Long term health monitoring techniques, Engineered demolition techniques for dilapidated structures, Use of Sensors – Building Instrumentation.

Revised Bloom's Taxonomy Level	L_3 – Apply, L_4 – Analyse.

Course outcomes:
At the end of the course the student will be able to:
1. Emphasise on the importance of structural maintenance, causes of deterioration and repair strategies.
2. Analyse the cause and effect of climate, chemicals and errors in design and construction of concrete structures.
3. Use proper materials and techniques for the repair of damaged structures.
4. Adopt various techniques of repair and rehabilitation of structures.
5. Monitor the health and choose appropriate technique for demolition of dilapidated structures.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

Textbook/ Textbooks

(1) Santakumar A.R, Concrete Technology. Oxford University press, 2nd Ed., 2018.

(2)Richardson B. A., Defects and Deterioration in Buildingts, E F & N Spon press, London, 2001.

Reference Books

(1)Gupta B. L. and Amit Gupta Maintenance and Repair of Civil Structures, Standard Publications.

(2)Mehta, P.K and Montevic. P.J., Concrete- Microstructure, Properties and Materials, ICI, 1997.

(3) Ranso, W. H., Concrete Repair and Maintenance Illustrated, RS Means Company Inc., 1981

COMPOSITE AND SMART MATERIALS			
Course Code	20CAS253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Composite materials: Classifications and applications. of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance & stiffness matrices, coupling.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-2

Anisotropic elasticity: Unidirectional and anisotropic lamina, thermo-mechanical properties, micro-mechanical analysis, classical composite lamination theory, Cross and angle–play laminates, symmetric, anti-symmetric and general asymmetric laminates, mechanical coupling, laminate stacking,

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-3

Analysis of simple laminated structural elements: Ply-stress and strain, lamina failure theories - first fly failure, environmental effects, manufacturing of composites.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-4

Smart materials: Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-5

Beam modeling with strain actuator, bending extension relation.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Course outcomes:
At the end of the course the student will be able to:
1. Carry out classification and application of various types of fibres.
2. Explain thermo-mechanical properties of materials.
3. Analyse environmental effects and failure theories of composite materials.
4. Familiarise with smart materials and structures.
5. Carry out the analysis of a beam model with induced strain actuation.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

Textbook/ Textbooks

(1) Robart M Jones, Mechanic of Composite Materials, McGraw Hill Publishing Co, 2015..

(2)Bhagwan D Agarawal, and Lawrence J Brutman, Analysis and Performance of Fiber Composites, John Willy and Sons, 2006.

Reference Books

(1)Madujit Mukhopadyay, Mechanics of composite materials and structures, University Press, 2004.

(2)Inderjit h Chopra, Lecture notes on Smart Structures, Department of Aerospace Engg., University of Maryland.

(3) Ceawley E. and Anderson E., Detailed models of piezo-ceramics actuation of beams, Proceedings of the 30th AIAA/ASME/ASCE/ASC – Structural dynamics and materials conference, Washington DC, April 1989.

GREEN BUILDING TECHNOLOGY			
Course Code	20CAS254	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1	
Overview of the significance of energy use and energy processes in building – Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management – Macro aspect of energy use in dwellings and its implications.	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,

Module-2	
Indoor environmental requirement and management - Thermal comfort – Ventilation and air quality – Air- conditioning requirement - Visual perception – Illumination requirement - Auditory requirement.	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply,

Module-3	
Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature – Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,

Module-4	
End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply,

Module-5	
Energy management options - Energy audit and energy targeting – Technological options for energy management. Building rating systems.	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply,

Course outcomes:

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

1. Know the characteristics of energy use and practice appropriate energy management.
2. Analyse the thermal comfort of building use and work out energy requirement.
3. Analyse the energy impact on the shape and orientation of buildings.
4. Utilise day lighting and efficient lighting system enhancing thermal performance of the buildings.
5. Practice energy audit and implement. proper energy management system.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.

Textbook/ Textbooks

(1)Bryant Edwards, Natural Hazards, Cambridge University Press, U.K., 2005.

(2)National Building Code of India, Vol. 1 and 2, Bureau of Indian Standanrds, 2016.

Reference Books

(1)Sam Kubba, Hand book of Green Building Design and Construction : LEED, BREEAM and Green Globes, 2012.
(2)Charles J Kibbart, Sustainable Construction: Green Building Design and Delivery, J Wiley and Sons,
(3) Sahni, Pardeep, Medury Uma and Dhameja Alka, Disaster Mitigation Experiences and Reflections, Prentice

SOFTWARE COMPUTATION LABORATORY –II			
Course Code	20CASL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl.NO	**Experiments**	**RBT levels**
1	Design of RCC beam elements using excel sheets	L1,L2,L3, L4, L5
2	Design of RCC elements column and footing using excel sheets	L1,L2,L3, L4, L5
3	Design of RCC slabs for different end conditions using excel sheets	L1,L2,L3, L4, L5
4	Structural Analysis of 2D beams with different loading and support conditions by using python	L1,L2,L3, L4, L5
Exercises on Structural Analysis are aimed at using Finite element analysis based on Industry Standard Software		
Course outcomes: At the end of the course the student will be able to: 1. Carry out structural analysis of RC elements 2. Analysis of beams for different loading and support conditions.		

TECHNICAL SEMINAR			
Course Code	20CAS27	CIE Marks	100
Number of contact Hours/week (L:P:SDA)	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the

Marks distribution for CIE of the course 20CAS27 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

*** END OF II SEMESTER***

MOOC			
Course Code	20CAS31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

The Assessment of MOOC and Online Courses shall be decided by the concerned School Board of Studies (BOS).

9.3.1 For > 3 credit courses

i	IA-I	25 marks
ii	IA-2	25 marks
iii	Semester end examination by the concern school board (demo, test, viva voice etc)	50 marks
	Total	100 marks

RELIABILITY ANALYSIS AND DESIGN OF STRUCTURAL ELEMENTS			
Course Code	20CAS321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Concept of variability: Applications of Statistical principles to deal with randomness in basic variables, statistical parameters and their significance, Description of various probability distributions – Binomial, Poisson, Normal, Log-Normal, Beta, Gama, distributions. Testing of goodness– of – fit of distributions to the actual data using chi-square method.
Self Study Component: Fit of distributions to the actual data using K.S Method.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-2

Statistical regression and correlation: Least – square and chi – square methods, Operation on one Random variable, expectation, multiple random variables, reliability distributions – basic formulation, the hazard function. Self Study Component: Weibull distribution.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-3

Statistical Quality control in Civil Engineering: Characteristic strength and characteristic load, probability modeling of strength, geometrical dimensions, material properties and loading. Application problems Mean value method and its applications in structural designs, statistical inference, Comparison of various acceptance and rejection testing. Self Study Component: Probability mass function.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-4

Safety assessment of structures: Reliability analysis using mean value theorem – I, II and III order Reliability formats. Self Study Component: Importance sampling techniques.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Module-5

Reliability analysis by Simulation techniques: Simulation techniques, reliability index - reliability formulation in various limit states, reliability based design, application to design of RC, PSC and steel structural elements. Self Study Component: Concepts of system reliability.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Apply

Course outcomes:

1. Apply statistical principles for analyzing randomness in variables.
2. Test goodness of fit of distribution in the data.
3. Adopt different acceptance and rejection tests for strength and other parameters of measurement.
4. Carry out reliability analysis and compute reliability index, for the given design details.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

(1) Ranganthan R, "Reliability Analysis and Design of Structures", Tata McGraw Hill V publishing Co. Ltd., New Delhi.

(2) Srinath L S, "Reliability Engineering", East West Books (Madras) Pvt. Ltd., 2005.

(3) Agarwal, K K, "Reliability Engineering", Apress Springer (India) Pvt. Ltd., 2007.

Reference Books

(1) John B.Kennedy and Adam M.Neville, "Basic Statistical Methods for Engineers and Scientists", Harper and Row Publishers, New York.

(2) Ang A.H.S and Tang W.H., "Probability concepts in Engineering planning and Design", John Wiley and sons, New York, Vol. I and II.

(3) Andrzej S. N and Kevin, R. C., "Reliability of Structures", McGraw Hill Company, KOGA, 2012.

(4) Devaraj V., and Ravindra, R., "Reliability Based Analysis and Design for Civil Engineers", IK International Publishing House Pvt. Ltd., 2017.

Note: Self study is for 5 marks only in CIE and not in SEE

STRUCTURAL HEALTH MONITORING			
Course Code	20CAS322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

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 multidisciplinarity: the most remarkable characters of SHM, Birth of the SHM Community

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply

Module-2

Vibration-Based Techniques for SHM Basic vibration concepts for SHM, Local and global methods, Damage diagnosis as an inverse problem, Model-based damage assessment, Mathematical description of structural systems with damage, General dynamic behavior, Statespace description of mechanical systems, Modeling of damaged structural elements, Linking experimental and analytical data, Modal Assurance Criterion (MAC) for mode pairing, Modal Scaling Factor (MSF), Co-ordinate Modal Assurance Criterion (COMAC), Damping, Expansion and reduction, Updating of the initial model, Damage 10 Hourslocalization and quantification, Change of the flexibility matrix, Change of the stiffness matrix, Strain-energy-based indicator methods and curvature modes, MECE error localization technique, Static displacement method, Inverse eigen sensitivity method, Modal force residual method, Kinetic and strain energy-based sensitivity methods, Forced vibrations and frequency response functions, Solution of the equation system, Regularization, Parameter subset selection, Other solution methods, Variances of the parameters, Neural network approach to SHM, The basic idea of neural networks, Neural networks in damage detection, localization and quantification, Multi-layer Perceptron (MLP), A simulation example, Description of the structure, Application of damage indicator methods, Application of the modal force residual method and inverse eigen sensitivity method, Application of the kinetic and modal strain energy methods, Application of the MultiLayer Perceptron neural network, Time-domain damage detection methods for linear systems, Parity equation method, Kalman filters, AR and ARX models, Damage identification in non-linear systems, Extended Kalman filter, Localization of damage using filter banks, A simulation study on a beam with opening and closing crack, Applications, I-40 bridge,,Steelquake structure, Application of the Z24 bridge, Detection of delamination in a CFRP plate with stiffeners

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-3

Fiber-Optic Sensors Classification of fiber-optic sensors, Intensity-based sensors, Phasemodulated optical fiber sensors, or interferometers, Wavelength based sensors, or Fiber Bragg Gratings (FBG), The fiber Bragg grating as a strain and temperature sensor, Response of the FBG to uniaxial uniform strain fields, Sensitivity of the FBG to temperature, Response of the FBG to a non-uniform uniaxial strain field,

Response of the FBG to transverse stresses, Photoelasticity in a plane stress state, Structures with embedded fiber Bragg gratings, Orientation of the optical fiber optic with respect to the reinforcement fibers, Ingress/egress from the laminate, Fiber Bragg gratings as 10 Hours L2, L3damage sensors for composites, Measurement of strain and stress variations, Measurement of spectral perturbations associated with internal stress release resulting from damage spread, Examples of applications in aeronautics and civil engineering, Stiffened panels with embedded fiber Bragg gratings, Concrete beam repair

Revised Bloom's Taxonomy Level	L_1 − Remembering,L_2 − Understanding. L_3 − Apply

Module-4

SHM with Piezoelectric Sensors The use of embedded sensors as acoustic emission (AE) detectors, Experimental results and conventional analysis of acoustic emission signals, Algorithms for damage localization, Algorithms for damage characterization, Available industrial AE systems, New concepts in acoustic emission, State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research, Lamb wave structure interrogation, Sensor technology, Tested structures (mainly metallic or composite parts), Acousto-ultrasonic signal and data reduction methods, The full implementation of SHM of localized damage with guided waves in composite materials, Available industrial acoustoultrasonic systems with piezoelectric sensors, Electromechanical impedance, E/M impedance for defect detection in metallic and composite parts, The piezoelectric implant method applied to the evaluation and monitoring of viscoelastic properties.

Revised Bloom's Taxonomy Level	L_2 − Understanding. L_3 − Apply

Module-5

SHM Using Electrical Resistance Composite damage, Electrical resistance of unloaded composite, Percolation concept, Anisotropic conduction properties in continuous fiber reinforced polymer, Influence of temperature, Composite strain and damage monitoring by electrical resistance, 0° unidirectional laminates, Multidirectional laminates, Randomly distributed fiber reinforced polymers, Damage localization. Low Frequency Electromagnetic Techniques Theoretical considerations on electromagnetic theory, Maxwell's equations, Dipole radiation, Surface impedance, Diffraction by a circular aperture, Eddy currents, Polarization of dielectrics, Applications to the NDE/NDT domain, Dielectric materials, Conductive 10 Hours L3, L4materials, Hybrid method, Signal processing, Timefrequency transforms, The continuous wavelet transform, The discrete wavelet transform, Multiresolution, Denoising, Application to the SHM domain, General principles, Magnetic method, Electric method, Hybrid method.

Revised Bloom's Taxonomy Level	L_3 − Apply, L_4 − Analyse

Course outcomes:

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

1. Emphasise the importance of structural health monitoring as part of system management.
2. Adopt vibration based techniques for health monitoring of a few structural elements and components.
3. Use fibre-optic and other types of sensors for estimating damage in a structural element.
4. Characterise the defect or damage in a structural element using piezo-electric sensors or acoustic emission methods.
- Apply general principles of structural health monitoring using magnetic, electric and hybrid

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, WileyISTE, 2006

2. J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure, Vol-1, Taylor and Francis Group, London, U.K, 2006.

Reference Books
1. Douglas E Adams, Health Monitoring of Structural Materials and ComponentsMethods with Applications, John Wiley and Sons, 2007.
2. Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007.
3. Smart Materials and Structures, Gandhi and Thompson
4. Structural Health Monitoring: Current Status and Perspectives

STRUCTURAL STABILITY ANALYSIS – CLASSICAL AND FE APPROACH			
Course Code	20CAS323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
Beam column: Differential equation. Beam column subjected to (i) lateral concentrated load, (ii) several concentrated loads, (iii) continuous lateral load. Application of trigonometric series. Euler's formulation using fourth order differential equation for pinned-pinned, fixed- fixed, fixed-free and fixed-pinned columns. Self Study Component: Beam column subjected to partial UDL, couples.			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.		
Module-2			
Buckling of frames and 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. Self Study Component: Columns subjected to non-conservative follower and pulsating forces.			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply		
Module-3			
Stability analysis by finite element approach: Derivation of shape functions for a two noded Bernoulli-Euler beam element (lateral and translational DOF) – element stiffness and Element geometric stiffness matrices – Assembled stiffness and geometric stiffness matrices for a discretised column with different boundary conditions – Evaluation of critical loads for a discretised (two elements) column (both ends built-in). Buckling of pin jointed frames (maximum of two active DOF).Symmetrical single bay portal frame. Self Study Component: Write algorithm and program to generate elastic bending stiffness matrix and geometric stiffness matrix for beam element.			
Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse		
Module-4			
Lateral buckling of beams –Differential equation, pure bending, cantilever beam with tip load, simply supported beam of I section subjected to central concentrated load. Torsional Buckling – Pure torsion of thin- walled bars of open cross section. Non-uniform torsion of thin -walled bars of open cross section. Self Study Component: Lateral buckling of simply supported I beam subjected to udl.			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding.. L_3 – Apply		
Module-5			
Buckling of rectangular plate: Buckling of uniformly compressed simply supported rectangular plate – Uniaxial and biaxial loading, Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides. Self Study Component: Buckling of rectangular plates under the action of shearing stresses.			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply		
Note: Self study is for 5 marks only in CIE and not in SEE			

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

1. Idealize the concepts of beam column structural behavior, stability of column and compute Euler's critical load for different boundary conditions.
2. Comprehend the energy method, bars on elastic foundation, successive approximation method for stability analysis.
3. Comprehend finite element method in stability analysis to simple plane truss and 2D beams and frames.
4. Grasp the concept of lateral buckling of beams, torsional buckling of beams and buckling of rectangular plate type structures.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

(1) Stephen P. Timoshenko, James M. Gere, "Theory of Elastic Stability", McGraw-Hill, New Delhi.

(2) Zeiglar.H,"Principles of Structural Stability", Blaisdall Publication.

(3) Rajasekaran.S, "Computational Structural Mechanics", Prentice-Hall, India.

Reference Books

(1) Robert D Cook, "Concepts and Applications of Finite Element Analysis", John Wiley and Sons, New

(2) Ray W Clough and J Penzien, "Dynamics of Structures", McGraw-Hill, New Delhi.

(3) Ashwini Kumar, "Stability of Structures", Allied Publishers Limited, 1998.

(4) Timoshenko and kriger, "Theory of plates and shells", McGraw –Hill Internal Book Company.

ACTION AND RESPONSE OF STRUCTURAL SYSTEMS			
Course Code	20CAS324	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
IS 875 PART 1, 2, 4, 5 : Sources, Nature and Magnitude, Probabilistic assessment, Characteristic and Design values. IS 875 PART 1 and 2 code provisions. Load combination rules for design. Load path for gravity loads- Tributary Area and Stiffness based approaches. Estimation of DL and LL on structural elements such as Slab, Beams, Columns, in different types of structural systems, Joint Loads on Trusses, Distributed load on Purlins- Numerical examples.			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply		
Module-2			
Wind Load - IS 875 PART 3: Buildings : Nature and Magnitude, Factors influencing wind loads, Internal and External pressure distribution, Design Wind Speeds and Pressure, Numerical Examples to calculate external and internal pressure for different types of buildings and regions – Flat roof, Pitched Roof, Sign board, Structural glazing, Water tank on shaft staging, Multi-storey Frames - Load path for Lateral loads.			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply		
Module-3			

Seismic Loads: IS 1893: Buildings : Nature and Magnitude, Centre of mass and rigidity, Calculation of Design Seismic Force by Static Analysis Method, Dynamic Analysis Method, Location of Centre of Mass, Location of Centre of Stiffness, and Lateral Force Distribution as per code provisions. - Load path for Lateral loads – Floor diaphragm action.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-4

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.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-5

Types of Analysis and Structural forms of Tall Buildings: Linear, Nonlinear behavior, Material nonlinearity, Geometric nonlinearity, Rigid and Elastic Supports, First Order Elastic Analysis, Second Order Elastic Analysis, First order Inelastic Analysis, Second order Inelastic Analysis – Concepts and Brief descriptions Structural forms in Tall buildings – Rigid frame, Braced Frames, Shear Walls, Core walls, Tubular, Belt truss, Outrigger.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Course outcomes:

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

1. Apply the load combination for design of structural elements.
2. Apply wind loads to different types of buildings and structures.
3. Design buildings for seismic loads
4. Compute appropriate vehicle loads on bridge structure.
5. Analyse structural elements of tall buildings

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

IS Codes : IS 875 Parts (1 to 5), IS 1893, IRC 6-2014,

Textbook/ Textbooks

(1) L. S. Srinath, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co, 2010.

Reference Books

(1) An explanatory Handbook on IS 875 (PART 3); Wind Load on Building and Structures, Document No: IITK- GSDMA Wind 07 V1.0 - IITK-GSDMA Project on Building Codes

(2) Explanatory Examples on Indian Seismic Code IS 1893 (Part I): Document No. IITK-GSDMA-EQ21-V2.0 - IITK-GSDMA Project on Building Codes.

(3) Aslam Kassimali, Matrix Analysis of Structures, CengageLearning, 2012

APPLICATIONS OF IOT IN CIVIL ENGINEERING			
Course Code	20CAS331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Internet of Things, promises, definition, scope, sensors for IoT applications, structure of IoT, IoT Map device

Industry Sensors: Definitions and Characteristics of first generation sensors, advanced generation sensors, Integrated IoT sensors, Polytronics systems, Sensor Swarm, Printed Electronics and IoT generation Road Map

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,

Module-2

Basics of Networking, Communication Protocols, Sensor Networks, Machine to Machine Communications, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,

Module-3

Internet of Things devices and sensors for collecting job site data, construction crew management, construction equipment management, IoT adoption to enhance productivity, maintenance, safety and security in construction industry.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,

Module-4

Structural health monitoring using Internet of Things and Microelectromechanical systems (MEMS) – introduction to MEMS, wireless sensor networks, smart sensors.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Module-5

Piezo sensors, Piezo generators & IoT, case studies of IoT & MEMS application in civil infrastructure projects.

Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply

Course outcomes:

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

1. Understand the basics of IoT, types of sensors & devices used.
2. Understand the basics of networking for M2M communications & programming
3. Interpret the adoption of IoT in various civil engineering activities
4. Illustrate the use of IoT & MEMS in structural health monitoring

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Reference Books

(1) Ashwin Pajankar, Internet of Things with Arduino and Bolt, BPB Publications (2018)

(2) Krishnan Saravanan, Implementation and Deployment of IoT Projects in Smart Cities, IGI Global Publications (2020)

(3) Qusay F Hassan, Internet of Things A to Z: Technologies and Applications, Wiley-IEEE Press (2018)

(4) ICCCBE 2020, Proceedings of the 18th International Conference on Computing in Civil and Building Engineering, Springer (2020)

ADVANCES IN ARTIFICIAL INTELLIGENCE			
Course Code	20CAS332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Module-1			
Introduction: What is AI? Foundations of AI, History of AI, Agents and environments, The nature of the Environment, Problem solving Agents, Problem Formulation, Search Strategies			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply, L_4 – Analyse.,		
Module-2			
Knowledge and Reasoning: Knowledge-based Agents, Representation, Reasoning and Logic, Prepositional logic, First-order logic, Using First-order logic, Inference in First order logic, forward and Backward Chaining			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply		
Module-3			
Learning: Learning from observations, Forms of Learning, Inductive Learning, Learning decision trees, why learning works, Learning in Neural and Belief networks			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply, L_4 – Analyse.		
Module-4			
Practical Natural Language Processing: Practical applications, Efficient parsing, Scaling up the lexicon, Scaling up the Grammar, Ambiguity, Perception, Image formation, Image processing operations for Early vision, Speech recognition and Speech Synthesis			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply		
Module-5			
Robotics: Introduction, Tasks, parts, effectors, Sensors, Architectures, Configuration spaces, Navigation and motion planning, Introduction to AI based programming Tools			
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply		
Course outcomes: At the end of the course the student will be able to: 1. Explain the history of AI and formulate problems and search strategies. 2. Adopt different methods of reasoning and logic for problem identification. 3. Practice different forms of learning. 4. Carry out language processing and speech recognition and speech synthesis processes. 5. Study basics of robotics and AI based programming tools.			
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each			
Textbook/ Textbooks			
(1) Stuart Russell, Peter Norvig: "Artificial Intelligence: A Modern Approach",2nd Edition, Pearson Education, 2007.			
(2) Yagna Narayana B., Artificial Neural Networks., PHI, 2004			
Reference Books			
(1) E. Rich and K. Knight., Artificial Intelligence , 2nd Edition, McGraw Hill, 1991			

(2) Patterson, D. W., Introduction to Artificial Intelligence and Expert Systems –PHI, 2005

(3) Giarratano, J. C., G. D. Riley, Expert Systems: Principles and Programming- 4 Ed, Thomson. 2005.

NUMERICAL METHODS AND PROGRAMMING			
Course Code	20CAS333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1	
Solutions of linear equations: Direct method – Cramer's rule, Gauss – Elimination method- Gauss –Jordan elimination – Triangulation (LU Decomposition) method – Iterative methods Jacobi – Iteration method – Gauss – Siedel iteration, Successive over –relaxation method. Eigen values and Eigen vectors: Jacobi Method for symmetric matrices- Given's method for symmetric matrices-Householder's method for symmetric matrices-Rutishauser method of arbitrary matrices – Power method	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply
Module-2	
Interpolation: Linear Interpolation - Higher order Interpolation – Lagrange Interpolation – Interpolating polynomials using finites differences- Hermite Interpolation - piece- wise and spline Interpolation	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply
Module-3	
Finite Difference and their Applications: Introduction- Differentiation formulas by Interpolating parabolas – Backward and forward and central differences- Derivation of Differentiation formulae using Taylor series- Boundary conditions- Beam deflection – Solution of characteristic value problems- Richardson's extrapolation- Use of unevenly spaced pivotal points- Integration formulae by interpolating parabolas-Numerical solution to spatial differential equations.	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply
Module-4	
Numerical Differentiation: Difference methods based on undetermined coefficients. Optimum choice of step length– Partial differentiation. Numerical Integration: Method based on interpolation-method based on undetermined coefficient – Gauss – Lagrange interpolation method- Radaua integration method-composite integration method – Double integration using Trapezoidal and Simpson's method	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply
Module-5	
Ordinary Differential Equation: Euler's method – Backward Euler method – Mid point method – single step method, Taylor's series method- Boundary value problems.	
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding. L_3 – Apply
Note: 1. Emphasis shall be on developing algorithms/ flow charts and converting them into working programs. **2.** Programs can be written in C/ C++ / MATLAB or any other programing language that the students find suitable	
Course outcomes: At the end of the course the student will be able to: 1. Obtain solutions to linear equations by various methods 2. Carry out higher order interpolation of polynomials using finite difference method. 3. Apply finite difference method and find numerical solutions to spatial differential equations. 4. Carry out numerical integration to find solutions to engineering applications. 5. Find out solutions to ordinary differential equations using different methods	

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

(1) Gerald, C.F. and Wheatley, P.O., Applied Numerical Analysis, 6ed., Pearson Education, 1999.

(2) Chapra, S.C. and Canale, R.P., Numerical Methods for Engineers with Programming and Software Applications, 3 Ed., Tata McGraw Hill, New Delhi, 1998.

Reference Books

(1) Schilling, R.J. and Harries, S.L., Applied Numerical Methods for Engineers using Matlab and C, Thomson Brooks/Cole, 2000

STRUCTURAL OPTIMIZATION - THEORY & COMPUTATIONS			
Course Code	20CAS334	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: 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.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. , L_4 – Analyse

Module-2

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

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_4 – Analyse, L_5 – Evaluate

Module-3

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

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse, L_5 – Evaluate

Module-4

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

Revised Bloom's Taxonomy Level	L_2 – Understanding. L_3 – Apply, L_4 – Analyse, L_5 – Evaluate

Module-5

Geometric programming: Geometric 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.

Revised Bloom's Taxonomy Level	L_4 – Analyse, L_5 – Evaluate

Course outcomes:
At the end of the course the student will be able to:
1. Formulate structural optimization problems.
2. Carry out linear programming by solving a system of linear simultaneous equations.
3. Apply different non-linear programming methods
4. Apply constrained optimization techniques for structural engineering problems.
5. Undertake geometric and dynamic programming techniques to structural engineering problems

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each

Textbook/ Textbooks

(1) Spunt, L., Optimum Structural Design, Prentice Hall, 1971.

(2) Bhavikatti S. S., Structural optimization using sequential linear programming, Vikas publishing, 2003.

Reference Books

(1) Rao S. S., Optimization – Theory and Practice, Wiley Eastern Ltd. 1978

(2) Uri Kirsch, Optimum Structural Design, McGraw Hill, New York, 1981.

(3) Bronson R. and, Govindsami N., Operation Research, Schaum's Outline Series, 2017.

PROJECT WORK PHASE – 1			
Course Code	20CAS34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation
CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

MINI PROJECT			
Course Code	20CAS35	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

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

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

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

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

CIE procedure for Mini - Project:
The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination
SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	20CASI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

To put theory into practice.

To expand thinking and broaden the knowledge and skills acquired through course work in the field.

To relate to, interact with, and learn from current professionals in the field.

To gain a greater understanding of the duties and responsibilities of a professional.

To understand and adhere to professional standards in the field.

To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.

To identify personal strengths and weaknesses.

To develop the initiative and motivation to be a self-starter and work independently. ■

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics. ■

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson. ■

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

PROJECT WORK PHASE -2			
Course Code	20CAS41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

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

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

Course outcomes:

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

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

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■