CIVIL ENGINEERING
STRUCTURAL ENGINEERING
M.Tech 1 YEAR I SEMESTER

S.No.	Name of the Subjects	Hrs/Week			Credits
		Lecture	Tutorial	Practical	
1	Applied Mathematics	4	--	--	8
2	Theory of Elasticity	4	--	--	8
3	Matrix Analysis of Structures	4	--	--	8
4	Structural Dynamics	4	--	--	8
5	Elective –I	4	--	--	8
	a) Experimental Stress Analysis				
	b) Sub-Structure Design				
	c) Structural Optimization				
6	Elective – II	4	--	--	8
	a) Repair and Rehabilitation of Structures				
	b) Analysis and Design of Tall Buildings				
	c) Plastic Analysis and Design				
7	Advanced Structural Engineering Laboratory	--	--	4	4

M.Tech 1 YEAR I SEMESTER

APPLIED MATHEMATICS

1. Applied partial Differential Equations: One-dimensional Heat equation and two-dimensional Laplace Equation in Cartesian, cylindrical and spherical coordinates (problems having axi-symmetry)

2. Two dimensional Laplace equations in Cartesian, Cylindrical and Spherical Coordinates (Problems having axi-symmetry)- Analytical solution by separation of variable techniques

3. Numerical Solutions to Heat and Laplace Equations in Cartesian Coordinates using Finite Differences, Implicit methods, Crank Nicholson Method, Jacobi Method, Gauss Seidal method

4. Applied Statistics: Regression and correlation analysis – Method of Least squares – Curve fitting – Curvilinear Regression – Non-linear curves – correlation coefficient

5. Linear Algebra: Matrix operations – matrix inversion – simultaneous linear equations – uniqueness and non-existence of solution, Gauss elimination method, Rank deficiency, Eigen value problem.

REFERENCES:

1. Solutions of partial Differential Equations" – Duffy, D.G. CBS Publishers, 1988
2. Introductory Methods of Numerical Analysis – Sastry, S.S. Prentice-Hall, 2nd Edition, 1992
3. Basic Statistics – Agarval, B.L., Wiley 1991, 2nd edition.
4. Numerical Algorithms – Krishnamurthy & Sen, Affiliated East-West Press, 1991, 2nd edition
5. Matrices" – Ayres, F., TMH – 1973.

M.Tech 1 YEAR I SEMESTER

THEORY OF ELASTICITY

1. Elasticity – Notation for forces and stresses – components of stresses and strains – Hooke's Law - Plane Stress – Plane strain – Differential Equations of equilibrium – Boundary conditions – Compatibility equations - Stress function – Boundary Conditions.

2. Two dimensional problems in rectangular co-ordinates – Solution by polynomials – Saint Venant's principle – Determination of displacements – Bending of simple beams – Application of Fourier series for two dimensional problems for gravity loading

3. Two dimensional problems in polar co-ordinates - General equations in polar co-ordinates – Stress distribution for problems having symmetrical about an axis - Strain components in polar co-ordinates – Displacements for symmetrical stress distributions - Stresses for plates with circular holes subjected to far field tension – stress concentration factor.

4. Analysis of stress and strain in three dimension - Principal stresses – Stress ellipsoid and stress director surface – Determination of principal stresses - Maximum shear stress – Homogeneous Deformation – General Theorems - Differential equations of equilibrium – Conditions of compatibility – Equations of equilibrium in terms of displacements – Principle of superposition – Uniqueness of solution –Reciprocal theorem.

5. Torsion of prismatical bars – Bars with elliptical cross section – Other elementary solution – Membrane analogy – Torsion of rectangular bars – Solution of torsional problems by energy method.

REFERENCES

1. Theory of Elasticity- Timoshenko & Goodier
2. Elasticity: Theory, Applications and Numeric- Martin H. Sadd

M.Tech 1 YEAR I SEMESTER

MATRIX ANALYSIS OF STRUCTURES

1. Introduction of matrix methods of analysis – Static indeterminacy and kinematic indeterminacy – Degree of freedom – Structure idealization- stiffness and flexibility methods – Suitability : Element stiffness matrix for truss element, beam element and Torsional element- Element force - displacement equations

2. Stiffness method – Element and global stiffness equation – coordinate transformation and global assembly – structure stiffness matrix equation – analysis of simple pin jointed trusses – continuous beams – rigid jointed plane frames

3. Stiffness method for Grid elements – development of stiffness matrix – coordinate transformation. Examples of grid problems – tapered and curved beams

4. Additional topics in stiffness methods – discussion of band width – semi band width – static condensation – sub structuring –Loads between joints-Support displacements-inertial and thermal stresses- Beams on elastic foundation by stiffness method.

5. Space trusses and frames - Member stiffness for space truss and space frame– Transformation matrix from Local to Global – Analysis of simple trusses, beams and frames

REFERENCES:

1. Matrix analysis of structures- Robert E Sennet- Prentice Hall- Englewood cliffs-New Jercy
2. Advanced structural analysis-Dr. P. Dayaratnam- Tata McGraw hill publishing company limited.
3. Indeterminate Structural analysis- C K Wang
4. Analysis of tall buildings by force – displacement – Method M. Smolira – Mc. Graw Hill.
5. Foundation Analysis and design – J.E. Bowls.

M.Tech 1 YEAR I SEMESTER

STRUCTURAL DYNAMICS

1. Introduction to Structural Dynamics: Fundamental objective of Dynamic analysis – Types of prescribed loadings – methods of Discretization – Formulation of the Equations of Motion.

2. Theory of Vibrations: Introduction – Elements of a Vibratory system – Degrees of Freedom of continuous systems - Oscillatory motion – Simple Harmonic Motion – Free Vibrations of Single Degree of Freedom (SDOF) systems – Undamped and Damped – Critical damping – Logarithmic decrement – Forced vibrations of SDOF systems – Harmonic excitation – Dynamic magnification factor – Band width.

3. Single Degree of Freedom System: Formulation and Solution of the equation of Motion – Free vibration response – Response to Harmonic, Periodic, Impulsive and general dynamic loadings – Duhamel integral.

4. Multi Degree of Freedom System: Selection of the Degrees of Freedom – Evaluation of Structural Property Matrices – Formulation of the MDOF equations of motion - Undamped free vibrations – Solution of Eigen value problem for natural frequencies and mode shapes – Analysis of dynamic response - Normal coordinates.

5. Continuous Systems: Introduction – Flexural vibrations of beams – Elementary case – Equation of motion – Analysis of undamped free vibration of beams in flexure – Natural frequencies and mode shapes of simple beams with different end conditions.

REFERENCES:

1. Dynamics of Structures by Clough & Penzien.
2. Structural Dynamics A K Chopra

M.Tech 1 YEAR I SEMESTER

(Elective I)

EXPERIMENTAL STRESS ANALYSIS

1. Introduction and Strain measurement methods – Model & Prototype – Dimensional analysis-Factors influencing model design – Scale factors and Model material properties – Methods of model design. Definition of strain and its relation to experimental determinations - properties of strain gauge systems – Mechanical, Optical, Acoustic and Pneumatic types.

2. Electrical resistance strain gages: Introduction – gauge construction – strain gauge adhesives - mounting methods – gauge sensitivities and gage factor – performance characteristics of wire and foil strain gauges – environmental effects. Analysis of strain gauge data – the three element rectangular rosette – the delta rosette – correction for transverse sensitivity.

3. Non – destructive testing: Introduction – objectives of non destructive testing.

   Ultrasonic pulse velocity method – Rebound Hammer method (Concrete hammer) – Acoustic Emission- application to assessment of concrete quality.

4. Theory of photo elasticity:

   Introduction – temporary double refraction – Index ellipsoid and stress ellipsoid – the stress optic law – effects of stressed model in a polariscope for various arrangements - fringe sharpening.

5. Two dimensional photo elasticity:

   Introduction – iso-chromatic fringe patterns – isoclinic fringe patterns – compensation techniques – calibration methods – separation methods – materials for photo-elasticity – properties of photo-elastic materials.

REFERENCES:

1. Experimental Stress Analysis- Riley and Dally
2. Experimental Stress Analysis - L.S. Srinath
3. Experimental Stress Analysis – Lee
4. Experimental Stress Analysis- Sadhu Singh

M.Tech 1 YEAR I SEMESTER

SUB-STRUCTURE DESIGN

1. Soil Exploration – Importance, Terminology, planning - Geophysical methods. Borings, location, spacing and depth, methods of boring including drilling, stabilization of boreholes, boring records.
2. Soil sampling – Methods of sampling -Types of samples and samplers- cleaning of bore holes, preservation, labeling and shipment of samples - Design considerations of open drive samplers.
3. Shallow Foundations –Bearing capacity – General bearing capacity equation, Meyerhof's, Hansen's and Vesic's bearing capacity factors - Bearing capacity of stratified soils - Bearing capacity based on penetration resistance- safe bearing capacity and allowable bearing pressure. (Ref: IS -2131 & IS 6403)
4. Types and choice of type. Design considerations including location and depth, Proportioning of shallow foundations- isolated and combined footings and mats - Design procedure for mats. Floating foundation- Fundamentals of beams on Elastic foundations. .(Ref: IS -456 & N.B.C. relevant volume)
5. Pile foundations-Classification of piles-factors influencing choice-Load -carrying capacity of single piles in clays and sands using static pile formulae- α - β - and λ - methods –Dynamic pile formulae-limitations- Monotonic and cyclic pile load tests – Under reamed piles.

6 Pile groups -Efficiency of pile groups- Different formulae-load carrying capacity of pile groups in clays and sands – settlement of pile groups in clays and sands – Computation of load on each pile in a group.

REFERENCES

1. Principles of Foundation Engineering by Braja M. Das.
2. Soil Mechanics in Engineering Practice by Terzagi and Peck
3. Foundation Design by Wayne C. Teng, John Wiley & Co.,
4. Foundation Analysis and Design by J.E. Bowles McGraw Hill Publishing Co.,
5. Analysis and Design of sub structures by Swami Saran
6. Design Aids in Soil Mechanics and Foundation Engineering by Shanbaga R. Kaniraj,Tata Mc. Graw Hill.
7. Foundation Design and Construction by MJ Tomlinson – Longman Scientific
8. A short course in Foundation Engineering by Simmons and Menzes - ELBS

M.Tech 1 YEAR I SEMESTER

STRUCTURAL OPTMIZATION

1. Introduction: Need and scope for optimization – statements of 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 behavior (monotonic and unimodal)

2. Classical optimization techniques: Differential calculus method, multi variable optimization by method of constrained variation and Lagrange multipliers (generalized problem) Khun-Tucker conditions of optimality -Fully stressed design and optimality criterion based algorithms- introduction, characteristics of fully stressed design theoretical basis- examples

3. Non-Liner programming: Unconstrained minimization- Fibonacci, golden search, 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- Zoutendjik's method- penalty function methods

4. Linear programming: Definitions and theorems- Simplex method- Duality in Linear programming- Plastic analysis and Minimum weight design and rigid frame

5. Introduction to quadratic programming: Geometric programming- and dynamic programming- Design of beams and frames using dynamic programming technique

REFERENCES

1. Optimization Theory and Applications – S.S. Rao, Wiley Eastern Limited, New Delh
2. Optimization Concepts and Application in Engineering- Belegundu A.D. and Chandrupatla T.R

M.Tech 1 YEAR I SEMESTER

(Elective -II)

REPAIR AND REHABILITATION OF STRUCTURES

1. Materials for repair and rehabilitation -Admixtures- types of admixtures- purposes of using admixtures- chemical composition- Natural admixtures- Fibres- wraps- Glass and Carbon fibre wraps- Steel Plates- Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects – Visual investigation- Acoustical emission methods- Corrosion activity measurement- chloride content – Depth of carbonation- Impact echo methods- Ultrasound pulse velocity methods- Pull out tests
2. Strengthening and stabilization- Techniques- design considerations- Beam shear capacity strengthening- Shear Transfer strengthening- stress reduction techniques- Column strengthening-flexural strengthening- Connection stabilization and strengthening, Crack stabilization
3. Bonded installation techniques- Externally bonded FRP- Wet layup sheet, bolted plate, near surface mounted FRP, fundamental debonding mechanisms- intermediate crack debonding- CDC debonding- plate end debonding- strengthening of floor of structures
4. Fibre reinforced concrete- Properties of constituent materials- Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes-Light weight concrete- properties of light weight concrete- No fines concrete- design of light weight concrete- Flyash concrete- Introduction- classification of flyash- properties and reaction mechanism of flyash- Properties of flyash concrete in fresh state and hardened state- Durability of flyash concretes.
5. High performance concretes- Introduction- Development of high performance concretes- Materials of high performance concretes- Properties of high performance concretes- Self Consolidating concrete- properties- qualifications.

REFERENCE:

1. Concrete technology- Neville & Brooks
2. Special Structural concrete- Rafat Siddique
3. Concrete repair and maintenance illustrated- Peter H Emmons
4. Concrete technology-M S Shetty

M.Tech 1 YEAR I SEMESTER

ANALYSIS AND DESIGN OF TALL BUILDINGS

1. Design Criteria Philosophy, Materials – Modern concepts – High Performance Concrete, Fibre Reinforced Concrete, Light weight concrete, Self Compacting Concrete

2. Gravity Loading – Dead load, Live load, Impact load, Construction load, Sequential loading. Wind Loading – Static and Dynamic Approach, Analytical method, Wind Tunnel Experimental methods. Earthquake Loading – Equivalent lateral Load analysis, Response Spectrum Method, Combination of Loads.

3. Behavior of Structural Systems- Factors affecting the growth, height and structural form, Behaviour of Braced frames, Rigid Frames, In-filled frames, Shear walls, Coupled Shear walls, Wall–Frames, Tubular, Outrigger braced, Hybrid systems.

4. Analysis and Design- Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of structures as an integral unit, Analysis for member forces, drift and twist. Computerized 3D analysis. Design for differential movement, Creep and Shrinkage effects, Temperature Effects and Fire Resistance.

5. Stability Analysis- Overall buckling analysis of frames, wall–frames, Approximate methods, Second order effect of gravity loading, P–Delta Effects, Simultaneous first order and P-Delta analysis, Translational instability, Torsional Instability, Out of plumb effects, Effect of stiffness of members and foundation rotation in stability of structures.

TEXT BOOKS:

1. Bryan Stafford Smith and Alex Coull, “Tall Building Structures - Analysis and Design”, John Wiley and Sons, Inc., 1991.
2. Taranath B.S, “Structural Analysis and Design of Tall Buildings”, McGraw-Hill, 1988.

M.Tech 1 YEAR I SEMESTER

PLASTIC ANALYSIS AND DESIGN

1. Introduction and basic hypothesis: Concepts of stress and strain – relation of steel Moment curvature relation- basic difference between elastic and plastic analysis with examples- Yield condition, idealizations, collapse criteria- Virtual work in the elastic-plastic state- Evaluation of fully plastic moment and shape factors for the various practical sections.

2. Method of Limit Analysis: Introduction to limit analysis of simply supported fixed beams and continuous beams, Effect of partial fixity and end, invariance of collapse loads, basic theorems of limit analysis, rectangular portal frames, gable frames, grids, superposition of mechanisms, drawing statistical bending moment diagrams for checks.

3. Limit design Principles: Basic principles, limit design theorems, application of limit design theorems, trial and error method, method of combining mechanisms, plastic moment distribution method, load replacement method, continuous beams and simple frames designs using above principles.

4. Deflection in Plastic beams and frames: Load deflection relations for simply supported beams, deflection of simple pin based and fixed based portal frames, method of computing deflections.

5. Minimum weight Design: Introduction to minimum Weight and linear Weight functions- Foulkes theorems and its geometrical analogue and absolute minimum weight design.

REFERENCES:

1. Plastic Methods of Structural analysis- B G Neal, Chapman and Rall publications
2. Plastic analysis and Design – C E Messennet, M A Seve

M.Tech 1 YEAR I SEMESTER

ADVANCED STRUCTURAL ENGINEERING LABORATORY

1. Strain measurement

   Electrical resistance strain gauges
2. Non destructive testing

   Impact Hammer test, UPV test
3. Qualifications tests on Self compaction concrete

   L Box test, J Box test, U box test, Slump test
4. Tests on Buckling of columns – Southwell plot
5. Identification of Dynamic Mode shapes and frequencies
6. Repair and rehabilitation of concrete beams

NOTE: A minimum of five experiments from the above set have to be conducted.