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UNIVERSITY OF MUMBAI

Syllabus for the M.E. (Civil)

Programme : M.E.

Course : Civil Engineering

(Structural Engineering Subjects)

(As per Credit Based Semester and Grading System with effect from the academic year 2012–2013)

Program Structure For Master Of Engineering

ME Civil Engineering

(Structural Engineering Subjects)

University of Mumbai

(With Effect from 2012-2013)

Semester I

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
STC101	Non Linear Analysis.	04	--	--	04	--	--	04
STC102	Theory of Elasticity and Plasticity.	04	--	--	04	--	--	04
STC103	Advanced Structural Mechanics.	04	--	--	04	--	--	04
STE101X	Elective I	04	--	--	04	--	--	04
STE102X	Elective II	04	--	--	04	--	--	04
STL101	Laboratory I	--	02	--	--	01	--	01
STL102	Laboratory II	--	02	--	--	01	--	01
Total		**20**	**04**	**--**	**20**	**02**	**--**	**22**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
STC101	Non Linear Analysis.	20	20	20	80	03	--	--	100
STC102	Theory of Elasticity and Plasticity.	20	20	20	80	03	--	--	100
STC103	Advanced Structural Mechanics.	20	20	20	80	03	--	--	100
STE101X	Elective I	20	20	20	80	03	--	--	100
STE102X	Elective II	20	20	20	80	03	--	--	100
STL101	Laboratory I	--	--	--	--	--	25	25	50
STL102	Laboratory II	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	**--**	**50**	**50**	**600**

Semester II

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
STC201	Finite Element Analysis	04	--	--	04	--	--	04
STC202	Theory of Plates and Shells	04	--	--	04	--	--	04
STC203	Advance Design of Concrete Structures	04	--	--	04	--	--	04
STE201X	Elective-III	04	--	--	04	--	--	04
STE202X	Elective-IV	04	--	--	04	--	--	04
STL201	Laboratory - III	--	02	--	--	01	--	01
STL202	Laboratory - IV	--	02	--	--	01	--	01
Total		**20**	**04**	--	**20**	**02**	--	**22**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract / oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
STC201	Finite Element Analysis	20	20	20	80	03	--	--	100
STC202	Theory of Plates and Shells	20	20	20	80	03	--	--	100
STC203	Advance Design of Concrete Structures	20	20	20	80	04	--	--	100
STE201X	Elective-III	20	20	20	80	03*	--	--	100
STE202X	Elective-IV	20	20	20	80	03	--	--	100
STL201	Laboratory - III	--	--	--	--	--	25	25	50
STL202	Laboratory - IV	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	--	**50**	**50**	**600**

* Indicate duration of the paper for the subject “Prestressed Concrete” (Elective – III) shall be of **four** hours.

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
STS301	Seminar	--	06	--	--	03	--	03
STD301	Dissertation I	--	24	--	--	12	--	12
Total		--	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract. / Oral	Total
		Internal Assessment			End Sem. Exam.			
		Test1	Test 2	Avg.				
STS301	Seminar	--	--	--	--	50	50	100
STD301	Dissertation I	--	--	--	--	100	--	100
Total		--	--	--	--	**150**	50	**200**

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
STD401	Dissertation II	--	30	--	--	15	--	15
Total		--	30	--	--	15	--	15

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract./ Oral	Total
		Internal Assessment			End Sem. Exam.			
		Test1	Test 2	Avg.				
STD401	Dissertation II	--	--	--	--	100	100	200
Total		--	--	--	--	**100**	**100**	**200**

Elective-I (Any One)	Elective-II (Any One)
Experimental Stress Analysis	Structural Optimization
Analysis of Composite Structures	Advanced Foundation Engineering
Structural Reliability	Structural Stability

Elective – III (Any One)	Elective – IV(Any One)
Prestressed Concrete **(Exam duration 4 hrs)**	Offshore Structures
Advanced Numerical Methods	Structural Dynamics
Management in Structural Engineering	Bridge Engineering

Note:

- In case of Seminar, 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I, 02 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation II, 02 Hour / week / student should be considered for the calculation of load of a teacher

- **End Semester Examination:** In all six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

Semester I

Subject Code	Subject Name	Credits
STC101	**NON LINEAR ANALYSIS**	**04**

Detailed Syllabus

Sr. No	Sub Sr. No	Content
1		Elastic Stability
	1.1	Geometric Non linearity-Basic concepts.
	1.2	Analysis of beams-Columns with various end conditions, use of trigonometric series.
	1.3	Elastic buckling of bars, Euler's formula, buckling of continuous beams, buckling of non-prismatic members, effect of shear force on buckling of bars, use of energy method and finite difference method.
	1.4	Buckling of single span portal frames.
	1.5	Torsional buckling: Pure torsion of thin walled beams of open cross section, Warping and warping rigidity, Torsional buckling of columns, combined buckling by torsion and flexure.
	1.6	Lateral tensional buckling of beams, Lateral buckling of beams in pure bending, Lateral torsional buckling of cantilever and S.S beams.
	1.7	Indian codal provisions regarding buckling of steel members–column and beams.
2		Plastic analysis.
	2.1	Concepts of plastic analysis of steel structures, stress strains relations.
	2.2	Shape factor-Plastic modulus, Plastic hinge, fully plastic moment, Moment curvature relations.
	2.3	Determination of collapse Load-Single and multiple span beams, carrying various types of loads.
	2.4	Collapse load analysis of pin jointed frames, Single/multiple span rigid jointed portal frames and single bay gable frames.
	2.5	Use of statically and mechanism method for calculation of collapse load, Lower and upper bound theorems, various types of failure mechanisms.
	2.6	Effect of axial force and shear force on fully plastic moment of a section.
	2.7	Design of beams and singe span rigid jointed frames subjected to a system of proportionate loading as per Indian Code Provisions.

Books Recommended:

(1) Timeshenko S., "Theory of Elastic Stability", McGraw Hill Book Co.
(2) Baker and Hayman, "Plastic Design of Steel Frames", Cambridge University Press
(3) Hodge, "Plastic Analysis of Structures", McGraw Hill Book Co.

Semester I

Subject Code	Subject Name	Credits
STC102	**THEORY OF ELASTICITY AND PLASTICITY**	**04**

Detailed Syllabus

Sr. No	Sub Sr. No	Content
1		Revision: Stress transformation and Strain transformation at a point in an elastic body, 3D Problems, Rigid body translation and rotation of an element in space. Generalized Hook law, Separation of Elastic Strains and rigid body displacement for a general displacement field u, v, w. Principal Stress and Strains.
2		Two Dimensional Problems in Elasticity- Plane Stress and Plane Strain Problems. Differential equations of equilibrium and compatibility equations. Boundary Conditions & Stress Functions.
	2.1	Problems in Rectangular coordinates, Polynomial solutions, Cantilever loaded at the end, Simply supported load beam under uniformly distributed load, linear loading.
	2.2	Two dimensional problems in polar coordinated, stress distribution symmetrical about an axis, pure bending of curved bar, Displacement for symmetric loaded cases, Bending of curved bar by forces at end. Effect of circular hole in plate under in plane loading. Concentrated load at point of Straight boundary. Stresses in circular disk. Forces acting on end of wedge.
3		Three dimensional problems in Elasticity.
	3.1	Differential equation of equilibrium in 3D, Condition of Compactibility, Determination of Displacement, Principal of superposition, Uniqueness theorem.
	3.2	Problems of Rods under axial stress, Bar under its own weight, Pure bending of Prismatic roads.
	3.3	Torsion of Prismatic bars of Elliptical, rectangular, triangular and other sections. Membrane analogy-Torsion of narrow rectangular bars. Torsion of hollow shaft and thin tubes.
4		Bending of Prismatic bars as a problem of elasticity in 3D. Bending of a cantilever, Stress function, Circular and rectangular sections, Non symmetrical cross section. Shear centre for different cross sections of bars, Calculation of deflections.
5		Energy Theorems-Applications of complimentary energy theorems to the problems of elasticity.
6		Introduction to plasticity, Criteria of yielding, strain hardening, rules of plastic flow, different stress strains relations. Total Strain theory, theorems of limit analysis. Elastoplasic bending and torsion of bars.

Books Recommended:

(1) Wang, “Applied Elasticity”, McGraw hill book Co.

(2) Timoshenko, “Theory of Elasticity”, McGraw hill book Co.

(3) J. Chakrabarti, “Theory of Plasticity”, McGraw hill book Co.

Semester I

Subject Code	Subject Name	Credits
STC103	**ADVANCED STRUCTURAL MECHANICS**	**04**

Detailed Syllabus

Sr. No	Content
1	Unsymmetrical bending, flexural stresses due to bending in two planes, shear center, bending of unsymmetrical section.
2	Bending of beams with large initial curvature. Application of analysis of hooks, bends and curved links, etc.
3	Beams curved in plans loaded perpendicular to there plane, Fixed and continuous curved beams.
4	Theories of failure, Max stress theory, max shear stress theory, max strain theory, Von Mises & Trescas failure theories.
5	Beams on Elastic foundation, Beams of unlimited length, Semi infinite lengths and finite lengths on elastic foundation.
6	Analysis deep beams, determination of stresses and deflection.

Recommended Books:

(1) Wang, “Applied Elasticity”, McGraw hill book Co.
(2) Timoshenko, “Theory of Elasticity”, McGraw hill book Co.
(3) J. Chakrabarti, “Theory of Plasticity”, McGraw hill book Co.
(4) Timoshenko S., “Strength of Materials Vol – I & II”, CBS Publishers
(5) Shames I. H., “Mechanics of Deformable Solids”, Prentice Hall India
(6) Boresi A. P., “Advanced Mechanics of Material”, John Wiley & Sons.
(7) Srinath L. S., “ Advanced Mechanics of Solids”, Tata McGraw Hill

Semester I

Subject Code	Subject Name	Credits
STE101X	**EXPERIMENTAL STRESS ANALYSIS (ELECTIVE -I)**	**04**

Detailed Syllabus

Sr. No	**Content**
1	Introduction to general Experimentation- Need, Role and limitations, properties of engineering materials, Failure due to excessive stresses, Buckling, Fatigue, creep, impact. Testing machines for standard tests.
2	Strain measurements, types of strain gauges, Electrical resistance strain gauges, Cross sensitivity factor, Gauge indicators, Analysis of strains at a point, Measurement of dynamic strains, Galvanometer and Oscilloscope.
3	Model analysis basic concepts, model materials and their properties, dimensional analysis, means of application of forces, means of measurement of forces and displacements. Calculation of displacement in Prototypes.
4	Photo elasticity: Basic concepts, stress optic laws, Isoclinic's, Isochromatics, Material fringe value, Application to determination of stress in beams, rings and discs.
5	Non destructive methods of testing of concrete. Basic concepts in Ultrasonic testing, Schmidt Hammer, Magnetometer Determination of strength and quality of concrete using above methods. Determination of corrosion/ carbonation in R.C member Reviews of various other Non destructive techniques for determining quality of concrete Concept of condition survey of a structure, Load testing of structures, Codal provisions for load testing and Non destructive testing of concrete structures.

Books Recommended:

(1) Dally and Riley, "Experimental Stress Analysis", McGraw Hill Book Co.
(2) M-Frocht, "Photoelasticity", John Wiley.
(3) Bungy S., "Testing of Concrete in Structures", Survey University Press.
(4) Ramarutham: Experimental Stress Analysis, Dhanpatrai and Publishers

Semester I

Subject Code	Subject Name	Credits
STE202X	**ANALYSIS OF COMPOSITE STRUCTURES (ELECTIVE - I)**	**04**

Detailed Syllabus

Sr. No	**Content**
1.	Constituents Materials for composites-fibre and matrix.
2.	Structural application of composites .Fabrication processes.
3.	Mechanical behaviour of composites.
4.	Stress –strain relations for orthotropic materials.
5.	Lamina stress-strain relations.
6.	Stress, vibration and buckling analysis of laminates bars beams, arches, plates and shells.
7.	Strength of Lamina, failure criteria.
8.	Hygrothermal behaviour.
9.	Shear deformation theories for laminates.

Recommended Books:

(1) Jones R.M.,Mechanics of Composite Materials ,Mc Graw Hill ,Tokyo.

(2) Christensen R.M.,Mechanics of Composite Materials,John Wiley & Sons ,New York.

(3) Agarwal B.D. and Broutman , L.J.Analysis and performance of fibre Composite .John Wiley & Sons, New York.

(4) Calcote L.R., The Analysis of Laminated Composite Structures,Van Nostrand Reinhold Co., New York .

(5) Holmes, M and Just, D.J.GRP in Structural Engineering, applied Science Publishers, London.

(6) Gibson R.F., Principles of Composite Material Mechanics.

(7) Reddy J.N., Analysis of Composite Laminated Plates, Mc Graw Hill.

Semester II

Subject Code	Subject Name	Credits
STE101X	**STRUCTURAL RELIABILITY (ELECTIVE - I)**	**04**

Detailed Syllabus

Sr. No	Content
1.	Concepts of structural safety: Design Methods, statistics and probability; data reductions, histograms, sample correlation, random variable, discrete and continuous variables and common probability distribution.
2.	Resistance distribution and parameters: Statistical analysis of materials, steel, concrete, bricks and mortor; Dimensional variations, characterization of variables and allowable stresses based on specified reliability. Probabilistic analysis for live load, gravity load and wind load.
3.	Computation of basic structural reliability, reliability analysis of simple element such as beam and column. Reliability methods, basic variables, first order second moment methods (FOSM) and concept of reliability index. Reliability of structural systems: Redundant and non-redundant systems, series, parallel and mixed systems.
4.	Monto Carlo Methods of Analysis: Study of structural safety- generation of random numbers – continuous, discrete and jointly distributed variables- Application to reliability analysis of concrete structures.
5.	Reliability based design: Load and resistance factors of design, safety checking formats and code calibrations, ARE Code provision, Introduction to stochastic process.
6.	Decision Analysis: Introduction, simple risk decision problems, decision problems, decision models, decision tree, decision criteria, decision based on existing information, prior analysis.

Books Recommended:

(1) R.Ranganatham: Reliability Analysis and Design of Structures, Mc Graw- Hill
(2) Edward Haugen: Probabilistic Approaches to Design, John Wiley and Sons, London
(3) R.E. Melchers, Structural Reliability- Analysis and Prediction, Ellis Horwood Ltd., Chichester, UK

Semester I

Subject Code	Subject Name	Credits
STE102X	**STRUCTURAL OPTIMIZATION (ELECTIVE – II)**	**04**

Detailed Syllabus

Sr. No	Content
1	**Introduction of Optimization**: Historical development-Engineering Applications of optimization.
2	**Classical optimization Techniques**: Single variable Optimization. Multivariable Optimization with no Constrains. Multivariable optimization with Equality and the Quality Constraints.
3	**Linear programming**: Simplex Method-Simplex Algorithm.
4	**Non Linear Programming**: One dimensional Methods-Elimination Methods-Unrestricted Search-Exhaustive Search-Fibonacci Method-Golden Section Method Interpolation method-Quadratic and cubic Interpolation Methods-Direct Root Method.
5	**Non-linear programming**: Unconstrained Optimization Techniques-Direct Search Method-Random Search, Univariate and Pattern Search Methods- Descent Methods-Gradient of a function-Steepost Descent Method-Fletcher- Reeves Conjugate Gradient Method, Quasi Newton Method, Dividon Fletcher Powells Variable Metric method.
6	**Non Linear Programming**: Constrained Optimization Technique- Direct Methods-Methods of Feasible Direction- Indirect Methods- Transformation Techniques-Basic Approach in the Penalty Function Method- Interior and Exterior Penalty function methods.
7	Introduction to Dynamic programming.
8	Introduction to CPM and PERT.
9	Application of above method to some Structural Engineering problems.

Recommended Books:

(1) Rao S. S. , “Optimization – Theory and Applications”, Wiley Eastern

(2) Fox R. L., “Principles of Operation Research”, Prentice Hall of India.

(3) Wagner H.M., “Principles of Operation Research”, Prentice Hall of India.

(4) Gass S.I., “Linear Programming”, McGraw Hill Book.Co.

(5) Srinath L.S. “PERT and CPM - Principles and Applications”, East-West Press.

Semester I

Subject Code	Subject Name	Credits
STE102X	**ADVANCED FOUNDATION ENGINEERING (ELECTIVE – II)**	**04**

Detailed Syllabus

Sr. No	Content
1	**Consolidation:** One dimensional consolidation, Terzaghi's theory, Derivation of equation , determination of a_v, m_v, C_c, C_v from laboratory tests, determination of Pe by various methods, field consolidation curve, secondary consolidation, quassi-pre consolidation, three dimensional consolidation, practical applications
2.	**Shear strength:** Coulomb's law of shear strength, Mohr- Coulomb's Criteria of failure, shear strength and shear strain behaviour of sandy and clayey soils under un- drained, drained and consolidated drained conditions, concept of progressive failure, critical void ratio, and practical applications.
3.	**Estimation of stresses in soils:** Boussinesque and Westergaard's theories, Newmark Chart, Practical applications.
4.	**Geotechnical investigations**: Sub-surface ground investigations, direct methods of explorations, influence of types of soils, types of foundations, etc. on the programme of exploration, lateral extent and depth of exploration, bore log details, profiles of soil in various directions, indirect methods and practical applications.
5	**Bearing capacity of soil and Shallow foundations:** Type of shallow foundations, gross load and net load, gross and net ultimate bearing capacity, safe bearing capacity and allowable bearing pressure, modes of failure, criteria of failure, Bearing capacity theories postulated by Terzaghi and Mayerhof, Compressibility (including critical rigidity index) criteria, Factor of safety, Bearing capacity of clay and sand in settlement, settlement analysis for clay, normally and over consolidated soils, settlement analysis of sand, Schemertmann method, practical applications
6.	**Pile foundation**: Axially loaded and laterally loaded piles, Bearing capacity of soils. Necessity of piles, types of piles, static and dynamic resistance of pile; Pile load carrying capacity using dynamic formulae and their limitations, Pile load carrying capacity using Terzaghi's, Meyerhof's , Berzantsv's, Vesic's, Indian Standards 2911 (Part I and II) method, settlement of pile in clay, Pile groups, Load carrying capacity in sandy and clayey soils, group efficiency, group settlements, practical application
7.	**Ground improvement**: Principles, necessity, various methods of ground improvement, sand

	drains, stone column, stabilization, grouting, reinforced earth, geotextiles, and diaphragm wall
8	**Geosynthetics:** Types Applications: (a) Reinforcement (b) Separator (c) Filteration (d) Drainage Mechanism of how it works Basic design concepts for all above applications.

Books Recommended:

(1) Taylor D. W., Foundation of Soil Mechanics, Asia Publications, Bombay.
(2) Terzaghi & Peck, Soil Mechanics in Engineering Practice, Wiley & Sons.
(3) Bowels J. E., Foundation Analysis and Design, McGraw Hill Book co.
(4) Dr. Alamsingh, Soil Mechanics and Foundation Engineering, Vol. I- II. Standard Book House.
(5) Dr. Alamsingh, Geotechnical Engineering, Standard Book House
(6) Dr. B.C.Punimia, Soil Mechanics and Foundation Engineering.
(7) Dr. Koner, Designing with Geosynthetics.
(8) Swami Saran, Analysis and Design of Substructures. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Semester I

Subject Code	Subject Name	Credits
STE102X	**STRUCTURAL STABILITY (ELECTIVE – II)**	**04**

Detailed Syllabus

Sr. No	Content
1	Fundamental concepts, elastic structural stability, structural instability, analytical methods for the stability analysis, equilibrium, imperfections and energy methods.
2	Elastic buckling of columns, assumptions, critical load for various boundary conditions, columns with geometric imperfection, large deflection theory of columns, Southwell plot, Orthogonality of buckling modes, eccentrically loaded columns, numerical techniques – Finite difference and Finite element approach.
3	Elastic buckling of beam-column, differential equations of beam-column, beam-column with concentrated point load, several point loads, continuous lateral load, single couple, uniformly distributed load, end couples.
4	Elastic buckling of frames, triangular, partial, multi-storey portal and box frames with symmetric & anti symmetric buckling, stiffness method approach, approximate method, buckling of open sections, torsional buckling.
5	Elastic buckling of thin plates, equilibrium approach, rectangular plate with axial load in one and two directions, various boundary conditions, Energy methods – Rayleigh Ritz and Gelerkin, large deformation theory of plates and effective width concept, post buckling behaviour of plates.
6	Dynamic stability of structures, objectives, Hamilton and Lagrange's equation for discrete and continuous systems, pulsating load on a column.

Recommended Books:

(1) Timoshenko S.P. and Gere J.M., Theory of Elastic Stability, Mc Graw Hill, Singapore.
(2) George Gerard, Introduction to Structural Stability Theory, Mc Graw Hill, New York.
(3) Iyenger N.G.R., Elastic Stability of Structural elements, Mc Millan, India.
(4) Ashwini Kumar, Stability of Structures, Allied Publishers, New Delhi.

Semester I

Subject Code	Subject Name	Credits
STL101	**(Laboratory Practice - I)**	**01**

Detailed Syllabus

Sr. No	**Content**
1	This will be based on the syllabi of theory subjects [MSTR-C101, MSTR-C102 and MSTR-C103]. It shall consist of the assignments based on the syllabus of the respective subjects. The assignments should be given in such a manner that it will cover the contents of the syllabus evenly.
2.	The students shall be encouraged to deliver the seminar pertaining to any one of the topics in each above subject heads.

Semester I

Subject Code	Subject Name	Credits
STL101	**(Laboratory Practice - II)**	**01**

Detailed Syllabus

Sr. No	**Content**
1	This will be based on the syllabi of theory subjects [MSTR-E101 X and MSTR-E102 X]. It shall consist of the assignments based on the syllabus of the respective subjects. The assignments should be given in such a manner that it will cover the contents of the syllabus evenly.
2.	The students shall be encouraged to deliver the seminar pertaining to any one of the topics in each above subject heads.
3.	At least one site visit and preparation of study report of various case studies for actual field/ practice oriented problems for each of the above subjects and/ or the, students may be asked to perform few practical of the related subject and submit the report thereof.

Semester II

Subject Code	Subject Name	Credits
STC201	**FINITE ELEMENT ANALYSIS**	**04**

Detailed Syllabus

Sr. No	Content
1	Review of Variation methods- Calculus of variation- Variotional Principles of solid Mechanics. Principle of Minimum Potential Energy, Principle of Complementary Energy-Hamilton Principle.
2	The Basic component-Concept of an element-Various Element Shapes-Displacement models-Formulation of Finite Element Method. Using principle of virtual Displacement-Derivation of Element Stiffness and loads for Pin Jointed Bar element, Beam element, Triangular Plate element (In plane forces), Triangular and Rectangular Plate Element in Bending.
3	Variational Formulation of Finite Element Method (FEM)
4	Isoparametric element-Local vs. Natural Co-ordinates system, Line, Triangular, Quadrilateral and Tetrahedral Element-Interpolation Displacement Models Formulation of Isoparametric Finite element matrices in Local and Global Coordinate system.
5	Implementation of FEM-Discretization of the Structure-Calculation of Element Stiffness, Mass and Equivalent Nodal Loads, Assemblage of Structures Matrices, Boundary Conditions-Solutions of the overall problem. Calculations of Element Stresses, Computer Program Organization.
6	Introduction to Non Linear Analysis-Geometric Non-Linearity- Geometric Stiffness of an Axial Element, Stability of Bar Spring System. General Formulation of a Geometrically Non linear Problem. Geometric Stiffness of a Beam-Column of Triangular element. Non linear material behavior. Non linear spring-Elastic Plastic Analysis by FEM-Elasto-Plastic Analysis of Truss-Two Dimensional Element Formulations-General Formulation of a Physically Non-linear Problem.
7	Introduction to Dynamic Analysis by FEM-Formulation of Inertial Properties-Lumped Mass vs. Consistent Mass matrices-Condensation and Assembly of Mass Matrices-Formulation of Dynamic Properties-Free Vibration, Steady-State and Transient Response Analysis for simple Problems.
8	Formulation and solution of Problems in Structural Mechanics using the above methods.

Recommended Books:

(1) Zienkiewicz O.C, “The Finite Element Method in Engineering Science”, McGraw Hill Book Co.
(2) J.N. Reddy, “Finite Element Analysis”, McGraw Hill Book Co.
(3) Chandragupta T.R. and Belagundu A.D., “Introduction to Finite Elements in Engineering”,
(4) Prentice Hall of India Pvt. Ltd.
(5) Rajshekaran S., “Finite Element Analysis”, Wheeler publishing
(6) Krishnamoorthy C.S, “Finite Element Analysis”, Tata McGraw Hill.
(7) Cook R.D., Malkus D.S. and Plesha M.E. “Concepts and Applications of Finite Element
(8) Analysis”, John Wiley & Sons (Asia) Pvt Ltd.
(9) Bickford W.B., “A First Course in Finite Element Method”, IRWIN, Homewood, IL 60430.
(10) Rao S.S, The Finite Element Method in Engineering, Pergamon Press.
(11) Weaver W and Johnston P.R., “Finite Element for Structural Analysis”, Prentice Hall.

Semester II

Subject Code	Subject Name	Credits
STC202	**THEORY OF PLATES AND SHELLS**	**04**

Detailed Syllabus

Sr. No	Content
1	Introduction to theory of plates with small and large deflections: Distinction between Plate and Shell action.
2	Pure bending of Thin Plates, Curvature at a point, Circle of curvature, Moment Curvature relationships, Relationships Between Twisting moment and Twist of Surface.
3	Symmetrical bending of thin circular plates with small deflection under axi-symmetric transverse loads, Differential equation of equilibrium, Different support conditions, Plates with overhangs, Plates with co-axial circular opening.
4	Small deflection theory for lateral loaded thin rectangular plates, Various support conditions, Naviers and Levis solution for uniformly distributed and concentrated loads, Use of numerical technique for the solution of plates, Concept of Influence Surface, Study of simply supported plates with continuous edge moment.
5	Introduction to Structural behavior of thin shells, membrane and bending actions.
6	Mathematical representation of a shell surface, Principal curvatures, Gauss curvature, Classification of shells.
7	Membrane theory of thin shells, Stress resultant, Application to cylindrical shells under symmetrical loads and surfaces of revolution under axi-symmetric loads.
8	Bending theory of open circular cylindrical shell with special emphasis on approximate theories of Finster walder and Shorer theories. Introduction to DJK, Flugg and other exact theories: Different boundary conditions for single and multiple shells.
9	Bending theory of closed circular cylindrical shell, stiffness coefficients at free edges along radial and rotational directions, Bending theory of spherical shells. Geckelers approximations, stiffness coefficients.

Recommended Books:

(1) Timoshenko, ‘Theory of Plates and Shells”, McGraw Hill Book Co.

(2) Chandrashekhara, Analysis of thin concrete shells, McGraw Hill Book Co.

(3) Ramaswamy G.S, Design and Construction of concrete shell Roofs, McGraw Hill Book Co.

(4) Varadan T.K. and Bhaskar K. Analysis of plates Theory and Problems, Narros Publishing House.

Semester II

Subject Code	Subject Name	Credits
STC203	**ADVANCED DESIGN OF CONCRETE STRUCTURES**	**04**

Detailed Syllabus

Sr. No	Sub Sr. No	Content
1.	Ultimate Load Analysis of Concrete Structures.	
	1.1	Stress strain characteristics of concrete and reinforcing steel, review of elastic theory and ultimate strength theory, Whitney's rectangular stress block, analysis and design of singly and doubly reinforced rectangular and T sections.
	1.2	Introduction to the concept of limit design. Moment curvature relationship of reinforced concrete sections, rotation capacity of sections, ultimate load analysis by Cambridge and Baker's method. Application to continuous beams and simple rectangular portal frames.
	1.3	Yield line analysis of slabs virtual work and equilibrium method. Application to orthotropically reinforced rectangular slabs with various boundary conditions under uniformly distributed loads.
2.	Reinforced concrete design by Limit State Method, Review of limit state method as per IS Code-456-2000. Limit state of collapse in flexure, Direct compression, Compression with bending, shear & torsion, Limit state of serviceability for deflection and cracking, application to beam slab system of typical residential, office, industrial floors and rectangular portal frames, Gable ended frames, Bus stop shelter frames.	
3	Large span roofs.	
	3.1	Folded plates roofs- Whitney's Method, Simpsons method and design based on IS Codes.
	3.2	Circular cylindrical shell roofs beam theory of cylindrical shells, Single and multiple bays with various edge conditions.
4		Silos and Bunkers. Lateral pressures as per Janssen's and Airy's theories, Design consideration for square, rectangular and circular shapes, Design of Hopper and Supporting structures using WSM
5.	Special Foundation: Design of Strip footing, Raft foundation, Pile foundation including pile cap.	

Recommended Books:

(1) V. Ramakrishnan and P.D.Arthur, “Ultimate Strength design for structural concrete”, Wheeler Publishing Co.
(2) Karve S.R. and Shah V.C, “Design of reinforced cement concrete structures using Limit State Approach”, Structures Publishers.
(3) G.S Ramaswamy, “Design and construction of concrete shell roofs”, McGraw Book Co.
(4) Jain O.P and Jaikrishna, “Plain and reinforced concrete”, Vol-II, Nemchand and Bros.
(5) Ramamrutham S. Design of reinforced Concrete Structures. Dhanpat Rai and Sons.
(6) P. C. Vargis, Design of Reinforced concrete shells and folded Plates.PHI Learning Pvt. Ltd.
(7) P. C. Varghese, Design of Reinforced concrete Foundation. PHI Learning Pvt. Ltd.
(8) P. C. Varghese, Advanced Reinforced Concrete Design, PHI Learning Pvt. Ltd.
(9) Ramachandra, Design of Concrete Structures Vol. I & II. Standard Book House.

Semester II

Subject Code	Subject Name	Credits
STE202X	**PRESTRESSED CONCRETE (ELECTIVE - III)**	**04**

Detailed Syllabus

Sr. No	Content
1.	Introduction to basic concept and general principles of prestressed concrete. Materials used in prestressed concrete and methods and techniques of prestressing. Prestressing system.
2.	Analysis of prestressed concrete section for flexure considering loading stages, computation of sectional properties, critical sections under working loads for pre tensioned and post tensioned members .load balancing method of analysis of prestressed concrete beams. Losses in prestress. Aplication to simply supported beams and slabs.
3.	Design philosophy of prestressed concrete section .Permissible stresses in concrete and steel. Design approaches using working stress method as per IS 1343-1980.Limit State of collapse-flexure and shear as applied to prestressed concrete beams .Kern points ,choice and efficiency of sections, cables profiles and layouts, cable zone ,deflection of prestressed concrete members.
4.	End zones stresses in prestressed concrete member's .pre-tensioned transfer bond, transmission length. End blocks of post tensioned members.
5.	Design of simply supported pre-tensioned and post-tensioned slabs and beams.
6.	Design of bridge girder subjected to IRC loading
7.	Analysis and design of composite concrete prestressed structures
8.	Introduction to application of prestressing to continuous beams .Linear transformation and concordancy of cables.

Recommended Books:

(1) T.Y.Lin, Design of Prestressed Concrete Structures, John Wiley Publishers.
(2) N.Krishna Raju , Prestressed Concrete ,Tata McGraw Hill.
(3) Y.Guyon, Prestressed Concrete, Contractors Record Ltd.
(4) R.H.Evans & E.W.Bennette, Prestressed Concrete, McGraw Hill Book Co.
(5) S. Ramamrutham, Prestressed Concrete, Dhanpat Rai & Sons.

Semester II

Subject Code	Subject Name	Credits
STE201X	**ADVANCED NUMERICAL METHOD (ELECTIVE – III)**	**04**

Detailed Syllabus

Sr. No	Content
1	**Introduction:** Roots of a non-linear equation and Roots of a polynomial of nth degree [Incremental search method; Method of successive approximations; Newton's method; Bisection method; Secant method; Müller's method; Synthetic division; Bairstow's method] and convergence study.
2	**Solution of (non-homogeneous) linear algebraic equations**: Review of matrix algebra; Gauss elimination method; Cholesky's decomposition method; Householder method; Gauss-Seidal iterative method.
3	**Solution of non-linear algebraic equations**: Method of successive approximation; Newton's method; Modified Newton – Raphson method; Secant method.
4	**Eigen values and Eigen vectors:** Reduction of generalized Eigen value problem to the standard Eigen value problem; methods for obtaining Eigen values and Eigen vectors [Polynomial method; Vector iteration method; Mises power method; Jacobi method].
5	**Time marching schemes for solution of problems in time domain:** Numerical integration (2 – D) [Newton – Cotes method; Gauss – Legendre method].
6	**Solution of differential equations:** Ordinary and partial differential equations, Taylor series, Euler's method; Runge – Kutta method; Simple applications in structural mechanics such as critical loads of struts, beam columns, Solution of transcendental equation, applications of buckling of simple portal frames
7.	**Finite difference method**: Simple applications to problems of beam and plates , Laplacian equation, consolidation equation, laterally loaded piles etc.
8.	**Regression Analysis:** Least square method, Polynomial function curve fitting Interpolation-Polynomial approximation, Lagranges method, Spline interpolation

Recommended Books:

(1) Chapra, S. C. and Canale R. P., "Numerical Methods for Engineering", Tata McGraw Hill.

(2) Carnahan, B., Luther, H. A. and Wilkes, J. O., "Applied Numerical Methods", John Wiley.

(3) Heath, M. T.,"Scientific Computing: An Introductory Survey", McGraw Hill.

(4) Douglas Faires, J. and Richard Burden, "Numerical Methods", Thomson.

(5) Rajasekaran, S., “Numerical Methods in Science and Engineering”, S. Chand.
(6) E. Balguruswamy, “Numerical Methods”, TMH Publications
(7) Pallab Ghosh, “Numerical Methods with Computer Programming in C++”, PHI Pvt. Ltd.
(8) John F.Flemming, “Computer Analysis of Structural Systems”, Mc Graw Hill International Edition
(9) Atkinson, K.E., “An Introduction to Numerical Analysis”, J. Wiley and Sons
(10) Wilkinson, J.H., “The Algebric Eigen Value Problems”, Oxford University Press

Semester II

Subject Code	Subject Name	Credits
STE201X	**MANAGEMENT IN STRUCTURAL ENGINEERING (ELECTIVE - III)**	**04**

Detailed Syllabus

Sr. No	Content
1	Resource Management Human, Time, Materials & Equipments, Finance & Logistic Management
2	Structural Health, factors affecting health of structures, effect of leakage, age, creep, corrosion, fatigue on life of structure. Structural health monitoring. Various measures, regular maintenance, structural safety in alteration. Quality control & assurance of materials of structure, durability of concrete, Factors affecting durability of concrete, Corrosion in structures, Testing and prevention of corrosion, fire safety.
3	Structural Audit, Assessment of health of structure, study of structural drawings, nature of distress, visual observations, Collapse and investigation, limitations on investigator, tools for investigation, Various NDT Methods for assessing strength of distressed materials, investigation management, review of assimilated information, interviews and statements, evaluation and reporting, presentation of report, communication gap among client, architect, consulting engineer & contractor.
4	Retrofitting of Structures, parameters for assessment for restoration strategies, selection of construction chemicals during restoration, Specification for important items of work in restoration, Structural detailing for restoration, and Various techniques of retrofitting.
5	Safety during construction, formwork and staging, material handling, Existing methods of formwork, Modular formwork, Structural aspects for formwork in buildings & bridges.
6	Demolition of Structure, study of structural system and structural drawings, need and importance for demolition, outline of various demolition methods and their evaluation, partial and controlled demolition, role of safety measures, temporary support structures in demolition. Recycling of demolished materials, contracts.

Recommended Books:

(1) Handbook of material management by Deananmmer, McGrawHills
(2) Fundamentals of material management by Gopalkrishnan, Tata McGraw Hills.
(3) Financial Management by M Y Khan and Jain, Tata McGraw Hills
(4) Properties of Concrete by A M Neville, Longman

(5) Durable Structures by R.N.Raikar, R & D Centre, (SDCPL), Raikar Bhavan, Sector 17, Vashi, Navi Mumbai.

(6) R.N. Raikar, 'Learning from Failures', R & D Centre, (SDCPL), Raikar Bhavan, Sector 17, Vashi, Navi Mumbai.

(7) R.N. Raikar, 'Diagnosis and treatment of structures in Distress', R & D Centre, (SDCPL), Raikar Bhavan, Sector 17, Vashi, Navi Mumbai.

(8) Jayakumar J. Shah, A Book – A Handy Guide to Repairs, Rehabilitation and Waterproofing of RCC Building (Structures), Third updated photo-copy set.

(9) Formwork Construction and Practice by Richardson.J.G, VP

(10) Formwork for Concrete Structures by Peurifoy. R.L., Tata McGraw-Hill Publishing Company Limited

(11) Formwork to Concrete by Austin.C.K, Chapman and Hall

(12) Design & Construction of Formwork for Concrete Structures by Wynn.A.E, Concrete Publishing Limited

(13) Demolition and reuse of concrete by Y Kasai, Chapman and Hall

(14) Demolition by Colin Toplins, Construction Press

(15) Demolition Techniques, Construction Press

(16) Demolition of Structures, Report by Mr. Girish Kulkarni, Mumbai

(17) Structural Audit, Report by Mr. Umesh Dhargalkar, Mumbai

(18) Jayakumar J. Shah, An Article – House Keeping of RCC Buildings, Published in April 2001 issue of the Housing Times, Vikas Premises, Fort Mumbai 400001.

(19) Jayakumar J. Shah, An Article – Repairs & Rehabilitation of RCC Buildings (Structures) – Materials and Techniques, Published in March 2002 issue of New Building Materials and Construction World, New Delhi.

(20) Jayakumar J. Shah, An Article – Repairs, Rehabilitation of Structurally Distressed RCC Members of Buildings, Published in July 2000 issue of Construction World, ASAP Media, Mumbai.

(21) J. J. Shah, Point of View – Repair, Rehabilitation and Waterproofing of structures-Some View, Published in April 1998 issue of The Indian Concrete Journal, Mumbai.

(22) Krautkramer, J and Krautkramer,H., Ultrasonic Testing of Materials, Springer-Verlag, Berlin, 1969.

(23) Mani, K and Srinivasan, P., An Article 'Corrosion Damage and its Evaluation by Testing' in Advanced Testing and Evaluation of Structures and Components, Allied Publishres, Chennai, 2002 pp 14.01 – 14.33.

(24) Ouyang, C., Landis, E., and Shah, S.P., An Article, 'Damage Assessment in Concrete using Acoustic Emission,' in Nondestructive Testing of Concrete Elements and Structures, ASCE, New York, 1992, pp 13-24.

(25) Popovics S, and Popovics J.S., An Article, 'A Critique of the Ultrasonic Pulse Velocity Method for Testing Concrete' in Nondestructive Testing of Concrete Elements and Structures, ASCE, New York, 1992, pp 94-103.

(26) Sreenath H.G., An Article, ‘Safety Auditing of Concrete Structures. In Advanced Testing and Evaluation of Structures and Components, Allied Publishres, Chennai, 2002 pp 9.01 – 9.19.

(27) Thandavamoorthy T.S., et al ‘Health Assessment of Concrete Structures by Ultrasonic pulse Velocity Technique an experimental Investigation’, in Building Materials, RRL Bhopal, February 26-27, 2004, pp. 284-89.

(28) Websites for Formwork:

(a) http://www.dir.gld.gov.au/workplace/law/codes/formwork design

(b) www.peri-usa.com/,www.specialformwork.com/

(29) Websites for Demolition of Structures:

(a) www.Howstuffworks.com

(b) www.Findarticles.com

(c) www.historylinks.org

(d) www.implosionworld.com

(e) www.home.earthlik.com

(f) www.seattlepi.com

(g) www.seattletimes.com

(h) www.phillyblast.com

(i) www.usgs.gov

Semester II

Subject Code	Subject Name	Credits
STE201X	**OFFSHORE STRUCTURES (ELECTIVE - IV)**	**04**

Detailed Syllabus

Sr. No	**Content**
1.	Structural forms of offshore structures, loads. Introduction to structural dynamics, Vibration of bars, beams and cones with reference to soil as half-space
2.	Behaviour of concrete gravity platform as a rigid body on soil as a continuum.
3.	Wind load. Effect of size, shape and frequency.
4.	Aerodynamic admittance functions and gust factor
5.	Spectral response due to wind for various types of structures.
6.	Wave loads by Morison equation. Static and dynamic analysis of fixed structures.
7.	Use of approximate numerical methods.

Recommended Books:

(1) Graff W. J. Introduction of Offshore Structures, Gulf Publication.
(2) Clough. R. W and Penzien, J., Dynamics of structures, McGraw Hill Co.
(3) Gerwick.B.C. Construction of Offshore Structures, John Wiley & Sons.

Semester II

Subject Code	Subject Name	Credits
STE201X	**STRUCTURAL DYNAMICS (ELECTIVE - IV)**	**04**

Detailed Syllabus

Sr. No	Sub Sr. No	Content
1.		Introduction to structural Dynamics- Definition of Basic Problem in Dynamics.
	1.1	1 Static vs. Dynamic loads.
	1.2	Different types of dynamics loads.
2.		Introduction to single Degree of freedom (SDOF) Systems.
	2.1	Undamped vibration of SDOF system natural frequency and period of vibration
	2.2.	Damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement
	2.3	Forced vibration, response to periodic loading, response to pulsating forces, dynamic load factor.
	2.4	Response of structure subjected to General dynamic load, Duhamel's Integral Numerical Evaluation of Dynamic Response of SDOF systems
	2.5	Response of structure in frequency domain subjected to general periodic and not periodic/impulsive force of short duration, use of complex frequency response function, use of Fourier series for Periodic Forces.
	2.6	Introduction to vibration isolation.
	2.7	Distributed mass system idealized as SDOF system, use of Rayleigh's method.
	2.8	Response of SDOF system subjected to ground motion
3		Lumped mass multidegree of freedom (MDOF) system, coupled and uncoupled system
	3.1	Direct determination of frequencies of vibration and mod shape.
	3.2	Orthogonality principle.
	3.3	Vibration of MDOF systems with initial conditions
	3.4	Approximate method of determination of natural frequencies of vibration and mode shapes – Vector Integration Method
	3.5	Energy methods and use of Lagrange's method in writing equation of motions decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness.
	3.6	Forced vibration of MDOF system, Modal Analysis. Application to multi-storey rigid frames subjected to lateral dynamic loads.

4		Earthquake analysis – Introduction.
	4.1	Seismicity of a region, causes of earthquake
	4.2	Intensity of earthquake, Richter Scale, Measurement of Earthquake ground motion, Seismogram
	4.3	Application of modal analysis concept to seismic disturbance, Response spectrum method.
	4.4	I.S code provisions for seismic analysis of buildings and water towers.
	4.5	Approximate method of earthquake analysis – Seismic co-efficient method and its limitation
	4.6	Introduction to history analysis
5		Structure with distributed mass system, use of partial differential equation.
	5.1	Free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes
	5.2	Forced vibration of single span beams subjected to the action of specified dynamic loads.

Recommended Books:

(1) Roy R. Carig., Structural Dynamics – An Introduction to computer methods, John Wiley & Sons.

(2) Anil K. Chopra, Dynamics of Structures, Prentice Hall of India.

(3) Clough & Penzsien, Dynamics of Structures McGraw-Hill.

(4) John M. Bigg, Structural Dynamics McGraw-Hill.

(5) Mario Paz, Structural Dynamics Theory and Computation, CBS Publisher.

Semester II

Subject Code	Subject Name	Credits
STE201X	**BRIDGE ENGINEERING (ELECTIVE - IV)**	**04**

Detailed Syllabus

Sr. No	Content
1	Introduction to bridge engineering, classification and components of bridges, layout, planning, Investigation for bridges. Choice of the types of bridges, Conceptual bridge design.
2.	Structural forms of bridge decks, beam and slab decks, cellular decks. Standard specification for bridges, IRC loadings for road bridges, IRS loading standards for railway bridges. Bridge appurtenances.
3	Design of slab culvert, box culvert and skew bridge.
4	Behaviour, analysis and design of RC and PSC box girder bridge decks.
5	Introduction to Courbon's method, Henry-Jaegar method and Guyon-Massonet method. Design of T-beam PC bridges using Courbon's method.
6	Introduction to Structural classification of Rigid Frame bridge, analysis and design of Rigid Frame bridge.
7	Classification and design of bearings. Expansion joints. Forces acting on abutments and piers, analysis and design, types and design of wing walls.
8	Bridge foundations: Shallow and deep foundation – design and construction aspects including open well, pile and caisson foundation.
9	Modern methods of construction of concrete, steel and composite bridges; their impact on analysis and design.
10	Introduction to analysis and design of long span bridges, suspension and cable stayed bridges.

Recommended Books:

(1) D. Johnson Victor - Essentials of Bridge Engineering Fifth Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
(2) T.R. Jagadeesh, M.A. Jayaram - Design of Bridge Structures, Prentice-Hall of India.
(3) N. Krishna Raju - Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
(4) David Lee – Bridge Bearings and Expansion Joints,E & FN Spon.
(5) V.K. Raina – Concrete Bridge Practice Analysis, design and Economics, Tata McGraw Hill.
(6) IRC Codes – IRC: 5, IRC: 6, IRC: 18, IRC: 27, IRC: 45, IRC: 78, IRC: 83.
(7) Joseph E. Bowles – Foundation Analysis and Design, McGraw-Hill International Edition.
(8) Ponnuswamy S. Bridge Engineering, Tata McGraw Hill.

(9) Nainan P. Kurian – Design of Foundation Systems, Narosa Publishing House.
(10) Swami Saran, Analysis and Design of Substructures. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Semester II

Subject Code	Subject Name	Credits
STL201	**(Laboratory - III)**	**01**

Detailed Syllabus

Sr. No	**Content**
1	This will be based on the syllabi of theory subjects [MSTR-C201, MSTR-C202 and MSTR-C203]. It shall consist of the assignments based on the syllabus of the respective subjects. The assignments should be given in such a manner that it will cover the contents of the syllabus evenly.
2.	The students shall be encouraged to deliver the seminar pertaining to any one of the topics in each above subject heads.

Semester II

Subject Code	Subject Name	Credits
STL202	**(Laboratory Practice - IV)**	**01**

Detailed Syllabus

Sr. No	**Content**
1	This will be based on the syllabi of theory subjects [MSTR-E201 X and MSTR-E202 X. It shall consist of the assignments based on the syllabus of the respective subjects. The assignments should be given in such a manner that it will cover the contents of the syllabus evenly.
2.	The students shall be encouraged to deliver the seminar pertaining to any one of the topics in each above subject heads.
3.	At least one site visit and preparation of study report of various case studies for actual field/ practice oriented problems for each of the above subjects and/ or the, students may be asked to perform few practical of the related subject and submit the report thereof.

Semester III

Subject Code	Subject Name	Credits
STS301	**Seminar**	**03**

Guidelines for Seminar

- Seminar should be based on thrust areas in Structural Engineering including materials and allied subjects involving the knowledge of Structural Engineering (e.g. Geotechnical Engineering, Transportation Engineering, Hydraulics Engineering with emphasis in the context soil- structure interaction, fluid- structure interaction, fluid-soil-structure interaction, pavement engineering, etc.)
- The objective behind seminar is to equip the student for carrying out literature survey, summarize the findings of the literature and formulate the problem or arrive upon the statement of the problem. Along similar lines, the student can work for their dissertation in the subsequent stages.
- The student in consultation with the Guide/ Supervisor shall settle or finalize / identify the topic of the seminar in the context of the specialization or allied theme. The students shall carry out literature survey pertaining to the topic, various sub-topics/ approaches/ methods falling within the purview of the topic. The student shall use multiple literatures and understand the topic, analyze the literature and summarize the findings. The report shall be compiled in a standard format. The student shall have to present the deliver the seminar/presentation in front of the board of examiners (refer note below)**.**
- The supervisor may ask the student to author a technical paper based on the seminar report and present it in a seminar or conference of national repute. Publication of paper in an International Conference shall be preferred. The paper could be a review paper.
- The assessment of the seminar shall be assessed in respect of the following points:
  - Quality of Literature survey and Novelty in the topic
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation
  - Efforts made by the students to author a technical paper (preferably of review nature) and its subsequent publication either in the journal or in the conference proceedings and presentation in the conference.

IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.

3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

Semester IV

Subject Code	Subject Name	Credits
STD301 / STD401	**Dissertation (I and II)**	**12**

Guidelines for Dissertation

- Student should carry out the preliminary literature survey and subsequently, identify the problem in broad terms for Dissertation and finalize/ settle it in consultation with Guide/ Supervisor.
- Pursuant to this, the student shall refer multiple literatures pertaining to the theme of the problem and understand the problem and define the problem in the precise terms.
- Student should attempt solution to the problem by analytical/simulation/experimental methods. The solution shall be validated with proper justification. The students shall compile the report in standard format.
- Student should publish at least one paper based on the work in reputed International / National Conference in which papers are blindly reviewed (desirably in Refereed Journal). More weightage shall be given for the journal publication.
- The work to be pursued as a part of the dissertation shall be divided broadly in two parts, namely- Dissertation Stage I and Dissertation Stage II.
- The topic of the Dissertation should be such that it is a value addition for the existing knowledge in the field and has some worthwhile research input.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
  - Methodology for carrying out the work defined as a Problem Statement (Formulation in respect of the analytical studies/ Experimental Work / Combination thereof depending upon the nature of the work involved)/ Data Collection, etc.
- Dissertation I should be assessed through a presentation by a panel of internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

After completion of about 80% of the work (which shall be decided by the Guide/ Supervisor), proposed to be a part of the Dissertation, the student shall deliver a Pre-submission seminar based on the work pursued by him/ her during the second stage. It will be assessed by the panel of internal examiners appointed by the Head of the Department/ Institute of the respective programme, as the case may be.

The student shall take into account the suggestions made by the examiners/s during pre-submission

seminar in view of the work pursued by the students and shall try to incorporate it in the work, if the suggestions are worthwhile, consistent with the situation and provided they are such that those can be accommodated/ included in the work being pursued by the candidate at that point of time.

After the pre-submission seminar, the student shall compile the report in a standard format and written in the systematic manner and chapter wise.

The student shall adhere to the following scheme of chapterization while compiling the final report in general. The Guide/ Supervisor shall ensure the student has written the Dissertation Report in appropriate language (grammatically correct).

1. Introduction: The student shall give the introduction to the theme of the subject chosen as a Dissertation, give further current state of art related to the theme (i.e., brief review of literature), broad problem definition and scope of the work. The student shall also state at the end of this chapter the scheme of chapterization included in his/ her Dissertation.

2. Theoretical Aspects/ Review of Literature: The student is expected to highlight the various theoretical aspects pertaining to the topic chosen, literature (updated) available related to the various aspects of the topic chosen citing the research work carried out by the earlier researchers and summarize the findings of the literature. The student may state the precise the problem definition.

3. Formulation/ Methodology/ Experimental Work: In this chapter, the student is expected to explain the methodology for pursuing his/ her work. In case of analytical work, student may give the Formulation along with validation for assessment of accuracy of the numerical procedure being used/ proposed by him/ her. In respect of experimental work, the student may outline the experimental set up/ procedure. In case of the work in which either approach is involved, the student may appropriately provide the methodology to cover either approach. This chapter may be supported by the Data Collection if the work involves the Collection of the Data and its subsequent processing.

4. Analysis/ Results and Discussion: The student is expected to present the results emerging from the analytical/ theoretical/ experimental study/ studies being pursued by the students. The results shall be discussed properly. The results may be compared with the results published by the earlier researchers if the work being pursued by the student warrants the same. The student may indicate the broad conclusions/ inferences at the end.

5. Summary and Conclusions: Based on the results discussed in the previous chapter, the student shall give in the systematic manner the conclusions/ inferences emerged from the study and summarize it properly. The student shall indicate the scope of the future work which can be extended by any other student/ researcher in the future. The student may point out the limitation/s left out in the work pursued by him/ her while carrying out the work contained in the Dissertation.

6. References: The student shall at the end give the list of the references in the appropriate manner. This part should not be treated as a Chapter. For referencing style, student may refer any standard journal of national and international repute.

7. Publication/s: The student shall give the list of the technical/ research papers published/ accepted for publication in the referred journal/ conference proceedings. This part should not be treated as a Chapter.

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Methodology for carrying out the work defined as a Problem Statement (Formulation in respect of the analytical studies/ Experimental Work / Combination thereof depending upon the nature of the work involved)
- Quality of work attempted
- Presentation of the results along with the validation of results or part thereof.
- Quality of Written Report and Oral Presentation
- Publication of the technical/ research paper by the student in a conference of National/ International repute. Publication of paper in a referred/ peer reviewed journal is highly preferred.

- Dissertation II shall be assessed through a presentation jointly by the Internal Examiner (Guide/ Supervisor) and External Examiner appointed by the University of Mumbai.