Syllabus of MST
M.Tech

Session: -

August – December 2015

Contents

Subject	***Structural Dynamics***
MST-I	**UNIT I:** **Theory of vibrations**: Introduction - Elements of vibratory system – Types of vibration- Degrees of Freedom-Continuous System - Lumped mass idealization - Oscillatory motion - Simple Harmonic motion – Vibration control in the design of structures. **UNIT II** **Introduction to Structural Dynamics** : Fundamental objectives of dynamic analysis - Types of prescribed loading - Methods of discretization - Formulation of equations of motion by different methods – Direct equilibration using Newton's law of motion / D'Alembert's principle, Principle of virtual work. **UNIT III** **Single Degree of Freedom Systems** : Free vibrations of single degree of freedom system - undamped and damped vibrations - critical damping - Logarithmic decrement ,Formulation and solution of the equation of motion - Free vibration response - Response to Harmonic, Periodic, Impulsive and general dynamic loadings - Duhamel integral.Forced vibration of SDOF systems - Harmonic excitation -Dynamic magnification factor – Phase angle – Bandwidth
MST-II	Numerical solution of single degree of freedom systems – Central Difference Method – Average acceleration method, Wilson-θ method- Newmark – β method. Earthquake response of linear systems. **UNIT IV** **Multi Degree of Freedom Systems** : Selection of the degrees of Freedom - Evaluation of structural property matrices - Formulation of the MDOF equations of motion - Undamped free vibrations - Solutions of Eigen value problem for natural frequencies and mode shapes - Analysis of Dynamic response – Normal co-ordinates - Uncoupled equations of motion - Orthogonal properties of normal modes - Mode superposition procedure.
MST-III	**UNIT V** **Practical Vibration Analysis**: Introduction - Stodola method - Fundamental mode analysis-Analysis of second and higher modes - Holzer method - Basic procedure. **UNIT VI** **Continuous Systems**: Introduction - Flexural vibrations of beams - Elementary case – Derivation of governing differential equation of motion - Analysis of undamped free vibrations of beams in flexure - Natural frequencies and mode-shapes of simple beams with different end conditions Principles of application to continuous beams.

Subject	***Theory and Design of Plates, Shells and Grids***
MST-I	**Analysis of Plates** Introduction- Assumptions in the theory of thin isotropic plates. Pure bending of plates, slope and curvature, relations between bending moments and curvature, Particular cases of pure bending. Symmetrical bending of circular plates-Differential equation-Uniformly loaded circular plates with simply supported and fixed boundary conditions-Annular plate with uniform moments and shear forces along the boundaries
MST-II	Small deflections of laterally loaded plates-Differential equation-Boundary conditions-Navier solution and Levy's solution for simply supported rectangular plates-
MST-III	**Analysis of Grids** Bending of anisotropic plates - Derivation of governing differential equation – Determination of Rigidities in various cases like R.C. slabs, corrugated sheet – Application to the theory of grid works. Various methods of analyzing grids for roofs and bridges. Distribution of concentrated loads to various beams of grid floors and bridge decks.

Subject	***Finite Element Methods***
MST-I	**Introduction** Brief History , Role the Computer , General Steps of the Finite Element Method , Applications of the Finite Element Method , Advantages of the Finite Element Method , Computer Programs for the Finite Element , Methods for Solution of Simultaneous Linear Equations , Banded-Symmetric Matrices, Bandwidth, Skyline, and Wavefront Methods **Introduction to the Stiffness Method** Definition of the Stiffness Matrix , Derivation of the Stiffness Matrix for a Spring Element, Assembling the Total Stiffness Matrix by Superposition , Boundary Conditions , Potential Energy Approach to Derive Spring Element Equations **Trusses** Derivation of the Stiffness Matrix for a Bar Element in Local Coordinates , Selecting Approximation Functions for Displacements , Transformation of Vectors in Two Dimensions , Global Stiffness Matrix , Computation of Stress for a Bar in the x-y Plane , Solution of a Plane Truss , Transformation Matrix and Stiffness Matrix for a Bar in Three-Dimensional Space , Use of Symmetry in Structure, Inclined or Skewed Supports, Potential Energy Approach to Derive Bar Element Equations , Comparison of Finite Element Solution to Exact Solution for Bar , Galerkin's Residual Method and Its Use to Derive the One-Dimensional Bar Element Equations **Beams** Beam Stiffness, Assemblage of Beam Stiffness Matrices , Beam Analysis Using the Direct Stiffness Method , Distributed Loading , Comparison of the Finite Element Solution to the Exact Solution for a Beam , Beam Element with Nodal Hinge , Potential Energy Approach to Derive Beam Element Equations , Galerkin's Method for Deriving Beam Element Equations
MST-II	**Frames and Grids** Two-Dimensional Arbitrarily Oriented Beam Element , Rigid Plane Frame Examples , Inclined or Skewed Supports – Frame Element , Grid Equations , Beam Element Arbitrarily Oriented in Space , Concept of Substructure Analysis **Plates with Plane Stress and Plane Strain** Basic Concepts of Plane Stress and Plane Strain, Derivation of the Constant-Strain Triangular Element Stiffness Matrix and Equations , Treatment of Body and Surface Forces , Explicit Expression for the Constant-Strain Triangle Stiffness Matrix **Practical Considerations in Modelling and Result Interpretation** Finite Element Modelling , Equilibrium and Compatibility of Finite Element Results , Convergence of Solution , Interpretation of Stresses , Static Condensation , Flowchart for the Solution of Plane Stress/Strain Problems , Computer Program Assisted Step-by-Step Solution, Other Models, and Results for Plane Stress/Strain Problems

	Axisymmetric Elements Derivation of the Stiffness Matrix, Solution of an Axisymmetric Pressure Vessel, Applications of Axisymmetric Elements
MST-III	**Isoparametric Formulation** Isoparametric Formulation of the Bar Element Stiffness Matrix , Rectangular Plane Stress Element , Isoparametric Formulation of the Plane Element Stiffness Matrix , Gaussian and Newton-Cotes Quadrature , Evaluation of the Stiffness Matrix and Stress Matrix by Gaussian Quadrature , Higher-Order Shape Functions **Three-Dimensional Stress Analysis** Three-Dimensional Stress and Strain, Tetrahedral Element, Isoparametric Formulation **Plate Bending Element** Basic Concept of Plate Bending, Derivation of a Plate Bending Element Stiffness Matrix and Equations, Computer Solution for a Plate Bending Problem

Subject	***Numerical Methods in Engineering***
MST-I	Equation: Roots of algebraic transcendental equation, Solution of linear simultaneous Equations by different methods using Elimination, Iteration, Inversion, Gauss-Jordan and Gauss Siedel iteration method – Factorisation method – Ill conditioned matrix.
MST-II	Finite Difference Technique: Partial differential equation: Laplace, Poisson and wave equation – Explicit and implicit methods. Initial and Boundary value problems of ordinary and partial differential equations, Solution of Various types of plates and other civil engineering related problems
MST-III	Numerical integration: Newton Cotes closed quadrature – Trapezoidal rule – Simpson's $1/3^{rd}$ rule – $3/8^{th}$ rule method. Homogeneous and Eigen Value problem, Non-linear equations, Interpolation. Statistical Methods: Method of correlation and Regression analysis for fitting a polynomial equation by least square Initial Value problem: Galerkin's method of least square, Initial Value problem by collocation points, Runge kutta Method

Subject	***Advanced Solid Mechanics & Structural Analysis***
MST-I	**Introduction:** Matrix methods of analysis and their suitability, static and kinematic indeterminacies as related to two-dimensional and three-dimensional skeletal structures, generalized system of coordinates. **Force method:** Development of flexibility matrices for statically determinate and in determinate beams, rigid-jointed plane frames and pin-jointed plane frames
MST-II	Assembly of global flexibility matrix from element flexibility matrices. Analysis of continuous beams, rigid-jointed plane frames and pin-jointed plane frames using physical and element approaches.
MST-III	**Displacement method:** Development of stiffness matrices for statically determinate and in determinate beams, rigid-jointed plane frames and pin-jointed plane frames. Assembly of global stiffness matrix from element stiffness matrices. Analysis of continuous beams, rigid-jointed plane frames and pin-jointed plane frames using physical and element approaches.

Subject	***Site Investigations***
MST-I	1. Soil formation -Processes – Characteristics of major soil deposits of India. Necessity and mportance of soil exploration Method of sub surface exploration Test pits , Trenches, Caissons, Tunnels and drifts, Wash boring , Percussion drilling , Rotary drilling, Factors affecting the selection of a suitable method of boring. Extent of boring, Factors controlling spacing and depth of bore holes, Spacing and depth for various Civil engineering structures. 2. Indirect method of exploration, Seismic method, Electrical resistivity, Resistivity sounding and profiling, Qualitative and quantitative interpretation of test results, Comparison of resistivity and seismic surveys, Shortcomings. 3. Stablization of bore holes, Different method of stabilisation of the bore holes, their relative merits and demerits. 4. Ground water Observation: Different method of ground water observation: Time lag in observation, Sampling of ground water. 5. Sampling: Source of disturbance and their influence, Type of sampler, Principle of design of sampler, Representative and undisturbed sampling in various types of soils, Surface sampling, Amount of sampling, Boring and sampling record, Preservation and shipment of sample preparation of bore log. 6. In situ Permeability. Pumping in test in a cased hole with open end, Falling head packer test constant head packer test, Pump in out tests in a single test wall and open pit or unlined hole. Piezometer merhods .
MST-II	7. Water content at site: Speedy moisture tester, Their relative merits and demerits. 8. Fields Tests: Standard penetration test, Dynamic cone penetraion tests with and without bentonite mud slurry. Static cone penetration test, Surface sampling. Cylic plate load test, Large shear box test, Vane shear test, Pile load, , Block resonance test, wave propagation test. Small size penetrometers, Pressuremeter test and Diltometer test. Various corrections in the test results and interpretation of test results for design of foundations. Correlation among various test results. Precautions to be exercised during the execution of these tests. Preparation of bore hole log.
MST-III	9. Investigation below sea/river bed – methods and equipments – interpretation of offshore exploration, Instrumentation in soil engineering - strain gauges - resistance and inductance type - load cells, earth pressure cells - settlement and heave gauges - piezometers and slope indicators -inclinometer, Field visit, data and report preparation.

Subject	***Applied Soil Mechanics***
MST-I	Introduction to stability of slopes, Stability number, Friction circle, Bishop's method of slices- simple and rigorous; Wedge method, Factor of safety w.r.t height and strength. Stabilisation of soils: Mechanical, Electrical and Chemical methods of stabilisation, Problems of excavation, Dewatering, Stability of base and embankment.
MST-II	Swell and shrinkage, Soils characteristics, swelling pressure of soils, Mechanics of Swelling, Crack. Design of open cuts.
MST-III	Earth work construction, Embankments, Earth dams, Field compaction, Seepage and piping in embankments and dams construction problems. Arching in Soil & underground culvert and conduits.

Subject	***Analysis of Settlement of Soils & Foundations***
MST-I	Stress Strain Relation; Evaluation of parameters, types of settlements- elastic and inelastic, Method for estimation
MST-II	Consolidation theories- one and three dimensional
MST-III	Settlement of footings- isolated footings, strip footing, Rafts, Piles and piles groups, Analysis of foundation Soil system.

Subject	***Environmental Chemistry and Microbiology***
MST-I	Heavy Metals: In water, complex formation, metal speciation. Atmospheric Chemistry: Photochemical reactions in atmosphere, Redox reactions, sources of air pollution, Major chemical pollutants and their effects, Indoor air pollutants.
MST-II	Introduction and Scope: Air-water, water-sediment / soil and air – water – sediment interactions, physical water quality parameters. Chemistry of Natural Water: Reaction stoichiometry, basic concepts from equilibrium chemistry, acid-base reactions, solubility of salts (soil chemistry) and related water quality parameters. Nutrients and Organic Impurities in Water: Oxidation-reduction reactions, water and wastewater quality parameters (ORP, BOD, COD, TOC etc.).
MST-III	Microbiology - classification - identification – Taxonomy - Reproduction and growth - cultures & characteristics - Enzymes - Microbial metabolism - energy production – biosynthesis, Mixed and pure culture – Growth rate – Application. Fungi, Bacteria, molds and yeast, algae, protozoa, viruses. Control of microorganisms. Microbiology of domestic water and wastewater, industrial microbiology. Epidemiology of infectious diseases, microbial agents of diseases.

Subject	***Solid and Hazardous Waste Management***
MST-I	**Introduction:** Definition of solid wastes and hazardous wastes, Nuisance potential and extent of solid waste problems, Objectives and scope of integrated solid waste management. **Characterization and Quantification:** Types, composition, characteristics and quantities of wastes, Methods of quantification and characterization of wastes. **Collection, Storage and Transportation of Wastes:** Types of collection systems and their components, Concept of waste segregation at source and recycling and reuse of wastes; Household, street and community level collection bins and storage containers.
MST-II	**Solid Waste Processing and Treatment:** Waste processing – processing technologies – biological and chemical conversion technologies – Composting - thermal conversion technologies - energy recovery – incineration **Hazardous Waste Treatment and Disposal:** Biological and chemical treatment of hazardous wastes; Solidification and stabilization of wastes; Incineration for the treatment and disposal of hazardous wastes; Land farming; Landfill disposal of hazardous waste; Bioremediation of hazardous waste disposal sites.
MST-III	**Sanitary Landfills:** Site selection and approval; design, development, operation and closure of landfills, Management of leachate and landfill gases, environmental monitoring of landfill sites. **Legal Requirements:** Municipal solid waste rules; Hazardous waste rules; Biomedical waste rules; E-waste rules; Rules related to recycled plastics, used batteries, flyash, etc

Subject	***Physico-Chemical Treatment Methods***
MST-I	**Water – Quality, Standards and Criteria**: Physical, chemical and biological water quality parameters; Water quality guidelines, criteria and standards, wastewater effluent standards Purification of water:- natural treatment processes – physical, chemical, biologiocal processes, water treatment technologies- overview, primary, secondary, tertiary treatment – unit operations, unit processes Screening & Grit removal:- screens, grit channels, aerated grit chambers
MST-II	Settling tanks, Coagulation, Flocculation:- theory of settling, types of settling, settling tanks, coagulation – flocculation, flash mixing tanks, flocculation tanks, clarifiers and clariflocculators, tube settlers and plate settlers Aeration- diffused and surface and gas transfer process
MST-III	Filtration System- filtration theory, filter hydraulics, slow sand filters, rapid gravity filters, pressure filters multimedia filters Disinfection- chlorination, ozonation, UV radiations Other water treatment technologies- Ion exchange process, adsorption process, adsorption equilibria – adsorption isotherms, membrane processes, de-fluoridation units, household level water purification systems

Subject	***Physics of Environment***
MST-I	**UNIT-I Radiation Sciemce** Radiation spectrum (ionizing & non ionizing radiation), Laws of radioactive disintegration, Interaction of nuclear radiation with matter (qualitative discussion only), Dosimetry and effects of radiations, Radiation detectors (GM counter, Ionization counter, Proportional counter and Scintillation counter), Radioactive waste management.
MST-II	**UNIT – II Atmospheric Physics** Basic structure of atmosphere, Stefan Law, Wien's displacement law, Planck's Temperature, Earth's radiation budget, Atmospheric photosensitivity, Fundamental forces and apparent forces, mass, momentum and energy conservation, Hydrostatic equilibrium, Adiabatic lapse rates and stability, Geostrophic balance, Planetary atmospheres.
MST-III	**UNIT – III Climate Physics** Green house effect, Feedback mechanisms, Ozone layer depletion and Global warming, Aerosols & Cloud formation, Precipitation, Ice age, Climate effects of ocean (Convection, Thermal Inertia & Ocean circulation), Remote sensing.