DEPARTMENT OF CIVIL ENGINEERING

M.TECH (STRUCTURAL ENGINEERING)

Scheme of Instruction and Examination
(Regulation:R16)

(with effect from **2016-2017** admitted batch onwards)

I – SEMESTER

Code No.	Course title	Credits	Lecture Hrs	Lab Hrs	Total Contact Hrs/Week	Sessional Marks	Exam Marks	Total Marks
M16 ST 1101	Theory of Elasticity	4	4	--	4	30	70	100
M16 ST 1102	Advanced Reinforced Concrete Design	4	4	--	4	30	70	100
M16 ST 1103	Matrix methods of Structural Analysis	4	4	--	4	30	70	100
M16 ST 1104	Structural Dynamics	4	4	--	4	30	70	100
#1	Elective-I	4	4	--	4	30	70	100
#2	Elective-II	4	4	--	4	30	70	100
M16 ST 1111	Computer applications in Structural Engineering	2	--	3	3	50	50	100
M16 ST 1112	Design of Structures	2	--	3	3	50	50	100
	Total	**28**	**24**	**6**	**30**	**280**	**520**	**800**

	Course Code	Course
#1-Elective-I	M16 ST 1105	Advanced Foundation Engineering
	M16 ST 1106	Wind Analysis and Design of Tall Structures
	M16 ST 1107	Experimental Stress Analysis
#2-Elective-II	M16 ST 1108	Advanced Concrete Technology
	M16 ST 1109	Bridge Engineering
	M16 ST 1110	Optimization Techniques

Code: M16 ST 1101

THEORY OF ELASTICITY

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. This subject is taught to impart knowledge on theory of elasticity.

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

1. Analyze the stresses and strains for two dimensional and three dimensional elements.
2. Understand the equilibrium and compatibility conditions.
3. Solve the problems on Torsion for different shaped bars.

SYLLABUS

Plane Stress and Plane Strain: Components of stress, Strain, Hookes law, Stress and strain at a point. Plane stress, Plane strain, Equations of equilibrium, Boundary conditions, Compatibility equations stress foundation.

Two Dimensional Problems in Rectangular Coordinates: Solution by polynomials, Saint Vanant's principle determination of displacements, Bending of cantilever loaded at the end, Bending of a beam by uniform load.

Two Dimensional Problem in Polar Coordinates: General equations of equilibrium, Stress function and equation of compatibility with zero body forces. Analysis of thick cylindrical shells with symmetrical leading about the axis, Pure bending of curves bars, Strain components in polar coordinates, Rotating disks.

Three Dimensional State of Stress: Differential equations of equilibrium – Boundary conditions for compatibility – Displacements – Equations of equilibrium in terms of displacements – Principle of superposition – Uniqueness of solution.

Torsion: Torsion of straight bars – St.-Venant solution – Stress function, Warp function – Elliptic cross section – Membrane analogy torsion of bar of narrow rectangular cross section.

Analysis of Stress and Strain in Three Dimensions: Introduction – Principal stresses, - Determination of principal stress – Stress invariants – Maximum sheering stress strain at point.

TEXT BOOK:

1. "Theory of Elasticity" by Timoshenko and Goodier, McGraw Hill Company.

REFERENCE BOOKS:

1. "Theory of Elasticity" by Sadhu Singh, Khanna publisher
2. "Applied Elasticity" by C.T. Wang., McGraw Hill Company
3. "Advanced Strength of Materials" by Denhortog, Dover publications

Code: M16 ST 1102

ADVANCED REINFORCED CONCRETE DESIGN

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

The main objectives of this Course is

1. To Estimate the crack width and deflection with regard to the serviceability.
2. To analyze and design a grid floor system.
3. To analyze and design a flat slab system.
4. T**o** analyze and design bunkers, silos and chimneys.
5. To analyze and design of concrete structures against fire resistance, according to ISO 834 standards

COURSE OUTCOMES:

After completion of course the students should be ability to

1. Estimate the crack width and deflection with regard to the serviceability.
2. Analyze and design a grid floor system.
3. Analyze and design a flat slab system.
4. Analyze and design bunkers, silos and chimneys.
5. Analyze and design of concrete structures against fire resistance, according to ISO 834 standards.

SYLLABUS

Deflection of Reinforced Concrete Beams and Slabs: Introduction, Short-term deflection of beams and slabs, Deflection due to imposed loads, Short-term deflection of beams due to applied loads, Calculation of deflection by IS 456, Deflection of continuous beams by IS 456, Deflection of slabs.

Estimation of Crack width in Reinforced Concrete Members: Introduction, Factors affecting crack width in beams, Mechanisms of flexural cracking, Calculation of crack width, Simple empirical method, Estimation of crack width in beams by IS 456, Shrinkage and thermal cracking.

Redistribution of Moments in Reinforced Concrete Beams: Introduction, Redistribution of moments in fixed beam, Positions of points of contra flexures, Conditions for moment redistribution, Final shape of redistributed bending moment diagram, Moment redistribution for a two-span continuous beam, Advantages and disadvantages of moment redistribution, Modification of clear distance between bars in beams (for limiting crack width) with redistribution, Moment-curvature (M - ψ), Relation of reinforced concrete sections.

Approximation Analysis of Grid Floors: Introduction, Analysis of flat grid floors, Analysis of rectangular grid floors by Timoshenko's plate theory. Analysis of grid by stiffness matrix method, Analysis of grid floors by equating joint deflections, Comparison of methods of analysis, Detailing of steel in flat grids.

Design of Flat Slabs: Introduction, Proportioning of Flat Slabs, Determination of Bending moment and Shear Force, Direct Design method, Equivalent Frame method, Slab Reinforcement.

Bunkers and Silos : Introduction, Design of Rectangular Bunkers, Design of Tension member, Design of Circular Bunker, Design of Silos.

Chimneys : Introduction, Design factors, Stresses due to Self Weight and Wind load, Stress in horizontal reinforcement, Temperature Stresses, Combined effect of Self Weight, Wind load and Temperature, Temperature stresses in Hoop(Horizontal) Reinforcement.

Design of Reinforced Concrete Members for Fire Resistance: Introduction, ISO 834 standard heating conditions, Grading or classifications, Effect of high temperature on steel and concrete, Effect of high temperatures on different types of structural members, Fire resistance by structural detailing from tabulated data, Analytical determination of the ultimate bending moment, Capacity of reinforced concrete beams under fire, Other considerations.

TEXT BOOK:

1. "Advanced Reinforced Concrete Design" by P.C. Varghese, Prentice Hall India Learning Private Limited.

REFERENCE BOOKS:

1. "Reinforced Concrete" by Park &Paulay, Wiley publications.
2. "Reinforced Concrete Limit state Design" - P. Dayaratnam, Oxford & IBH publications.

Code: M16 ST 1103

MATRIX METHODS OF STRUCTURAL ANALYSIS

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

The main objectives of this Course is

1. To prepare the students to have a basic knowledge in the matrix methods such as flexible matrix method and Stiffness matrix method.
2. To prepare the students to analyze the beams by matrix methods.
3. To prepare the students to analyze the Plane truss problems by matrix methods.
4. To prepare the students to analyze the Plane Frames by matrix methods.

COURSE OUTCOMES:

After completion of course students should be able to

1. Analyze various beams by the matrix methods at different loading conditions.
2. Analyze various Plane truss problems by the matrix methods.
3. Analyze Plane Frames by the matrix methods at different loading conditions.

SYLLABUS

Introduction to Matrix methods: Introduction, coordinate systems, displacement and force transformation matrices, element and structure stiffness matrices, Element and structure flexibility matrices, equivalent joint loads, stiffness and flexibility approaches.

Matrix methods for beams: Analysis of beams, fixed and continuous beams by flexibility method. Analysis of beams, fixed and continuous beams by stiffness method.

Matrix methods for Plane truss problems: Analysis of 2-D trusses by flexibility method. Analysis of 2-D trusses by stiffness method

Matrix methods for Plane Frames: Analysis of 2-D frames by Flexibility matrix methods. Analysis of 2-D frames by Stiffness matrix methods.

TEXT BOOKS:

1. Analysis of Inderminate structures – C.K Wang, McGraw Hill Co.
2. Matrix Analysis of framed Structures-W Weaver& Gere, Van Nostrand Reinhold Company
3. G.S.Pandit, S.P.Gupta, “Matrix methods of Structural Analysis”, TataMcGraw Hill Co..
4. William Weaver, James M. Gere, “Matrix Analysis and Framed Structures”, D. Van Nostrand Co., 1980.

REFERENCE BOOKS:

1. DevdasMenon,"Advanced StructuralAnalysis", Narosa Publishing House, 2009.
2. AsslamKassimali,"Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.

Code: M16 ST 1104

STRUCTURAL DYNAMICS

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

The main objectives of this Course is

1. To find the behavior of structures subjected to dynamic loads such as wind, earthquake and blast loads.
2. To study the different Dynamic analysis procedures for calculating the response of structures.

COURSE OUTCOMES:

After completion of course students should be able to

1. Solve the problems on Single degree of freedom.
2. Understand the difference between harmonic loading and impulse loading and the related analysis procedures.
3. Evaluate the structural properties, mode shapes for different structures.

SYLLABUS

One Degree Systems: Undamped systems, Various forcing functions damped systems, Response to pulsating force, Support motion.

Lumped Mass Multidegree System: Direct determination of natural frequencies, Characteristic shapes, Stodola-Vianelle method, Modified Rayleigh-Ritz method, Lagrange's equation, Model analysis of multi degree systems, Multistorey rigid frames subjected to lateral loads, Damping in multi degree systems.

Structures with distributed mass and load, Single span beams, Normal modes of vibration, Forced vibrations of beams, Beams with variable cross-section and mass.
Approximate design methods, Idealized system, Transformation factors, Dynamic reactions response calculations, Design example (RC beam, Steel beam and RC slab), Approximate design of multi degree systems.

Matrix Approach: Coordinates and lumped masses, Consistent mass matrix, Undamped force vibration of a system with one degree freedom, Response of single degree freedom undamped system, Viscous damped vibration of a single degree freedom system, Undamped vibration of multi degree freedom system, Orthogonality of natural nodes, Normal coordinates.

TEXT BOOK:

1. "Structural Dynamics" by John M. Biggs, McGraw Hill Co.

REFERENCE BOOKS:

1. "Structural Analysis" by A. Ghali& A.M. Neville, CRC Press
2. Dynamics of Structures by Anil Kumar Chopra, Pearson Prentice Hall

Code: M16 ST 1105

ADVANCED FOUNDATION ENGINEERING

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

The main objectives of this Course is

1. To enable participants select the best foundation solutions for different types of Civil Engineering problems
2. To develop deeper understanding of foundation analysis.
3. To develop understanding of choice of design parameters.
4. To learn about advanced topics of foundation design and analysis.
5. Participants will be equipped with abilities to evaluate bearing capacity and settlement failure conditions for shallow and deep foundations.

COURSE OUTCOMES:

After completion of course students should be able to

1. The design of shallow and deep foundations to carry ultimate loads.
2. Interpretation and selection of appropriate soil parameters from site investigation data.
3. Field monitoring in geotechnical design.
4. Select the most appropriate foundation solution for a given situation; derive appropriate soil parameters.
5. Distinguish between different foundation types and their appropriate use.
6. Synthesize foundation performance measurements from a range of test data reported in the literature.

SYLLABUS

Foundations, Types of shear failures in foundation soils, Types of foundations, Introduction: Principles of Design of Design Loads, Basic Concepts of safe and allowable bearing capacity. Shallow Foundations

Bearing Capacity Analysis: Bearing capacity theories – Terzaghi, Meyerhof, Skempton, Hansen, Vesic and IS Methods, Bearing capacity evaluation from Standard Penetration test and Plate load test.

Settlement Analysis: Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesion less soils by Schemartmann and Hartman method, Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control.

Proportioning of footings: Isolated column footings, Strip, combined Footings and Strap Footing. Raft Foundations: Bearing capacity of raft foundation, floating raft, Types of rafts, Beam on Elastic foundation and Conventional methods of Design, determination of modulus of subgrade reaction.

Deep Foundations : Pile Foundations: Types, load capacity- dynamic formulae, static formula; pile load tests- Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction.

Well Foundations: Types, Bearing Capacity of well foundations, Construction of pneumatic caissons, Tilts and Shifts: precautions, Remedial measures; Lateral stability analysis by Terzaghi's Method, Design aspects of Components of well foundation.

Foundations in Expansive Solis : Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and 'CNS' concepts.
Foundations of Transmission Line Towers: Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

TEXT BOOKS:

1. Analysis and Design of Substructures by Swami Saran, Oxford &IBH Publishing Co.
2. Foundation Engineering by P.C. Vargheese, Prentice Hall of India
3. Basic and Applied Soil Mechanics by GopalRanjan and A.S.R. Rao, New Age International Publications

REFERENCE BOOKS:

1. Foundation Analysis and Design by J.E. Bowles, McGraw Hill Publishing Co.
2. Foundation Design by W.C. Teng, John Wiley, New York.

Code: M16 ST 1106

WIND ANALYSIS AND DESIGN OF TALL STRUCTURES

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

The main objectives of this Course is

1. This course is intended to teach the concept of tall structures.
2. Various methods to analyze the tall structure will be explained in the classes.

COURSE OUTCOME:

Upon completion of this course, the student will be able to

1. Know the types of tall buildings.
2. Analyze the plane frame systems by different methods.
3. Design the shear wall system and in filled frame systems.
4. Design the RC chimney and Bunkers and Silos.

SYLLABUS

Introduction: Basic wind speed, Design wind speed, Design wind pressure, offshore wind velocity, wind pressures and forces in buildings/structures, External pressure coefficients for various roofs, dynamic effects.

Lateral load Analysis of Multistory Building Frames: Analysis of Multistory Building Frames for lateral loads, Cantilever method, Portal method and Factor method.

Design of Shear Wall: Introduction, Types of shear walls, Behaviour of cantilever wall with rectangular cross-section, flange cantilever shear walls, Moment-Axial load interaction for shear wall section, Interaction of shear walls and rigid joined frames, Shear walls with openings, Coupled shear walls.

Design of Chimneys (RCC): Introduction, Wind pressure, Stress in chimney shaft due to self weight and wind, Stress in horizontal reinforcement due to wind shear, Stresses due to temperature difference. Design of RC chimney.

Bunkers and Silos: Introduction, Differences between bunker and silo, Design of square or rectangular bunkers, Design of circular bunkers, Design of silos, Silos for storage of cement.

Multistory Building Frames: Analysis of multistory frames, Method of substitute frames,Bending moments in beams and columns.

TEXT BOOKS:

1. "Limit State Design of Reinforced Concrete" by Ashok Kumar Jain & B.C.Punmia,Laxmi Publications.
2. "Tall Chimneys" by Manohar, S.N., Tata McGraw-Hill Pub. Co.
3. "Design of Steel Structures"byN.Subramanian, Oxford Publications.

REFERENCE BOOKS:

1. "Reinforced Concrete Structures" by Park, R. &Paulay, T**,** Wiley publications
2. "Advanced Reinforced Concrete Design",byN.KrishnaRaju, TataMcGraw Hill Co..

Code: M16 ST 1107

EXPERIMENTAL STRESS ANALYSIS

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. The main objectives of this Course is to impart knowledge about the instruments and its applications.

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

1. Know the working principle of strain gauges.
2. Do the model analysis using different theorems.
3. Know the concepts of photo elasticity and its applications.
4. Analysis of Stress, strain, Stress- Strain relation and theories of failure

SYLLABUS

Electrical Resistance Strain Gauges: Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

Photoelasticity: Two dimensional photo elasticity, Concept of light – photoelastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three dimensional photo elasticity.

Brittle Coating And MoireMethods : Introduction to Moire techniques, brittle coating methods and holography.

TEXT BOOK:

1. "Experimental Stress Analysis", Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., , Tata McGraw-Hill, New Delhi, 1984.

REFERENCE BOOK:

1. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc

Code: M16 ST 1108

ADVANCED CONCRETE TECHNOLOGY

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. This course mainly aims to develop the knowledge about properties of cement concrete and importance of admixtures in concrete.

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

1. Know the various materials in concrete and admixtures.
2. Do the Mix design by different methods.
3. Get a thorough knowledge of various types of cement, aggregates and properties of special concrete.
4. Know the different procedures for testing concrete

SYLLABUS

Durability of concrete and concrete construction: Durability concept, pore structure and transport processes, reinforcement corrosion, fire resistance, frost damage, sulphate attack, alkali silica reaction, delayed ettringite formation, methods of providing durable concrete, short-term tests to assess long-term behaviour.

Mix design: Review of methods and philosophies of IS, BS and ACI methods, mix design for special purposes. Acceptance criteria for compressive strength of concrete.

Special concretes: Lightweight concrete, autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete, High strength concrete, refractory concrete, high density and radiation-shielding concrete, polymer concrete, fibre-reinforced concrete, mortars, renders, recycled concrete, Ferro Cement, Self Compacting Concrete.

Special processes and technology for particular types of structure: Sprayed concrete, underwater concrete, grouts, grouting and grouted concrete, mass concrete, slip form construction, pumped concrete, concrete for liquid retaining structures, vacuum process, concrete coatings and surface treatments.

Test methods: Analysis of fresh concrete, Accelerated testing methods, Tests on hardened concrete, Core cutting and testing, partially destructive testing, Non-destructive testing of concrete structures

TEXT BOOKS:

1. Properties of Concrete, A.M.Neville, Longman 1995.
2. Concrete Technology Theory and Practice, M.S.Shetty, S.Chand& Company Ltd, New Delhi.

REFERENCE BOOKS:

1. Concrete micro-structure, Properties and Materials, P.K.Mehta, J.M.Monteiro, Printice Hall INC & McGraw hill, USA.
2. Concrete Technology by M.L.Gambhir, Tata McGraw Hill publications.

Code: M16 ST 1109

BRIDGE ENGINEERING

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVE:

1. This subject is taught to impart the knowledge in the analyses and design of concrete bridges.

COURSE OUTCOMES:

Upon completion of this course, the student will be able to
1. Understood the load distribution and IRC standards.
2. Design the slab bridges.
3. Design the Arch bridges and
4. Design the bridge bearings, hinges and expansion joints.

SYLLABUS

Introduction to bridge engineering. Historical background of bridges and types.Bridge aesthetics and proportioning. Design process. Review of applicable design codes. Loads on bridges and force distribution.Bridge geometry.

Analysis and design of Slab Bridge, Skew slab bridge.

Analysis and design of T-beam bridge: Deck slab considering IRC loads, longitudinal girders(Interior, Exterior), Cross girder.

Analysis and design of prestressed concrete girder and box girder bridges considering only primary torsion, Design of end block.

Bridge Bearing: Types of bearings, Rocker bearing, Elastomeric bearing.

TEXT BOOKS:
1. "Essentials of Bridge Engineering", D. Jhonson Victor, Oxford University Press.
2. "Design of Bridges", N.KrishnaRaju, Oxford & IBH Publishing Co.Pvt.Ltd, New Delhi

REFERENCE BOOKS:
1. Concrete Bridge Practice-Analysis, Design and Economics By Dr. V.K.Raina, Shroff Pub & Dist. Pvt. Ltd.
2. Bridge Engineering By S.Ponnu Swamy, McGraw Hill Education.
3. Bridge Engineering By K.S.Rangwala & P.S.Rangwala, JBA Publishers.

Code: M16 ST 1110

OPTIMIZATION TECHNIQUES

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To familiarize the student on various methods of optimization and design of structural members.

COURSE OUTCOMES:

Students will be able to

1. Derive optimized structure using classical and modern methods of optimization.
2. Gain the knowledge on Formulation of Structural Optimization problems.
3. Gain the knowledge on the concept of classical methods of optimization for multivariable
4. With equality or inequality constraints: solution by method of Lagrange Multiplier - Applications in structural engineering, Kuhn-Tucker conditions.

SYLLABUS

Introduction: Need and scope of optimization, Historical development, Statement of an optimization problems, Objective function and its surface, design variables, constraints and constraint surface. Classification of optimization problems, various functions (continuous, discontinuous, and discrete) and Function behaviour (Monotonic, Non-Monotonic and Uni-modal)

Classical Optimization Techniques: Differential calculus method, Multivariable optimization by method of constrained variation and Lagrange multipliers (generalized problem). Kuhn-Tucker conditions for optimality.
Fully stressed design and optimally criterion based algorithms, Introduction, Characteristics of fully stressed design theoretical basis – Examples.

Non-linear Programming: Unconstrained minimization – Fibonacci, Golden section, Quadratic and Cubic interpolation methods for a one-dimensional minimization and Univariate Method, Powel's method, Newton's method and Davidon Fletcher Powell's method for multivariable optimization. Constrained minimization – Cutting plane method, Zoutendijk's method and penalty function methods.

Linear programming – Definitions and theorems – Simplex method – Duality in linear programming.Plastic analysis and minimum weight design and rigid frame.
Introduction to quadratic programming, Geometric programming and Dynamic programming.Design of beams and frame using dynamic programming technique.

TEXT BOOKS:

1. "Optimization Theory and Applications" by Rao, S.S., Wiley Eastern Ltd., New Delhi, 1978.
2. "Optimum Design of Structures" by Majid, K.I., Newnes-Butter Worths, London, 1974.

REFERENCE BOOKS:

1. "Mathematical Foundations for Design: Civil Engg. Systems" by Robert, M. Stark and Robert L. Nicholls, McGraw Hill Book Company, New York, 1972.
2. "Optimum Structural Design, Theory and Applications", Edited by Gallegher, R.H. and Zienkiewiez, O.C., John Wiley and Sons, New York, 1973.

Code: M16 ST 1111

COMPUTER APPLICATIONS IN STRUCTURAL ENGINEERING (VIVA-VOCE)

Tutorial	**: 3 Periods**	**Sessionals**	**: 50**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 50**
		Credits	**: 2**

COURSE OBJECTIVES:

1. To apply the civil engineering software to some of the structural engineering problems.

COURSE OUTCOMES:

Students will be able to
1. Analyze the structural elements using software designs.
2. Design the structures fir the dynamic loads using software's.
3. Solve the finite elements application problems of structural engineering by software's.

SYLLABUS

Application of software's in Structural Engineering (by using STAAD Pro, ETABS STRAP, STRUDS etc) for the following problems.

1. Analysis and Design of Beams.
2. Analysis and Design of Footings.
3. Analysis and Design of Trusses.
4. Analysis and Design of Two Dimensional Frames.
5. Analysis and Design of Three Dimensional Frames.
6. Analysis and Design of Water Tanks.
7. Analysis and Design of Steel Members.
8. Implementation of Concepts of FEM using a Computer Language.

REFERENCE BOOKS:

1. Computer Applications In Structural Engineering by David R.Jenkins, American Society of Civil Engineers
2. Computer aided design-Software and Analytical tools by C.S. Krishnamoorthy & S. Rajesh.
3. Computer aided design in reinforced concete, V.L.Shah.

Code: M16 ST 1112

DESIGN OF STRUCTURES
(VIVA-VOCE)

Tutorial	**: 3 Periods**	**Sessionals**	**: 50**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 50**
		Credits	**: 2**

COURSE OBJECTIVES:

1. To Design of Folded Plates
2. To Elevated Service Reservoirs
3. To analysis and design Retaining walls
4. To design Grid floor
5. To design Flat slab
6. To design Pressed steel tank
7. To design Buried pipes

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

1. Design of Folded Plates, Elevated Service Reservoirs, Analysis and design Retaining walls, Design Grid floor, Design Flat slab, Design Pressed steel tank, Design Buried pipes

SYLLABUS

On any **THREE** of the following:

1. Design of Folded Plates
2. Elevated Service Reservoirs
3. Retaining walls
4. Grid floor
5. Flat slab
6. Pressed steel tank
7. Buried pipes

REFERENCE BOOKS:

1. "Advanced Reinforced Concrete Design" by P.C. Varghese., PHI Learning pvt. Ltd
2. "Reinforced Concrete Design" by S.Unnikrishna Pillai & Devadas Menonon Tata McGrawhill education Pvt. Ltd.
3. "Advanced Reinforced Concrete Design" by N.Krishna Raju,CBS publishers & distributors pvt Ltd.
4. "Design Of Reinforced Concrete Structures", by N.Subramanian, Oxford University press
5. Limit State Design of Steel Structures by S.K.Duggal, Tata Mc.Graw Hills.
6. "Design Of Reinforced Concrete Structures",by S.Ramamrutham, Dhanpat Rai Publishers.

DEPARTMENT OF CIVIL ENGINEERING

M.TECH (STRUCTURAL ENGINEERING)

Scheme of Instruction and Examination
(Regulation:R16)

(with effect from **2016-2017** admitted batch onwards)

II – SEMESTER

Code No.	Course title	Credits	Lecture Hrs	Lab Hrs	Total Contact Hrs/Week	Sessional Marks	Exam Marks	Total Marks
M16 ST 1201	Theory of Plates and Shells	4	4	--	4	30	70	100
M16 ST 1202	Structural Stability	4	4	--	4	30	70	100
M16 ST 1203	Finite Element Methods of Analysis	4	4	--	4	30	70	100
M16 ST 1204	Earthquake Engineering	4	4	--	4	30	70	100
#3	Elective-III	4	4	--	4	30	70	100
#4	Elective-IV	4	4	--	4	30	70	100
M16 ST 1211	Repair and Rehabilitation of Structures	2	--	3	3	50	50	100
M16 ST 1212	Advanced Design of Structures	2	--	3	3	50	50	100
Total		**28**	**24**	**6**	**30**	**280**	**520**	**800**

	Course Code	Course
#3-Elective-III	M16 ST 1205	Reliability Analysis and Design
	M16 ST 1206	Prestressed Concrete
	M16 ST 1207	Ground Improvement Techniques
#4-Elective-IV	M16 ST 1208	Industrial Structures
	M16 ST 1209	Design of steel bridges
	M16 ST 1210	Inelastic Design of Slabs

Code: M16 ST 1201

THEORY OF PLATES AND SHELLS

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To familiarize with the concepts of plates and shells and designing of shells.

COURSE OUTCOMES:

Students will be able to

1. Analyze and design for plates for different loadings.
2. Analyze and design of shells.
3. Explain the concept of curvature in shells.
4. Gain knowledge on beams, theory of cylindrical shells.

SYLLABUS

Bending of Long Rectangular Plates to a Cylindrical Surface: Differential equation for cylindrical bending of plates – Uniformly leaded rectangular plates with simple supported edges and with built in edges. Pure bending of plates slopes – Curvatures of bent plates – Relations between bending moments and curvature – Particular cases – Strain energy in pure bending – Limitations.

Symmetrical Bending of Circular Plates: Differential equation – Boundary conditions. Simply supported rectangular plates under sinusoidal loading – Naviers solution and its application to concentrated load – Levy's solution for uniformly distributed load or hydrostatic pressure – Bending of rectangular plates by moments distributed along the edges – Differential equation of rectangular plate within plane and lateral forces.

Membrane analysis:

a) Shells of revolution (axi-symmetrical loading), Spherical shells, Conical shells, Elliptical shell of revolution, Torus, Hyperboloid of revolution of one sheet, Shells of uniform strength membrane deformation.

b) Membrane analysis of shells of translation, Circular cylinder, Diretrix, Parabola, Cycloid, Catenary and Membrane deformations.

c) Membrane analysis of shells of general shape: Anticlastic, Synclastic shells, Hyperbolic paraboloid, Candella shells, Conoid, Elliptic paraboloid, Rotational paraboloid.

Bending analysis of cylindrical shell: Beam method, Schorer method, Finsterwalder method.Classification analysis.

TEXT BOOK:

1. "Theory of Plates and Shells" by Timoshenko, S. and Wernewsky-Kriegar, McGraw Hill Co

REFERENCE BOOKS:

1. "Design of Reinforced Concrete Shells and Folded Plates" by P.C.Varghese, PHI
2. "Stresses in Shells" by Flugge, Springer
3. "Design and Construction of Shells" by Ramaswamy, G.S, Wiley Publicatations.

Code: M16 ST 1202

STRUCTURAL STABILITY

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To impart the knowledge on linear and nonlinear behaviour of structures.
2. To familiarize the student with stability of plates under combined loads.

COURSE OUTCOMES:

Students will be able to

1. Analyze structures with linear and nonlinear behaviour.
2. Gain the knowledge on Stability of Continuous systems.
3. Distinguish elastic buckling and in elastic buckling.

SYLLABUS

Buckling of Columns: Method of neutral equilibrium, Critical load of the Euler column, Linear column theory – An eigen value problem, Effective length concept, Higher order differential equation for columns initially bent columns, Effect of shear stress on buckling, eccentrically loaded columns, beam columns (Beam columns with concreted lateral load, distributed, load end moment), Inelastic buckling of columns, Double modulus theory, Tangent modulus theory, Shanley theory of inelastic column behaviour.

Approximate Methods of Analysis: Conservation of energy principles, Calculation of critical loads using approximate deflection curve, Principle of stationary potential energy, Raleigh-Ritz method, Buckling load of column with variable cross-section, Galerkin's method, Calculation of critical load by finite differences, Unevenly spaced pivot points, Matrix stiffness method, Effect of axial load on bending stiffness-slope deflection equations, Buckling of column loaded along the length using energy methods.

Buckling of Frames: Modes of buckling, Critical load of a simple frame using neutral equilibrium, Slope deflection equations and matrix analysis. Lateral buckling of cantilever and simply supported beams of rectangular and I-sections and use of energy method and finite differences.

Buckling of Plates: Differential equation, Strain energy of bending, Critical load, Finite difference approach inelastic buckling of plates.

Matrix approach for Frames: Criterion for determination of critical loads, Stiffness influence coefficients for members without axial load, Derivation of stability functions, Problem involving Non-sways, Modified stiffness of beams, Frames with sway, Multi-bar frames.

TEXT BOOKS:

1. "Principles of Structural Stability Theory" by Alexander Chajes, Prentice Hall
2. "Theory of Elasticity Stability" by Timoshenko and Gere, McGraw Hill pub.
3. "Structural Stability of Columns and Plates"NGRIyengar,EWP affiliated EastWest Press.

REFERENCE BOOKS:

1. An introduction to elastic stability of structures,By G.J.Simitses,1976 Prentice Hall NJ.
2. Stability of Structures By ZP Bazant and L Cedolin,1990,Oxford University Press.

Code: M16 ST 1203

FINITE ELEMENT METHODS OF ANALYSIS

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To apply the concepts of Finite element method for solving structural Engineering problems.

COURSE OUTCOMES:

Students will be able to

1. Understand the fundamentals of Finite element method.
2. Derive the solution of the problems of 1D and 2D by FEM.
3. Apply the concept of iso-parametric formulation for solving problems.
4. Derive the shape functions for higher order elements.
5. Determine solution for higher order elements problems by numerical techniques.

SYLLABUS

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axi-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

Two dimensional FEM: Different types of elements for plane stress and plane strain analysis – Displacement models Generation of element stiffness and nodal load matrices –static condensation.

Isoperimetric representation and its formulation for 2d analysis.Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

TEXT BOOKS :

1. Introduction to Finite element Method by TirupathichandraPatla and Belugundu, PHI
2. C.S.Krishnamoorthy, (2002), Finite Element Analysis, Tata McGraw Hill Publishing Co. Ltd.

REFERENCE BOOKS :

1. The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill, 1971.
2. Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,VanNostrand, 1972.

Code: M16 ST 1204

EARTHQUAKE ENGINEERING

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To impart the knowledge of designing earthquake resistant structures and familiarize the code provisions.

COURSE OUTCOMES:

Students will be able to

1. Describe various terms of engineering seismology.
2. Design earthquake-resistant structures.
3. Gain the knowledge on seismic codal provisions and detailing.
4. Acquire the knowledge in structural irregularities in seismic planning and shear wall concept.

SYLLABUS

One Degree Systems: Undamped systems, Various forcing functions damped systems, Response to pulsating force, Support motion. Lumped Mass Multidegree System: Direct determination of natural frequencies, Characteristic shapes, Stodola-Vianelle method, Modified Rayleigh-Ritz method, Lagrange's equation, Model analysis of multi degree systems, Multistorey rigid frames subjected to lateral loads, Damping in multi degree systems.

Matrix Approach: Coordinates and lumped masses, Consistent mass matrix, Undamped force vibration of a system with one degree freedom, Response of single degree freedom undamped system, Viscous damped vibration of a single degree freedom system, Undamped vibration of multi degree freedom system, Orthogonality of natural nodes, Normal coordinates.

Earthquakes, Epicenter, Hypocenter and earthquake waves, Measurement of ground motion, Seismic regions, Intensity and Isoseismals of an earthquake, Magnitude and energy of an earthquake, Consequences of earthquakes, Seismic zoning. Earthquake Response of Linear Systems: Earthquake excitation, Equation of motion, Response quantities, Response history, Response spectrum concept, Deformation, Pseudo-velocity, and Pseudo-acceleration, Response spectra, Peak structural response from the response spectrum, Response spectrum characteristics, Elastic design spectrum, Comparison of design and response spectra, Distinction between design and response spectra.

Earthquake analysis of Multistorey buildings: By seismic coefficient method and Response spectrum method, Base shear, Fundamental period of buildings, Distribution of forces along the height.

Earthquake analysis of Water towers: Introduction, Behaviour under earthquake loads, Design features, Water tower as a rigid jointed space frame, Hydrodynamic pressures in tanks.

Earthquake analysis of Stack like structures: Introduction, Fundamental period of vibration, Dynamic bending moment, Shear diagram.

Earthquake analysis of dams: Hydrodynamic pressures on dams, Zanger's method, Vertical component of reservoir load, Concrete or masonry gravity dams.

TEXT BOOKS:

1. "Elements of Earthquake Engineering" by Jaikrishna and Chandrasekharan, SarithaPrakasham, Meerut.
2. "Dynamics of Structures, Theory and Applications to Earthquake Engineering" by Anil K. Chopra, Prentice Hall of India.
3. "Earthquake resistant design of structures" by S.K.Duggal, Oxford University Press.

REFERENCE BOOKS:

1. "Structural Dynamics" by John M. Biggs, McGraw Hill Co.
2. "Structural Analysis" by A. Ghali& A.M. Neville, CRC press
3. "Earthquake resistant design of structures" by PankajAgarwal and Manish Shrikhande, Prentice Hall of India Pvt. Ltd.

Code: M16 ST 1205

RELIABILITY ANALYSIS AND DESIGN

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To learn the importance of reliability in Civil engineering and concepts of computing structural reliability.

COURSE OUTCOMES:

Students will be able to

1. Understand the importance of reliability in Civil engineering.
2. Apply the concepts of computation of structural reliability for solving engineering problems.
3. Gain the knowledge of reliability based structural design.

SYLLABUS

Concepts of Structural Safety: General, Design methods.

Basic Statistics: Introduction, Data reduction, Histograms, Sample correlation.

Probability Theory: Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distribution, Extremal distribution.

Resistance Distributions and Parameters: Introduction, Statistics of properties of concrete, Statistics of properties of steel, Statistics of strength of bricks and mortar, Dimensional variations, Characterization of variables, Allowable stresses based on specified reliability.

Probabilistic Analysis of Loads: Gravity loads, Wind load.

Basic Structural Reliability: Introduction, Computation of structural reliability. Monte Carlo Study of Structural Safety: General, Monte Carlo method, Applications.

Level 2 Reliability Methods: Introduction, Basic variables and failure surface, First-order second-moment methods (FOSM).

Reliability Based Design: Introduction, Determination of partial safety factors, Safety checking formats, Development of reliability based design criteria, Optimal safety factors, Summary of results of study for Indian standard – RCC design. Reliability of Structural Systems: Preliminary concepts as applied to simple structures.

TEXT BOOK:

1. "Structural Reliability Analysis and Design" by Ranganatham, R., Jaico Publishing house.

REFERENCE BOOK:

1. "Structural Reliability" by Melchers, R.E., Wiley publications.

Code: M16 ST 1206

PRESTRESSED CONCRETE

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To impart the knowledge on pre-stressing techniques and materials required for pre-stressing.
2. To familiarize the student with the losses of pre-stress and design of beams and slabs.

COURSE OUTCOMES:

Students will be able to

1. Analyze and design pre-stressed concrete members.
2. Gain the knowledge on materials, prestressing Systems, end anchorages.
3. Gain the knowledge on losses of pre-stress.
4. Analyze and design of sections for flexure.
5. Apply the concept of prestress for designing of slabs.

SYLLABUS

Introduction: Basic concepts of prestressing need for high strength steel and concrete, advantages of prestressed concrete. Materials for prestressed concrete, high strength concrete and high strength steel.

Prestressing systems and losses of prestress: (1) Freyssinet Anchorage System (2) Gifford Udall System (3) Magnel-Blaton System, Tensioning devices, anchoring devices. (d) Pretensioning and Post tensioning. Prestressing losses, Elastic shortening, loss due to shrinkage, loss due to creep, loss due to friction, loss due to slip etc.I.S.code provisions.

Analysis of prestressed Concrete Beams: Assumptions, Analysis of prestress, Resultant stresses at a section, pressure or thrust line, concept of load balancing, cable profile, kern distance, stress in tendons as per IS 1343, cracking moment.

Shear and Torsional Resistance of Prestressed Concrete Members: Shear and Principal Stresses, Ultimate Shear Resistance of Prestressed Concrete Members, Design of Shear Reinforcements, Prestressed Concrete members In Torsion, Design of Reinforcements for Torsion, Shear and Bending

Transfer of prestress in Pretensioned members: Transmission length, bond stress, Transverse tensile stress, End Zone reinforcement, flexural bond stress, I.S. Code Provisions.

Anchorage zone in post tensioned members: Introduction, stress distribution in End block, Investigation on Anchorage Zone Stresses- Magnel's method, Guyon's method of approach of analysis of end block (Not more than 2 cables).

Deflection of Prestressed Concrete Members: Importance of Control of Deflections, Factors Influencing Deflections, Short-Term Deflection of Uncracked members, Prediction of Long Time Deflections, Deflection of Cracked Members, Requirements of various Codes of Practice.

TEXT BOOKS:

1. Prestressed Concrete by N.KrishnaRaju, TataMcGrawhill, NewDelhi
2. Design of Prestressed Concrete Structures by T.Y. Lin and Ned. H. Burns, JohnWilley & sons.

REFERENCE BOOKS:

1. Prestressed Concrete by N.Rajagopalan, Alpha Science publications.
2. Prestressed Concrete by P. Dayaratnam, Delhi publications.

Code: M16 ST 1207

GROUND IMPROVEMENT TECHNIQUES

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To introduce the various types of improvement methods of engineering properties soils.
2. To introduce the application of engineering methods to ground improvement projects.

COURSE OUTCOMES:

After completion of course students should be able to

1. Implement the stabilization methods
2. Apply grouting and dewatering techniques
3. Understand the concept of in-situ reinforcement

SYLLABUS

Compaction: Theory of compaction, Shallow Surface Compaction - Equipment, Placement water content, factors affecting shallow compaction; Deep compaction: Methods - Vibrofloatation, Terra probe method, Pounding, Blasting, Compaction piles; Compaction Control.

Vertical Drains:Sand drains, Sand wicks, Rope drains, Design of vertical drains, Stone columns, application of the techniques to Marine clays.

Stabilization:Introduction, objectives, Methods of stabilization – Mechanical, Cement, Lime, Bituminous, Calcium chloride; construction methods, factors affecting stabilization of soils; Deep Mixing methods – Soil lime Columns and Cement Lime Columns, applications.

Dewatering: Definition, necessity, Methods of dewatering – Interceptor ditch, Single, Multistage and Vacuum well points, Horizontal wells, Electro-osmosis. Permanent drainage by Foundation drains and Blanket drains.

Grouting: Definition, Objectives of grouting, Grouts and their properties, Categories of Grouting, Grouting methods: Ascending, Descending and Stage Grouting in Soils, Hydrofracture, Grouting Equipment, Post grouting tests. In-situ Reinforcement**:** Ground Anchors, Tiebacks and Soil Nailing, Micropiles.

TEXT BOOK:

1. Ground Improvement Techniques by P. Purushothama Raj, Laksmi Publications, New Delhi.

REFERENCE BOOK:

1. Engineering Principles of Ground Modification by Monfred R Hausmann, McGraw Hill Publishing Co.

Code: M16 ST 1208

INDUSTRIAL STRUCTURES

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVE:

1. This subject imparts a broad knowledge in the area of industrial structures.

COURSE OUTCOMES:

Upon completion of this course, the student will be able to

1. Know the requirements of various industries.
2. Get an idea about the materials used and planning.
3. Know the construction techniques.
4. Understood the functional requirements.

SYLLABUS

Plastic Analysis: Introduction, Limit analysis of steel structures, Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Limit load, Coplanar load, Upper lower bound theorems. Redistribution of moments continuous beams: Relevant or irrelevant mechanisms, Types of mechanisms method for performing moment check. Portal frame, Mechanisms, Combination of mechanisms, Moment check, Partial complete and over complete collapse.

Light gauge steel structures: Local buckling of thin sections, Post packing of thin elements, Light gauge steel columns and compression members, Form factor for columns and compression members, Stiffened compression elements, Multiple stiffened compression elements, Unstiffened compression elements effective length of light gauge steel compression members, Basic design stress, Allowable design stress, Light gauge steel beams, Laterally supported light gauge steel beams web crippling. Allowable design stress in beams, Beams subjected to combined axial end bending stress, connections.

Analysis of Communication Towers: Analysis of Transmission line Towers: Loads on towers, Sag (dip) and Tension in uniformly loaded conductors, Analysis of towers (analysis as coplanar assembly), Design of members in towers, Design of foundation of towers. Design of Steel Chimneys for wind and gravity loads. Design of gantry girder.

TEXT BOOKS:

1. "Comprehensive Design of Steel Structures", B.C.Punmia,Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications (P) Ltd.
2. Design of Steel Structures by Duggal S.K, Tata McGrawHill Education2000

REFERENCE BOOKS:

1. "Plastic Analysis of Structures" by Beedle, Wiley Publications.
2. "Design of Steel Structures" by Arya&Ajmani, Nemchand Publishers.
3. "Design of Steel Structures" Vol2 by Dr.Rama Chandra, Scientific Publications

Code: M16 ST 1209

DESIGN OF STEEL BRIDGES

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To learn relevant code of practice for the design of steel Bridges.
2. To analyze and design of Plate girder Bridges.
3. To analyze and design of truss girder Bridges.
4. To know Bearings.

COURSE OUTCOMES:

After completion of course students should be able to

1. Apply the IS code of practice for the design of steel bridges.
2. Analyze and design of Plate girder Bridges.
3. Analyze and design of truss girder Bridges.

SYLLABUS

Steel Bridges: Introduction, classification of steel bridges, economical span, clearance requirements, dimensions of rolling stock, width of roadway and footway

Loads: Live load for Railway, Highway and combined rail cum road bridges, Impact effect, wind load, lateral force (racking force), longitudinal forces, centrifugal forces, seismic forces, temperature effects.

Plate girder bridges: Introduction, types, general arrangement, wind load effects, analysis and design of Deck type plate girder bridge for railways, analysis and design of Half-through plate girder bridge for railways, analysis and design of Through type plate girder bridge for railways.

Truss girder bridges: Introduction, general arrangement of components of truss girder bridge, self-weight of Truss girder bridge, wind load and wind effects, analysis of portal bracing, analysis and design of through type truss girder bridge

Bearings : Introduction, IS code requirements for bearings, Types of bearings, plate bearing, Rocker bearing, Roller bearing, Knuckle pin bearing, Railway board roller bearing

TEXT BOOKS:

1. Design of Steel structures by N. Subramanian, Oxford University Press.
2. Limit State Design of steel structures – Ramchandra and VirendraGehlot, Scientific Publishers (India)

REFERENCE BOOKS:

1. Comprehensive design of steel structures-B.C.Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi Publications (P) Ltd.
2. Design of Steel Structures by Duggal S.K, Tata McGrawHill Education2000

Code: M16 ST 1210

INELASTIC DESIGN OF SLABS

Theory	**: 4 Periods**	**Sessionals**	**: 30**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 70**
		Credits	**: 4**

COURSE OBJECTIVES:

1. To know elastic theory analysis.
2. To know the yield line theory.
3. To analyze the slabs by principle of virtual work.
4. To analyze the slabs by using equilibrium method.
5. To design the slabs for different edge conditions.

COURSE OUTCOMES:

After completion of course students should be able to

1. Understand the elastic theory analysis.
2. Understand the yield line theory.
3. Analyze the slabs by principle of virtual work.
4. Analyze the slabs by using equilibrium method.
5. Design the slabs for different edge conditions.

SYLLABUS

Basic elastic theory Analysis: Classical plate theory, Lagrange's equation, moment-deformation, shear-deformation relationships. Examples on square and rectangular plates carrying uniformly distributed load for different edge conditions.

Principles of yield line theory: slab reinforcement, section behavior and conditions at ultimate load. Yield lines as axes of rotation and basic rules for the determination of the pattern of yield lines. Different yield line patterns for rectangular and non rectangular slabs supported on three and four sides with different edge conditions.

Analysis by principle of virtual work: Derivation of virtual work equations for Isotropic and Orthotropic two-way Square/ Rectangular slabs supported on four sides for different edge conditions.

Analysis of rectangular/Square slabs supported on three sides with different edge conditions and one edge is free (Balcony slabs) using virtual work principle.

Analysis of rectangular/Square slabs supported on three (Balcony slabs) and four sides with different edge conditions using equilibrium method.

Design of rectangular/Square slabs supported on three (Balcony slabs) and four sides for different edge conditions.

Derivation of virtual work equations only, for two-way slabs supported on four sides with different edge conditions having openings at centre, central eccentric, corner, central short side and central long side.

TEXT BOOKS:

1. “Reinforced Concrete Slabs”, Robert Park, William L Gamble, JOHN WILEY &SONS. INC, New York, 2010.
2. “Ultimate Strength Design for Structural Concrete”. V.Ramakrishnan, P.D.Arthur. Wheeler books.

REFERENCE BOOK:

1. R H Wood and LL Jones “Yield line Analysis of Slabs”. Thames and Hudson, Chatto&Windus, London,1967

Code: M16 ST 1211

REPAIR AND REHABILITATION OF STRUCTURES (VIVA-VOCE)

Tutorial	**: 3 Periods**	**Sessionals**	**: 50**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 50**
		Credits	**: 2**

COURSE OBJECTIVES:

1. To familiarize the students with various types of deteriorations and need for rehabilitation.
2. To familiarize the student with Non – destructive testing and repairs.

COURSE OUTCOMES:

Students will be able to

1. Assess the damage intensity
2. Select proper rehabilitation and repair measures for different types of deteriorations.
3. Apply the Seismic Retrofitting techniques on reinforced concrete building.

SYLLABUS

Materials: Construction chemicals, Mineral admixtures, Composites, Fibre reinforced concrete, High performance concrete, Polymer-impregnated concrete.

Techniques to Test the Existing Strengths: Destructive and non-destructive tests on concrete.
Repairs of Multi-storey Structures: Cracks in concrete, Possible damages to the structural element beams, Slab, Column, Footing, etc., Repairing techniques like Jack Chu, Grouting, External pre-stressing, Use of chemical admixtures, Repairs to the fire damaged structure.

Repairs to Masonry Structures & Temples: Damages to masonry structures – Repairing techniques, Damages to temples – Repairing techniques.

Foundation Problems: Settlement of soils – Repairs, Sinking of piles – Repairs.

Corrosion of Reinforcement: Preventive measures – Coatings – Use of SBR modified cementitious mortar, Epoxy resin mortar, Acrylic modified cementitious mortar, Flowing concrete.

Temporary Structures: Need for temporary structures under any Hazard, Various temporary structures, Case-studies.

Case Studies: At least 2 case studies per each student.

REFERENCE BOOKS:

1. "Renovation of Structures" by Perkins, E & FN Spon.
2. "Repairs of Fire Damaged Structures" by Jagadish, R, McGraw Hill Co.
3. "Forensic Engineering" by Raikar, R.N, McGraw Hill Co.
4. "Deterioration, Maintenance and Repair of Structures" by Johnson, McGraw Hill Co.

Code: M16 ST 1212

ADVANCED DESIGN OF STRUCTURES (VIVA-VOCE)

Tutorial	**: 3 Periods**	**Sessionals**	**: 50**
Exam	**: 3 Hrs.**	**Ext. Marks**	**: 50**
		Credits	**: 2**

COURSE OBJECTIVES:

1. To Design of blast resistant structures.
2. To Design of berth structures.
3. To Design of Quay Walls.
4. To analyze & design of Pre-engineered buildings.
5. To analyze & design Bow string girder bridge.
6. To analyze & design balanced cantilever bridge.
7. To analyze & design Raft design.
8. To Design of Piles and pile caps.

COURSE OUTCOMES:

After completion of course students should be able to

1. Design of blast resistant structures, Design of berth structures, Design of Quay Walls, Analyze & design of Pre-engineered buildings, Analyze & design Bow string Girder Bridge, Analyze & design balanced cantilever bridge, Analyze & design Raft design, Design of Piles and pile caps.

SYLLABUS

On any **THREE** of the following:

1. Design of blast resistant structures
2. Design of berth structures
3. Design of Quay Walls
4. Pre-engineered buildings
5. Bow string girder bridge
6. Balanced cantilever bridge
7. Raft design
8. Design of Piles and pile caps

REFERENCE BOOKS:

1. "Essentials of Bridge Engineering" by Johnson victor, Oxford and IBH publishing Co.pvt Ltd, New Delhi.
2. "Design of Bridges" by N.Krishna Raju, Oxford and IBH publishing Co.pvt Ltd, New Delhi.
3. "Principles and Practice of Bridge Engineering " by S.P.Bindra, DanapthRai & Sons.
4. "Bridge Engineering " by R.Rangwala, Charotar publishing House Pvt. Ltd

DEPARTMENT OF CIVIL ENGINEERING

M.TECH (STRUCTURAL ENGINEERING)

Scheme of Instruction and Examination
(Regulation:R16)

(with effect from **2016-2017** admitted batch onwards)

III SEMESTER

Code No	Course title	Credits	Scheme of Examination	Total Marks
M16 ST 2101	Thesis Work-Preliminary	10	Review	100

1. Candidates can do their thesis work within the department or in any industry/research organization for two semesters (i.e. 3rd and 4th semesters). In case of thesis done in an industry/research organization, one advisor (Guide) should be from the department and one advisor (CO-Guide) should be from the industry/research organization.
2. The Thesis Work -Preliminary should be submitted at the end of 3rd semester and it will be evaluated through Review by a committee consisting of Head of the Department, External Examiner, PG coordinator and guide. The marks shall be awarded in the ratio of 20, 40, 20 and 20 percent by the members respectively.

DEPARTMENT OF CIVIL ENGINEERING

M.TECH (STRUCTURAL ENGINEERING)

Scheme of Instruction and Examination
(Regulation:R16)

(with effect from **2016-2017** admitted batch onwards)

IV SEMESTER

Course Code	Course Title	Credits	Scheme of Examination	Exam Marks	Total Marks
M16 ST 2201	Thesis Work- Final	14	Viva-voce	100	100

1. A publication of a paper on the thesis work in a National/International Journal at the end of 4th semester is mandatory for the submission of thesis work.
2. The Thesis should be submitted at the end of 4th semester and it will be evaluated through Viva–Voce examination by a committee consisting of Head of the Department, External Examiner, PG coordinator and thesis guide. The marks shall be awarded in the ratio of 20, 40, 20 and 20 percent by the members respectively.