Draft of Proposed Course Structure
for Post Graduate Degree Programme

M. Tech. in Civil Engineering
with Specialization in
Structural Engineering

Presented to Academic Council
on 15 April 2017

Dr. Babasaheb Ambedkar Technological University
Lonere 402 103, Dist- Raigad, Maharashtra, INDIA

Program Objectives

Goal of the Civil engineering with a specialization in Structural Engineering (SE) at Dr. Babasaheb Ambedkar technological University, Lonere (BATU) is to provide students with preparation to become worthy of professional careers in the field and to be motivated for lifelong learning. All prescribed courses have definite objectives and outcomes. Program objectives are expected qualities of engineers as under:

a) Preparation: To prepare students to excel in various educational programmes or to succeed in industry / technical profession through further education/training;

b) Core Competence: To provide students with a solid foundation in mathematical, scientific fundamentals required to solve Structural problems;

c) Breadth: To train students with a breadth of scientific knowledge to comprehend, analyze, design & create novel products and solutions for real life problems;

d) Professionalism: To inculcate in students professional/ethical attitude, effective team work skills, multidisciplinary approach and to relate engineering issues to a broader context;

e) Learning Environment: To provide students with academic environment of excellence, leadership, ethical guidelines and life-long learning needed for a long / productive career.

In addition to above DBATU graduate is expected to be

1. Taking pride in their profession and have commitment to highest standards of ethical practices and related technical disciplines;

2. Able to design structural system that is safe, economical and efficient;

3. Capable of using modern tools efficiently in all aspects of professional practices;

4. Dealing successfully with real life civil engineering problems and achieve practical solutions based on a sound science and engineering knowledge;

5. Shall be engage in continuous research, development and exchange of knowledge for professional development;

6. Be honest in their control and performing their duties and promote effective use of resources through open, honest and impartial services to the public;

7. Act in such a manner which will uphold the honour, integrity, or dignity of the engineering profession, and avoid knowingly engaging in business or professional practices of a fraudulent, dishonest or unethical nature;

8. Recognize that the lives, safety, health and welfare of the general public are dependent upon engineering, decision and practices;

9. Continue their professional development throughout their careers and provide opportunities for the professional development;

First Semester

Sr. No.	Subject Code	Name of Subject	Hours /Week			Credit	Examination Scheme				
			L	P	T		Theory		CA	PR/ OR	Total
							TH	MTE			
01	CVSE101	Theory of Elasticity and Plasticity	03	--	1	04	60	20	20	--	**100**
02	CVSE102	Matrix Methods of Structural Analysis	03	--	1	04	60	20	20	--	**100**
03	CVSE103	Structural Dynamics	03	--	1	04	60	20	20	--	**100**
04	CVSE104	Communication Skills	02	--	--	02	--	--	25	25	**50**
05	CVSE-L01	PG Lab-I	--	03	--	02	--	--	25	25	**50**
06	CVSE-E1	Elective-I	03	--	--	03	60	20	20	--	**100**
07	CVSE-E2	Elective-II	03	--	--	03	60	20	20	--	**100**
		Total for Semester I	**17**	**03**	**03**	**22**	**300**	**100**	**150**	**50**	**600**

Elective-I

CVSE-E1-01: Design of Bridges

CVSE-E1-02: Numerical Methods

CVSE-E1-03: Approximate Analysis of Structural Systems **

Elective-II

CVSE-E2-01: Advanced Pre-stressed Concrete

CVSE-E2-02: Design of Masonry Structures

CVSE-E2-03: Assessment of Structural Loading **

** Syllabus of these courses is under preparation.

Second Semester

Sr. No.	Subject Code	Name of Subject	Hours /Week			Credit	Examination Scheme				
			L	P	T		Theory		CA	PR/	Total
							TH	MTE		OR	
01	CVSE201	Theory of Plates and Shells	03	--	1	04	60	20	20	--	**100**
02	CVSE202	Finite Element Analysis	03	--	1	04	60	20	20	--	**100**
03	CVSE-S01	Seminar-I	--	04	--	02	--	--	50	50	**100**
04	CVSE-L02	PG Lab-II or Mini -Project	--	04	--	02	--	--	50	50	**100**
05	CVSE-E3	Elective-III (Departmental)	03	--	--	03	60	20	20	--	**100**
06	CVSE-E4	Elective-IV (Departmental)	03	--	--	03	60	20	20	--	**100**
07	CVSE-E5	Elective-V (Open)	03	--	--	03	60	20	20	--	**100**
		Total for Semester II	**15**	**08**	**02**	**21**	**300**	**100**	**200**	**100**	**700**

Elective-III

CVSE-E3-01: Design of Cold Formed Steel Structures

CVSE-E3-02: Structural Health Monitoring

CVSE-E3-03: Retrofitting of Structures

Elective- IV

CVSE-E4-01: Design of Tall Buildings

CVSE-E4-02: Earthquake Engineering & Design of Earthquake Resistant Structures

CVSE-E4-03: Structural Audits

Elective-V (Open)

CVSE-E5-01: Research Methodology

CVSE-E5-02: Soil Dynamics & Machine Foundations

CVSE-E5-03: Solution Procedures in Civil Engineering

Third Semester

Sr. No.	Subject Code	Name of the subject	Hours/Week L	P	T	Credit	Theory TH	Test	CA	PR / OR	Total
1	CVSE301	Project Management and Intellectual Property Rights (Self Study)*	--	--	--	02	--	--	50	50	**100**
2	CVSEPS1	Project Stage -I	--	--	--	10	--	--	50	50	**100**
		Total for Semester III	**--**	**--**	**--**	**12**	**--**	**--**	**100**	**100**	**200**

Fourth Semester

Sr. No.	Subject Code	Name of the subject	Hours/Week L	P	T	Credit	Theory TH	Test	CA	PR/ OR	Total
1	CVSEPS2	Project Stage-II	--	--	--	20	--	--	100	100	**200**
		Total for Semester IV	**--**	**--**	**--**	**20**	**--**	**--**	**100**	**100**	**200**
GRAND TOTAL											**1700**

* Student may select this course either from NPTEL/MOOC pool or any other approved reputed source. The submission of course completion certificate is mandatory.

<h1 style="text-align:center">Semester I</h1>
<h1 style="text-align:center">CVSE101 Theory of Elasticity and Plasticity</h1>

Teaching Schemes: 3 Lect. + 1 Tut hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

<h2 style="text-align:center">Course Contents</h2>

Module 1: Analysis of Stresses and Strains

Concept of Stress at a Point, Stress Tensor, State of Stress at a Point in Cartesian Coordinate System, Derivation of Stress Equilibrium Equations in Cartesian and Polar Coordinate System, Cauchy's Formula, Normal Stress, Shear Stress and Resultant Stress on any Inclined Plane, Transformation of Stresses, Stress Invariants, State of Pure Shear, Principal Stresses, Maximum Shear Stresses, Octahedral Stresses, Decomposition of State of Stress into Pure Shear and Hydrostatic Stress, Mohr's Circles/ Spheres for Various States of Stress, The State of Strain at a Point, Strain Displacement Relations, Strain Compatibility Condition, Volumetric Strain, Problems on Navier Lame's Equilibrium Equations, Problems on Beltrami - Michell Compatibility Equations, Boundary Value Problems in Elasticity.   **(08 Lectures)**

Module 2: Stress-Strain Relationship

Generalized Hooke's Law, Hooke's Law for Isotropic, Orthotropic, Plane Stress, Plane Strain and Axi-Symmetric Problems, Relations between Elastic Constants, Problems in 2D and 3D Cartesian Coordinate System, Airy's Stress Function, Bending of Beams, Straight Beams & Asymmetrical Bending, Euler Bernoulli Hypothesis, Shear Center or Center of Flexure, Shear Center in Thin Walled Open Sections and Other Sections.   **(08 Lectures)**

Module 3: Stress Concentration Problems

Stress Concentration Problems such as Stress Concentration due to Circular Hole in Stressed Plate (Kirsch's Problem), Stresses under Concentrated Load such as Concentrated Load acting on the Vertex of a Wedge (Michell's Problem) and Concentrated Load Acting on the Free Surface of a Plate (Flamant's Problem), Axi-symmetric Problems such as Stresses in Thick Cylinders Subjected to Internal and External Uniformly Distributed Pressures (Lame's Problem).   **(06 Lectures)**

Module 4: Torsion

Assumptions and Torsion Equation for General Prismatic Solid Bars, Warping of Non-Circular Sections and St. Venant's Theory, Prandtle's Stress Function Approach, Torsion of Circular, Elliptical and Triangular Cross-Section, Torsion of Thin-Walled Structures by Membrane Analogy, Torsion of Rolled Sections and Shear Flow.   **(06 Lectures)**

Module 5: Plasticity

Basic Equations, Similarities and Differences when Compared with Elasticity, Idealized Material Behaviour, Mechanical Models, Neck Formation, Failure Theories, Modes of Failure, Failure under Static Equilibrium, Buckling, Vibrations, Yielding, Fracture, Ductile and Brittle Failure, Yield Criteria, Rankine's Theory, Saint Venant's Theory, Tresca Criteria, Beltrami's Energy Criteria, Von Mises and Hencky & Huber's Theory, Comparison of Different Theories under Axial Tension and Torsion, Various Empirical Stress-Strain Relationships.   **(07 Lectures)**

Module 6: Yield Criteria & Yield Surface

Use of Factor of Safety in Design, Numerical on Bar subjected to Axial Load, Bending and Torsion, Theories of Plastic Flow, Mohr-Coulomb Yield Criteria, Drucker Prager Yield Criteria, Principal Stress Space & Yield Surface, Pi-Plane, Post Yield Stress Strain Behaviour, Plastic Stress Strain Relations, Prandtl Reuss Equation, Lavy-Mises Relation, Strain Hardening, Introduction to Visco-Elasticity and Visco-Plasticity, 1 D Models.   **(07 Lectures)**

Guidelines for Assignments: Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of minimum Three Modules.

References:

- L. S. Shrinath, Advanced Solid Mechanics, Tata-McGraw Hill Publications.
- Timoshenko & Goddier, Theory of Elasticity & Plasticity, Mc-Graw Hill Publications.
- Martin Sadd, Elasticity Theory, Applications & Numerics, Academic Press.
- M A Kazami, Solid Mechanics, Tata -McGraw Hill Publications.
- Sadhu Singh, Theory of Elasticity, Khanna Publishers, New Delhi.
- Irving Shames, Mechanics of Deformable Solids, Prantice Hall.
- N K Bairagi, Advanced Solid Mechanics, Khanna Publishers, New Delhi.
- Wang, Applied Elasticity, Dover Publications.
- N Dahl and T Lardner, S Crandall, Mechanics of Solids, McGraw Hill Publications.
- Scholer, Elasticity in Engineering, McGraw Hill Publications.

Outcomes:

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

- Understand concept of stress and strain at a point, Stress equilibrium and Strain compatibility and Analyse Stress and Strain at a point with various perspectives, etc. under in three dimensional state of stress.
- Establish relation between stress and strain for various materials, Elastic constants, and reduce 3D problems to 2 D problems.
- Formulate and Analyse stress concentration problems due to various complex situations.
- Formulate and Analyse members subjected to Torsion using various classical approaches.
- Able to understand different post yielding behaviour of materials and Plasticity theories.
- Able to understand various yield criteria, and concept of factor of safety in design of various structural members, concept of Viscoelastic and Viscoplastic materials.

CVSE102 Matrix Methods of Structural Analysis

Teaching Schemes: 3 Lect. + 1 Tut hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction

Introduction and Review of Various Methods for Finding Slopes and Deflections at a Point in Statically Determinate and Indeterminate Structures, Assessment of Deflected Shape of Structures for Different Loading & Support Conditions. **(02 Lectures)**

Module 2: Direct Flexibility Matrix Method

Direct Flexibility Matrix Method, Applications to Continuous Beams, Pin Jointed Frames, Rigid Jointed Frames.   **(06 Lectures)**

Module 3: Generalised Flexibility Matrix Method

Generalised Flexibility Matrix Method, Applications to Continuous Beams, Pin Jointed Frames, Rigid Jointed Frames.

(12 Lectures)

Module 4: Direct Stiffness Matrix Method

Direct Stiffness Matrix Method, Applications to Continuous Beams, Pin Jointed Frames, Rigid Jointed Frames.   **(06 Lectures)**

Module 5: Generalised Stiffness Matrix Method

Generalised Stiffness Matrix Method, Applications to Continuous Beams, Pin Jointed Frames, Rigid Jointed Frames.

(12 Lectures)

Module 6: Nonlinear Analysis

Material and Geometric Non-Linearity, Stiffness Method with Material Non-Linearity and Geometric Non-Linearity.

(04 Lectures)

Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the course shall be performed by the candidate containing numerical analysis of continuous beams, rigid jointed frames and pin jointed frames with all the methods mentioned in the syllabus. Additional analysis of structures with four or more degree of freedom using MATLAB/ SciLAB/ C / Spreadsheet coding is desired.

Guidelines for Class Test: Class Test shall cover syllabus of any three Modules.

References:

- Weaver W, Gere G. M., Matrix Analysis of Framed Structures, Van Nostrand Reinhold, New York.
- Hibbler R. C., Structural Analysis,
- Reddy C. S., Basic Structural Analysis, Tata Mc Graw Hill Publications.
- G. S. Pandit, S. P. Gupta, Structural Analysis – A Matrix Approach, Tata Mc Graw Hill Publications.
- Devdas Menon, Structural Analysis, Alpha Science.
- A. S. Meghare, S. K. Deshmukh, Matrix Methods of Structural Analysis, Charotor Publishing House.
- B. N. Thadani, J. P. Desai, Structural Analysis – A Matrix Approach, Ueinall Publications, Mumbai.

Outcomes:

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

- Draw deflected shapes of various structures for different loading and boundary conditions.
- Understand difference in force approach and displacement approach in structural analysis.
- Analyze various plane structural systems using direct and generalized flexibility approach.
- Analyze various plane structural systems using direct and generalized stiffness approach.
- Develop codes for computer based analysis of plane structures.
- Understand effect of material non linearity and geometric non linearity on force displacement relation and stiffness matrix.

CVSE103 Structural Dynamics

Teaching Schemes: 3 Lect. + 1 Tut hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: SDoF Systems

Simple Structures, SDoF System, Force -Displacement Relation, Damping Force, Equation of Motion, External Force, Mass Spring Damper System, Equation of Motion: Earthquake Excitation, Combining Static & Dynamic Responses, Methods of Solution of the Differential Equation, Free Vibration: Un-damped & Viscously Damped Free Vibration, Energy in Free Vibration, Coulomb Damped Free Vibration, Response to Harmonic & Periodic Excitations, Viscously Damped Systems, Systems with Non Viscous Damping. **(04 Lectures)**

Module 2: SDoF System under General Loading

Response to Unit Impulse, Arbitrary Time Varying Force, Response to Step and Ramp Forces, Response to Pulse Excitations, Rectangular Pulse, Half Sine Wave Pulse, Triangular Pulse, Response to Ground Motion, Numerical Evaluation of Dynamic Responses, Time Stepping Methods, Interpolation Methods, Newmark's Beta Method. **(06 Lectures)**

Module 3: Generalised SDoF System

Generalised SDF Systems, Rigid Body Assemblages, Systems with Distributed Mass & Elasticity, Lumped Mass System, Natural Vibration Frequency by Rayleigh's method, Shape Functions. **(06 Lectures)**

Module 4: MDoF Systems

Simple Systems, Two Storey Shear Buildings, General Approach for Linear Systems, Static Condensation, Symmetric and Asymmetric systems subjected to Ground Motion, Symmetric Systems subjected to Torsional Excitations, Multiple Support Excitations, Methods for Solving Equations of Motion. **(08 Lectures)**

Module 5: Dynamic Analysis and Response of Linear Systems

Systems without Damping, Natural Vibration Frequencies and Modes, Modal & Spectral Matrices, Orthogonality of Modes, Normalisation of Modes, Modal Expansion of Displacements, Free Vibration Response of Damped and Undamped and Classically Damped Systems, Damping in Structures, Classical Damping Matrix, Non Classical Damping Matrix, Two DoF Systems, Modal Analysis, Modal Response Contributions. **(08 Lectures)**

Module 6: Numerical Evaluation of Dynamic Response

Time Stepping Method, Analysis of Linear and Non Linear Systems, Systems with Distributed Mass and Elasticity, Undamped motions due to Applied Forces, Undamped motion due to Support Excitation, Natural Vibration Frequencies and Modes, Modal Analysis of Forced Dynamic Response, Rayleigh Ritz Method, Formulation using Conservation of Energy, Virtual Work, Finite Difference Method, Finite Element Method, Element Degree of Freedom and Interpolation Functions, Element Stiffness, Mass and Force Matrix, Comparison of FE Solution with Exact Solution. **(10 Lectures)**

Guidelines for Assignments: Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References:

- R. W. Clough & Joseph Penziene, Dynamics of Structures, Mc-Grew Hill Publications.
- A. K. Chopra, Dynamics of Structures: Theory & Application to Earthquake Engineering, Prentice Hall Publications.
- Mario Paz, Structural Dynamics, CBS Publication.
- Roy Craig, Structural Dynamics, John-Wiley & Sons.
- Jagmohan L. Humar, Dynamics of Structures, Swets and Zeitlinger, Netharlands.
- Jaikrisna, A. R. Chandrashekharan, Elements of earthquake Engineering, South Asian Publishers.
- Mukhopadhayay Madhujit, Structural Dynamics: Vibration and systems, Ane Books India Publisher.
- Patrick Paultre, Dynamics of Structures, Wiley India

Outcomes:

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

- Understand basics of response of structures to forced vibrations and free vibrations.
- Analyse response of SDoF systems to general loading and understand various methods of evaluation of dynamic response.
- Analyse response of structures to ground excitations, support excitations and torsional excitations.
- Understand and Analyse structures for natural frequency and modal analysis.
- Analyse response of structural system by numerical evaluation using various classical approaches.
- Understand and implement finite element approach in structural dynamics.

CVSE104 Communication Skill

Teaching Schemes: 2 Lect. hrs/week; **Evaluation Scheme:** Class Assessment 25; Oral examination 25

Course Contents

Module 1: Language for Technical Purpose and Presentation Tools

Technical vocabulary, Sentence structures, Microsoft office, Graphical presentations   **(03 Lectures)**

Module 2: Formal Written Communication

Drafting Letters, e-Mails, Memos, Notices, Circulars, Schedules.   **(03 Lectures)**

Module 3: Project Research Proposals and Reports

Research Proposal: Essentials, Abstract, Aims, Background & significance, Design & methods, Writing a sample proposal.

Project Report: Types of reports, Planning a report, Collection & organization of information, Structure & style, Proofreading etc.

Writing a sample report.   **(06 Lectures)**

Module 4: Leadership Skill and Team Building, Working.

Leadership Skills**:** Leadership quality and styles, Emotional intelligence, Diplomacy and Tact and effective communication, Case studies.

Need of team, Effective teams, Group development, Roles in group, Case studies.   **(06 Lectures)**

Module 5: Business Meetings

Understanding role of meetings, planning meetings, developing meeting agendas, scheduling meetings, conducting meetings effectively, Taking notes and publishing minutes and concluding meetings, action plans, Demo meetings.   **(06 Lectures)**

Module 6: Presentation Skills

Preparation, Understanding audience, Use of presentation tools, Presentation, nonverbal techniques, handling questions, Demo presentations.

(04 Lectures)

References:

- S. Hariharan, et.al. Soft Skills; MJP Publishers, 2010.
- John Seely, Oxford Guide to Effective Writing and Speaking; Oxford University Press, 2009.
- Thomas N. Huckin and Leslie A. Olsen, Technical Writing and Professional Communication
- for Nonnative Speakers of English; Tata McGraw Hills, International Edition, 1991.
- Jeff Butterfield,Soft Skills for Everyone,cengage Learning India Private Limited,2010.
- L. Ann Masters & Harold R. Wallace, Personal Development for Life & Work,10e,Cengage
- Learning India Private Limited,2011.

Outcomes:

PG Lab-I

CVSE-L01Structural Dynamics Lab

Teaching Schemes: **3** Pract. hrs/week; **Evaluation Scheme:** Oral 25; Class Assessment 25

Laboratory Work:

The students are expected to perform **any five** experiments out of list given below and submit report of same;

- Dynamics of a three-storied building frame subjected to harmonic base motion

- Dynamics of a one-storied building frame with planar asymmetry subjected to harmonic base motion
- Dynamics of a three-storied building frame subjected to periodic (non harmonic) base motion
- Vibration isolation of a secondary system.
- Dynamics of a vibration absorber.
- Dynamics of a four-storied building frame with and without an open ground floor.
- Dynamics of one-span and two span beams.
- Earthquake induced waves in rectangular water tanks.
- Dynamics of free-standing rigid bodies under base motions.
- Seismic wave amplification, liquefaction and soil-structure interactions.

Elective I

CVSE-E1/01 Design of Bridges

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction to Bridge Engineering

Historical Perspective, Introduction, Layout and Planning, Investigations for Bridges, Classification and Components of Bridges, Choice of Type of Bridges and Choice of Materials. General Arrangement of Various Types of Bridges including Arch Type, Slab Type, Slab and Beam Type, Plate Girder Type, Open Web Girder, Cable Stayed Type, etc., Conceptual Bridge Design.

(04 Lectures)

Module 2: Loading on Bridges

Loading Standards for Roads and Railway Bridges as per IRC Standards and IRS Standards, Analysis of other Loads Like Impact Factor, Centrifugal Forces, Wind Load, Earthquake Load, Hydraulic Forces, Longitudinal Forces, Earth Pressure, Buoyancy Effects, etc. Analysis by Pieguad's and Courbon's Theory. **(08 Lectures)**

Module 3: Structural Behavior of Various Bridges

Structural behavior of Box Girder Bridges, Arch Bridges, Suspension Bridges, Skew Bridges and Cable Stayed Bridges under various loads. **(04 Lectures)**

Module 4: Design of Bridge Decks

Load Distribution in Slab and Bridge, Behavior, Analysis and Design RC and Prestressed Deck Slab, Longitudinal and Cross Girders, Design of Long Span Bridge, Slab Culvert and Box Culvert. **(10 Lectures)**

Module 5: Design of Sub structure and Foundation

Design of Bearings, Design of Sub Structure and Foundations, Piers and Abutments of Different Types and Shapes, Shallow and Deep Foundation, Wing Walls. **(10 Lectures)**

Module 6: Construction Methods

Modern Methods of Construction of Concrete, Steel and Composite Bridges, their Impact on Analysis and Design, Study of various types of Joints to be provided during Construction. **(06 Lectures)**

Guidelines for Assignments: Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References

- Dr.V.K.Raina, Concrete Bridge Practice: Analysis, Design and Economics, Shroff Publishers & Distributors Pvt Ltd.,

- Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Reinforced Concrete Structures, Vol. II, Laxmi Publications.

- Jagadish & Jayaram, Design of Concrete Bridges, Tata McGraw Hill.

- Victor, Design of Concrete Bridges, Tata McGraw Hill.

- N. Krishnaraju, Prestressed Concrete Bridges, CBS Publishers & Distributors Pvt. Ltd.

- Ponnuswamy S., Bridge Engineering, Tata McGraw Hill.

- Dr. V. K. Raina., Concrete Bridge Practice: Construction, Maintenance & Rehabilitation, Shroff Publishers & Distrib. Pvt Ltd.

- Dr.V.K.Raina, Field Manual for Highway & Bridge Engineers, Shroff Publishers & Distributors Pvt Ltd.

- Dr.V.K.Raina, Handbook for Concrete Bridges, Shroff Publishers & Distributors Pvt Ltd.

- Victor D. J., Essentials of Bridge Engineering, Oxford & IDH

- David Lee, Bridge Bearing and Expansion Joints.

- Indian Road Congress Codes IRC-6,18,21,112

- Indian Railway Bridge Codes & Manuals.

- Indian Standard Codes (latest Versions) IS 456-2000, IS 1893-2002, IS 1343-2012

Outcomes:

Upon completion of the course the students will be able to:

- Understand the preliminary concepts, development, various types of bridges and it's conceptual design

- Study various types of loadings coming on road and railway bridges.

- Study the behaviour of various types of bridges under different loadings.

- Design of slab decks of various types of RC and PSC bridges.

- Perform the design of substructure components like piers, abutments, wing walls and it's foundation.

- Study the provision and importance of joints provided in the structure.

- Know the various construction techniques and practices adopted for different bridges and its impact on design.

Elective I

CVSE-E1/02 Numerical Methods

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction

Introduction and Necessity of Numerical Methods, Number representation and errors, Number in different bases, Non integer & Fraction, mantissa, exponent, normalized scientific notations, Errors in representing numbers, Inverse error analysis, Loss of Significance. **(04 Lectures)**

Module 2: Solution of Linear and Non-Linear Algebraic Equations

Systems of Linear Algebraic Equations, Introduction, ill Conditioning, Methods of Solution (Gauss Elimination Method, LU Decomposition Method, Doolittle Decomposition Method, Gauss-Jordon Elimination Method, Gauss Seidel Method), Symmetric & Banded Coefficient Matrices, Pivoting, Diagonal Dominance, Gauss Elimination with scaled row Pivoting, Roots of Algebraic & Transcendental Equations, Fixed point iteration method, Iterative Search Method, Bisection Method, Geometrical Approach to

Root Finding, Convergence towards Roots of Equation, Secant Method, False Secant/ Regula-Falsi Method, Ridder's Method, Newton Raphson Method, System of Non-Linear equations (Newton Raphson Method). **(06 Lectures)**

Module 3: Regression Analysis

Interpolation and Curve Fitting, Discrete Data, Lagrange's Interpolating Polynomial, Newton's Polynomial Method, Limitations of Interpolation with Polynomials, Spline Interpolation, Curve Fitting, Least Square Fit, Fitting with straight Line, Polynomial Fit, Weighted Linear Regression, Fitting Exponential Function. **(06 Lectures)**

Module 4: Numerical Integration Methods

Numerical Differentiation and Integration, Taylor's Series, Finite Difference Method, Error in Finite Difference Approximation, Richardson Extrapolation, Derivatives by Interpolation, Cubic Spline Interpolant, Numerical Integration or Quadrature, Newton Cotes Formula, Trapezoidal & Composite Trapezoidal Rule, Simpson Rule, Recursive Trapezoidal Rule, Romberg Integration, Gaussian Integration, Orthogonal Polynomial, Abscissas and Weights for Gaussian Quadrature, Gauss Legendre Quadrature, Gauss Laguerre & Gauss Hermite Method, Gauss-Chebyshev Quadrature, Gauss Quadrature with Logarithmic Singularity.

(08 Lectures)

Module 5: Solution of Differential Equations

Initial Value Problem, Taylor series approach, Euler's Method, Runge-Kutta Method, Second Order Runge-Kutta Method, Forth order Runge-Kutta Method, Stability of Euler's Method, Stiffness, Adaptive Runge-Kutta Method, Bulrisch Stoer Method, Numerical Methods in Structural Dynamics, Implicit and Explicit Method, Central Difference Method, Newmark-Beta Method, Wilson-Theta Method. **(08 Lectures)**

Module 6: Eigenvalues and Eigenvectors

Boundary Value Problem, Shooting Method, Two Point Boundary Value Problem, Eigenvalues and Eigenvectors, Symmetric Matrix Eigenvalue Problem, Inverse Power & Power Methods, Eigenvalue Problem in Structural Dynamics, Inverse vector iteration method. **(08 Lectures)**

Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Assignments covering programming in C or MATLAB for all methods is desirable.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References:

- L. Ridgway Scott., Numerical Analysis, Princeton University Press
- S. D. Conte, Carl de Boor, Elementary Numerical Analysis: An Algorithmic Approach, Mc Graw Hill Publications
- S. R. Otto, J. P. Deneir, An introduction to Programming and Numerical methods in MATLAB, Springer
- Jaan Kiusalaas, Numerical Methods in Engineering with MATLAB, Cambridge University Press.
- William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, Numerical Recipes in C, Cambridge University Press.

Outcomes:

Upon completion of the course the students will be able to:

- Formulate mathematical models of various engineering problems.
- Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions.
- Solve non-linear equations, simultaneous linear algebraic equations, Eigen value problems, using numerical methods.
- Perform numerical differentiation and integration and analyze the errors.
- Apply curve fitting techniques to experimental data.

- Implement knowledge of numerical methods in C-programming or MATLAB

Elective II

CVSE-E2/01 Advanced Prestressed Concrete

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction to Prestressed Concrete

Basic Principle of Prestressing, Methods and Systems of Prestressing, Material Requirements, Losses of Prestressing, Analysis of Rectangular, Symmetrical and Unsymmetrical, Flanged Beams, Concept of Cable Profile, Pressure Line, Thrust Lines, etc.

(04 Lectures)

Module 2: Design of Anchor Blocks

Design of Anchor Blocks using Magnel's Method, Guyon's Method and IS Code Method.   **(08 Lectures)**

Module 3: Analysis and Design of PSC Members

Analysis of PSC section for Flexural Strength, Shear Strength and Deflection, Design of Prestressed Concrete section for Flexural Strength by Analytical procedure and Magnel's Graphical method, Shear Strength and Deflection, Design of Statically Indeterminate Beams and Single Story Portal Frame, Concordant Cable Profile.   **(08 Lectures)**

Module 4: Composite Section

Analysis and Design of Composite Construction of Prestressed and in-situ Concrete Structures, Design of One way and Two way Slab, Grid Slab.   **(08 Lectures)**

Module 5: Design of Various PSC Structures

Design of Cylindrical and Non-cylindrical Pipes, Design of Poles, Circular Prestressing for Water Tanks, Design of Sleepers.

(08 Lectures)

Module 6: Causes and Remedies of Various Defects in PSC

Causes of various Defects in Prestressed Concrete like Cracking, Buckling, Deflection, Deterioration, Corrosion of Prestressing Steel, Concrete Crushing at End Anchorages, Grouting of Post Tensioned Tendons, Congested Connections, Dimensional Tolerances etc. and Remedial Measures   **(06 Lectures)**

Guidelines for Assignments:
- Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.
- One assignment based on visit to any of the prestressed concrete plant or ongoing site involving prestressed concrete activities is desirable.
- Use of IS 456-2000 and IS 1343 is allowed in the theory examination.
- The necessary charts for design of anchor blocks by various methods shall be provided in the question paper.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References:
- N. Krishnaraju, Prestressed Concrete, Tata Mc Graw-Hill Publishing Company.
- T. Y. Lin & Nedbhurns, Design of Prestressed Concrete Structures, John Wiley & Sons

- S.Ramamruthm, Pretsressed Concrete, Dhanpat Rai and Sons.
- Sinha and Roy, Fundamentals of Prestressed Concrete, S. Chand Ltd.
- N. Rajagopalan, Prestressed Concrete, Narosa Publishing House.
- James R. Libby, Modern Prestressed Concrete, CBS Publishers & Distributors Pvt. Ltd.
- IS 1343: 2012, Indian Standard Code of Practice for Prestressed Concrete.
- IS 784: 2001, Indian Standard Code for Circular Prestressing in prestressed concrete pipes.

Outcomes:

Upon completion of the course the students will be able to:

- Understand the preliminary concept, terminologies and methodologies related to prestressed concrete.
- Analyse and design of the anchor blocks.
- Analyse the PSC member for flexural, shear strength and deflection.
- Design the simple and indeterminate structures like continuous beams and portal frames.
- Analyse and design composite section and various slabs.
- Design various special types of PSC structures like pipes, poles, tanks, sleepers.
- Understand the causes of various defects in PSC structure and remedies for it.

Elective II

CVSE-E2/02 Design of Masonry Structures

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction

Masonry units, Materials and Types, History of Masonry Characteristics of Brick, Stone, Clay Block, Concrete Block, Stabilized Mud Block Masonry units – Strength, Modulus of Elasticity and Water Absorption. Masonry materials, Classification and Properties of Mortars, Selection of Mortar.   **(04 Lectures)**

Module 2: Strength of Masonry in Compression

Behaviour of Masonry under Compression, Strength and Elastic Properties, Influence of Masonry unit and Mortar Characteristics, Effect of Masonry unit Height on Compressive Strength, Influence of Masonry Bonding Patterns on Strength, Prediction of Strength of Masonry in Indian Context, Failure Theories of Masonry under Compression. Effects of Slenderness and Eccentricity, Effect of Rate of Absorption, Effect of Curing, Effect of Ageing, Effect of Workmanship on Compressive Strength.   **(06 Lectures)**

Module 3: Flexural, Shear and Bond Strength

Flexural Strength and Shear Strength of Masonry, Bond between Masonry unit and Mortar, Tests for determining Flexural, Shear and Bond strengths, Factors affecting Bond Strength, Effect of Bond Strength on Compressive Strength, Orthotropic Strength Properties of Masonry in Flexure, Shear Strength of Masonry.   **(08 Lectures)**

Module 4: Design of Load Bearing Masonry Buildings

Permissible Compressive Stress, Stress Reduction and Shape Reduction Factors, Increase in Permissible Stresses for Eccentric Vertical and Lateral Loads, Permissible Tensile and Shear Stresses, Effective Height of Walls and Columns, Opening in Walls, Effective Length, Effective Thickness, Slenderness Ratio, Eccentricity, Load Dispersion, Arching action,

Lintels, Wall Carrying Axial Load, Eccentric Load with Different Eccentricity Ratios, Wall with Openings, Free standing Wall, Design of Load Bearing Masonry for Buildings up to 3 to 8 Storey's using BIS Codal Provisions.

(12 Lectures)

Module 5: Earthquake Resistant Masonry Buildings

Behaviour of masonry during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS Codal provisions. Masonry arches, domes and vaults: Components and classification of masonry arches, domes and vaults, historical buildings, construction procedure.   **(06 Lectures)**

Module 6: Structural Aspects of Monuments & Ancient Structures

Evolution of Construction Practices, Materials of Construction, Choice of Structural Framing, Form Design, Geometric Proportions, Choice of Foundations, Footprint Ratio, Study of any Four Historical Monuments from Structural point of view.

(06 Lectures)

Guidelines for Assignments: Minimum Six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References:

- Hendry A.W., "Structural masonry", Macmillan Education Ltd., 2nd edition
- Sinha B.P & Davis S.R., "Design of Masonry structures", E & FN Spon
- Dayaratnam P, "Brick and Reinforced Brick Structures", Oxford & IBH
- Curtin, "Design of Reinforced and Prestressed Masonry", Thomas Telford
- Sven Sahlin, "Structural Masonry", Prentice Hall
- Jagadish K S, Venkatarama Reddy B V and Nanjunda Rao K S, "Alternative Building Materials and Technologies", New Age International, New Delhi & Bangalore
- IS 1905: 1987 Indian Standard Code of Practice for Structural Use of Unreinforced Masonry, Bureau of Indian Standards, New Delhi.
- SP20 (S&T): 1991, Handbook on Masonry Design and Construction, Bureau of Indian Standards, New Delhi.

Outcomes:

Upon completion of the course the students will be able to:

- Understand the preliminary information of various masonry structures including materials of construction, basic properties and parameters.
- Understand the compressive strength of masonry structures under various conditions and situation.
- Determine strength of masonry structure in flexure, shear, bond and factors affecting.
- Design the load bearing masonry buildings.
- Design the earthquake resistant masonry structures.
- Understand the structural aspects of monuments and historical buildings.

CVSE201 Theory of Plates & Shells

Teaching Schemes: 3 Lect. + 1 Tut hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction to Plate Theory

Thin and Thick Plates, Small and Large Deflection Theory of Thin Plate, Assumptions in Analysis of Thin Plates, Slope Curvature Relations, Moment - Curvature Relations, Stress Resultants, Governing Differential Equations for Bending of Plates, Various Boundary Conditions. **(08 Lectures)**

Module 2: Navier's and Levy's Solution

Rectangular Plates Subjected to Uniformly Distributed Load, Sinusoidal Load for Different Boundary Conditions. **(06 Lectures)**

Module 3: Circular Plates

Analysis of Circular Plates under Axis-Symmetric Loading, Moment Curvature Relations, Governing Differential Equation in Polar Co-Ordinates, Simply Supported and Fixed Edges, Distributed Load, Ring Load, a Plate with Hole at Center. **(08 Lectures)**

Module 4: Introduction to Shell Structures

Classification of Shells on basis of Geometry, Thin Shell Theory, Equation of Shell Surfaces, Stress Resultants, Stress-Displacement Relations, Compatibility and Equilibrium Equations. **(08 Lectures)**

Module 5: Membrane Analysis

Equation of Equilibrium for Synclastic Shells, Solution for Shells Subjected to Self Weight and Live Load, Cylindrical Shells - Equation of Equilibrium, Open Shells With Parabolic, Circular, Elliptical Directrix, Simple Problems, Shells With Closed Directrix-Circular, Elliptical-Simple Problems, Problems on Pipes Carrying Fluid/Liquid Under Pressure, Just Filled & Partly Filled. **(10 Lectures)**

Module 6: Bending of Cylindrical Shells

Symmetrically Loaded Circular Cylindrical Shells, Beam Theory, Finsterwalder's Theory, D.K.J. Theory- Donnell's Equation, Characteristic Equation, Schorer's Theory. **(08 Lectures)**

Guidelines for Assignments: Minimum six assignments consisting of theoretical as well as numerical aspects of the course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References

- S. Timoshenko and W. Krieger, Theory of Plates and Shells, Mc Grew Hill.
- Ansel C. Ugural, Stresses in Plates and Shells, Mc Graw Hill.
- G. S Ramaswamy, Design and Construction of Concrete Shell Roofs, CBS Publications.
- Chandrashekhara K., Analysis of Concrete Shells, New Age International Edition.
- Chandrashekhara K., Analysis of Plates, New Age International Edition.
- Reddy, J. N.; Theory and Analysis of Elastic Plates and Shells, Taylor & Francis.

Outcomes:

Upon completion of the course the students will be able to:

- Understand and derive governing differential equation for deflected shape of rectangular plates.

- Solve governing differential equation of deflected shape of rectangular plate for various loading and support conditions.
- Understand and derive governing differential equation for deflected shape of circular plates.
- Solve governing differential equation of deflected shape of circular plate for various loading and support conditions.
- Understand membrane theory for internal forces in different shells.
- Understand different theories of analysis of shells.

CVSE202 Finite Element Method

Teaching Schemes: 3 Lect. + 1 Tut hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction to FEM & Approximate Methods

Introduction, Overview of Various Methods to Solve Integral & Differential Equations (Point Collocation Method, Method of Least Square, Weighted Residual Method, Galerkin's Method), Variational Calculus (Hamilton's Variational Principle, Minimum Potential Energy Principle, Euler Lagrange Equation), Partial FEM (Kentorvich Method/ Finite Strip Method/ Semi-Analytical Method), Local & Global Finite Element Methods (Rayleigh-Ritz Method), Stepwise Procedure in FEM. **(08 Lectures)**

Module 2: One Dimensional FE Analysis

Application of FEM to Solve various 1-D problems (Shape Functions for 1-D Elements, Properties of Shape Functions, Lagrange Interpolating Polynomials), C^0 Continuity, 1-D FE Analysis (Discretization, Selection of Shape Function, Defining Gradients of Primary Unknowns & Constitutive Equations, Derivation of Element Equations, Assembly & Application of Boundary Conditions, Computation of Primary and Secondary Unknowns), Direct Approach for Assembly, Boundary Conditions (Geometric, Natural), Concept of Sub-Structuring (Static Condensation), Stiffness Matrix for Basic Bar & Beam Element, Representation of Distributed Loading, The Assembly Process within the PMPE Approach, Element Stresses), FE Analysis of 1-D Non-Prismatic Members, Solution of Differential Equation using FEM, Solution of BIVP using Galerkin's MWR (1-D Transient Analysis). **(10 Lectures)**

Module 3: FE Analysis by Direct Approach

C^1 Continuity, Formulation of 1-D Beam Element, Classical Beam Theory, Element Equation Formulation (Galerkin's Approach, Rayleigh-Ritz Approach), Derivation of Scalar Functional from Differential Equation and Vice Versa, Application to Fixed and Continuous Beams. **(06 Lectures)**

Module 4: Two Dimensional FE Analysis

Conditions of Symmetry & Anti Symmetry (Applications), 2-D FE Analysis, Review of Theory of Elasticity, CST Element (3-Node Triangular Element), Pascal's Triangle and Pyramid, Area Co-ordinate, Stepwise Formulation, Equivalent Load Vector, Plane Stress Problems using CST Elements, 2-D Stress Analysis using 4-noded Rectangular Element, Stepwise Formulation, Effect of Aspect Ratio, Explicit & Implicit Iso-parametric Formulation, Iso-parametric Elements for Plane Problems (Quadrilateral Element, Bilinear Element, Para-linear Element, Bi-Quadrilateral Element, Serendipity Elements, Lagrange Element), Numerical Integration, (1-D Domain, 2-D Domain, n-point Gauss Rule), Formulation of Transition Element. **(10 Lectures)**

Module 5: Three Dimensional FE Analysis

3-D Stress Analysis using FEM, Iso-parametric Formulation, 3-D Brick Element, Application to 3-D Analysis, FEA of Axi-symmetric Solids Subjected to Axi-symmetric and Asymmetric Loads (Application of Partial FEM). **(06 Lectures)**

Module 6: Computer Implementation of FEM

Computer Implementation of FEM, Application of FEM to Time Dependent Problems, Partial FEM, h-version of FEM, p-version of FEM, Adaptive Meshing, Exposure to Hybrid FEM (Mixed/ Hybrid Formulation, Unidirectional Composites), Introduction to ANSYS, Static & Dynamic Analysis of 1-D, 2-D and 3-D structures using ANSYS. **(08 Lectures)**

Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the course shall be performed by the candidate.

Guidelines for Class Test: Class test shall cover syllabus of any three Modules.

References:

- M. Mukhopdhyay, Concept and Application of Finite Element Analysis, Oxford and IBH Publishing Co. Pvt. Ltd.
- O.C.Zienkiewicz & R.L.Taylor, The Finite Element Method Vol .I & II, Tata McGraw Hill
- J.N.Reddy, An introduction to the Finite Element Method , Tata McGraw Hill Pub.
- R. D. Cook, Concept and Application of Finite Element Analysis, John Wiley & sons
- Hutton D.V., Fundamentals of Finite Element Analysis, Tata McGraw Hill Pub.
- C. S. Desai & J. F. Abel, Introduction to the Finite Element Method, CBS Pub.
- C. S .Krishnamoorthy, Programming in the Finite Element Method, Tata McGraw Hill
- T.R.Chandrupatla and Belegundu, Introduction to the Finite Element in Engineering Prentice Hall of India, pvt.ltd
- Bathe K.J., Finite Element Procedures, PHI learning pvt.ltd
- Y. M. Desai, T.I Eldho, Finite Element Method with application in Engineering, Pearson , Delhi
- S. S. Bhavikatti., Finite Element Analysis, New Age International Publication.

Outcomes:

Upon completion of the course the students will be able to:

- Understand the different energy methods in structural analysis and basic concepts of finite element method.
- Analyse 1-D problems related to structural analysis like Bars, Trusses, Beams and Frames using finite element approach.
- Find solution to problems using direct approach methods like Rayleigh – Ritz or Galerkin's Method.
- Solve 2-D problems using knowledge of theory of elasticity.
- Students will be able to implement the knowledge of numerical methods in FEM to find the solution to the various problems in statics and dynamics.
- Analyse 1D, 2D, and 3D structures using different software packages based on FEM.

CVSE-S01 Seminar I

Teaching Schemes: 4 Pract. hrs/week; **Evaluation Scheme:** Class Assessment 25; Oral Examination 25

Laboratory Scheme:

Seminar I shall be presented on one of the advanced topics chosen in consultation with the supervisor. Students must study latest literature. The concepts must be clearly understood and presented by the student. All modern methods of presentation should be used by the student. Minimum 03 presentations are expected within period of semester by the student. A hard copy of the report should be submitted before delivering the seminar. A copy of the report in soft form must be submitted to the Supervisor along with other details, if any.

CVSE-L02 PG Lab 2

Computer Software Laboratory

Teaching Schemes: 4 Pract. hrs/week; **Evaluation Scheme:** Class Assessment 25; Oral Examination 25

- Computer Software Laboratory using standard software (SAP/ ANSYS/ ETABS/ STAAD Pro) is recommended.
- The analysis and design of the structures containing anyone of building (G+2) or bridges or industrial truss or transmission tower.
- The comprehensive report of the analysis and design of the selected structure.

CVSE-L02 Mini Project

Teaching Schemes: 4 Pract. hrs/week; **Evaluation Scheme:** Class Assessment 25; Oral Examination 25

Laboratory Scheme:

Mini project shall be based on one of the topic chosen in consultation with the supervisor. Mini project may be interdisciplinary nature. Areas of recent techno-management development shall be explored. Research innovations may be considered as prospective areas. Mini project may be related with main project to explore possibilities of continuation further and to study the pre-requisites.

Elective III

CVSE-E3/01 Design of Cold Formed Steel Structures

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction
General, Types of Cold-Formed Steel Sections and Their Applications, Standardized Metal Buildings and Industrialized Housing, Methods of Forming, Research and Design Specifications, General Design Considerations of Cold-Formed Steel Construction, Economic Design and Optimum Properties, Yield Stress, Tensile Strength, and Stress–Strain Curve, Modulus of Elasticity, Tangent Modulus, and Shear Modulus, Ductility, Weldability, Fatigue Strength and Toughness, Influence of Cold Work on Mechanical Properties of Steel, Utilization of Cold Work of Forming, Effect of Temperature on Mechanical Properties of Steel, Testing of Full Sections and Flat Elements, Residual Stresses Due to Cold Forming, Effect of Strain Rate on Mechanical Properties. **(08 Lectures)**

Module 2: Strength of Thin Elements & Design Criteria
Definitions of Terms, Design Basis, Serviceability, Structural Behaviour of Compression Elements and Design Criteria, Perforated Elements and Members, Plate Buckling of Structural Shapes, Design Examples. **(07 Lectures)**

Module 3: Design of Axially Loaded Members
Design of axially loaded tension members, Flexural Column Buckling, Torsional Buckling and Flexural–Torsional Buckling, Effect of Local Buckling on Column Strength, Distortional Buckling Strength of Compression Members, Effect of Cold Work on Column Buckling, North American Design Formulas for Concentrically Loaded Compression Members, Effective Length Factor *K*, Built-Up Compression Members, Bracing of Axially Loaded Compression Members, Design Examples. **(10 Lectures)**

Module 4: Design of Flexural Members

Bending Strength and Deflection, Design of Beam Webs, Bracing Requirements of Beams, Torsional analysis of Beams and Combined Bending and Torsional Loading, Design Examples.   **(06 Lectures)**

Module 5: Design of Members under Combined Axial Load & Bending
Combined Tensile axial load and Bending, Combined Compressive axial load and Bending (Beam–Columns), North American Design Criteria, Design Examples, Second-Order Analysis.   **(07 Lectures)**

Module 6: Design of Connections
Types of Connectors, Welded Connections, Bolted Connections, Screw Connections, Other Fasteners, Rupture Failure of Connections, I or Box-Shaped Compression Members Made by Connecting Two C-Sections, I-Beams Made by Connecting Two C-Sections, Spacing of Connections in Compression Elements.   **(10 Lectures)**

Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References:
- W.W. Yu, "Cold-Formed Steel Design", John Wiley & Sons.
- IS 801: 1975, Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction.
- BS 5950-5:1998, Structural Use of Steelwork in Building: Code of Practice for Design of Cold Formed Thin Gauge Sections.

Outcomes:
Upon completion of the course the students will be able to:
- Understand the types of cross sections, mechanical and thermal properties and applications of cold formed steel structures.
- Understand the design criteria and strength of thin elements and analyse various cross section for strength in tension, compression, flexure, etc.
- Design the CFS flexural members.
- Design the CFS compression members.
- Design the CFS members subjected to axial load and bending.
- Study and design various types of connections in cold formed steel structures.

Elective III

CVSE-E3/02 Structural Health Monitoring

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction to SHM & Smart Materials
Motivation and objectives of structural health monitoring, Working principles of smart materials used for sensors and actuators, Structural Health Monitoring verses Non Destructive Testing, Piezoelectric materials (Constitutive relation, unimorph, bi-morph, Electromechanical coefficient, resonance/anti-resonance), Electrostrictive materials (Constitutive relation, sensor, actuator, figures of merit), Magnetostrictive materials (Constitutive relation, sensor, actuator, figures of merit), Optical Fiber (Fiber Bragg grating, strain sensing, ultrasonic sensing).   **(06 Lectures)**

Module 2: Vibration Control & SHM

Damage Diagnostic methods based on vibration response, Method based on modal frequency/shape/damping, Curvature and flexibility method, Modal strain energy method, Sensitivity method, Baseline-free method **(06 Lectures)**

Module 3: Electrical Impedance Methods in SHM

Damage Diagnostic methods based on electrical impedance method, Beam model, Plate Model **(06 Lectures)**

Module 4: Wave Propagation Methods in SHM

Damage Diagnostic methods based on wave propagation methods; Bulk waves/Lamb waves, Reflection and transmission, Wave tuning/mode selectivity, Migration imaging, Phased array imaging, Focusing array/SAFT imaging. **(06 Lectures)**

Module 5: Advanced signal processing methods in SHM

Wavelet, Neural networks, Vector support machine **(06 Lectures)**

Module 6: Applications of SHM

Applications of structural health monitoring in aerospace including sandwich composite structures, civil infrastructures, pipelines, rotating machinery. **(06 Lectures)**

Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References:

- V. Giurgiutiu, Structural Health Monitoring with Piezoelectric Wafer Active Sensors, Academic Press.
- B. Culshaw, Smart Structures & Materials, Artech House, Boston.
- A. V. Srinivasan, D. M. Macfarland, Smart Structures: Analysis & Design, University Press, Cambridge, UK.
- Fu Ko Chang, Structural Health Monitoring: Current Status and Perspectives,
- Philip, W., Industrial sensors and applications for condition monitoring, MEP.
- Armer, G.S.T (Editor), Monitoring and assessment of structures, Spon, London.
- Wu, Z.S. (Editor), Structural health monitoring and intelligent infrastructure, Volumes 1 and 2, Balkema.
- Harris, C.M., Shock vibration handbook, McGraw-Hill.
- Rao, J.S., Vibratory condition monitoring of machines, Narosa Publishing House, India.

Outcomes:

Upon completion of the course the students will be able to:

- Understand concepts in structural health monitoring and acquire knowledge of smart materials.
- Understand vibration control methods in structural health monitoring.
- Understand electrical impedance methods in structural health monitoring.
- Understand wave propagation methods in structural health monitoring.
- Understand advanced signal processing techniques in structural health monitoring.
- Understand applications of structural health monitoring in different structural systems.

Elective III

CVSE-E3/03 Retrofitting of Structures

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Serviceability and Durability

Quality Assurance for Concrete Construction, Permeability, Thermal Properties and Cracking, Distress Monitoring, Causes for Distress, Effects of Climate, Temperature, Chemicals, Wear and Erosion, Design and Construction Errors, Corrosion Mechanism, Effects of Cover Thickness and Cracking,

Non Destructive Testing: Ultrasonic and Sonic Test, Rebound Hammer Test, Strength Evaluation of Existing Structures.

(06 Lectures)

Module 2: Cracks in Structures

Causes, Thermal and Shrinkage cracks, Cracks due to Vegetation and Trees, Foundation Movements, Types and their Fatality, Diagnosis Techniques for Repair.

Moisture Penetration

Sources of Dampness, Moisture Movement from Ground, Reasons for Ineffective Damping, Leakage in Concrete Slabs, Pitched Roofs, Dampness in Solid Walls, Condensation, Remedial treatments, Chemical Coatings. **(06 Lectures)**

Module 3: Steel Structures and Masonry

Types and Causes of Deterioration, Preventive Measures, Repair Procedure, Brittle Failure, Defects in Connections, Welded Joints: Test for Defects; Mechanism of Corrosion , Methods of Corrosion Protection, Corrosion Inhibitors, Corrosion Resistant Steels, Coatings, Cathodic Protection. Design and Fabrication Errors, Distress during Erection.

Masonry Structures

Discoloration and Weakening of Stones, Preservation, Chemical Preservatives, Brick Masonry Structures, Distress and Remedial Measures. **(06 Lectures)**

Module 4: Materials for Repairs

Essential Parameters for Repair Material, Premixed Cement Concrete and Mortar, Sulphur Infiltrated Concrete, Fiber Reinforced Concrete, Special Elements for Accelerated Strength Gain, Expansive Cement, Polyester Resin.

Polymer Concrete: Physical and Mechanical Properties, General Guidelines and Precautions for Use, Field Application

Polymer Modified Concrete: Physical and Mechanical Properties, General Guidelines and Precautions for Use, Field Application, Epoxy Concrete and Mortar: Epoxies, Physical and Mechanical Properties, General Guidelines and Precautions for Use, Field Application.

Surface Coatings: Essential Parameters, Types, Characteristics. **(06 Lectures)**

Module 5: Maintenance and repair strategies

Definitions: Maintenance, Repair and Rehabilitation, Facets of Maintenance, Importance of Maintenance, Preventive Measures on Various Aspects Inspection, Assessment Procedure for Evaluating a Damaged Structure, Causes of Deterioration, Testing Techniques.

Techniques for Repairs

Repairs using Mortars and Dry Packs**,** Concrete Replacement, Surface Impregnation, Rust Eliminators and Polymers Coating for Rebar During Repair Foamed Concrete, Vacuum Concrete, Gunite and Shotcrete, Injection: Epoxy, Resin, Polymer Modified Cement Slurry; Shoring and Underpinning. Propping and Supporting: False Work, Requirement of Good False Work, Design Brief for False Work, Execution Procedure. **(06 Lectures)**

Module 6: Strengthening of Existing Structures

General Principle, Relieving Loads, Stress Reduction, Strengthening of Super Structures (Beam, Column, Slab including Joints) for Tension, Compression, Flexural, and Shear respectively, Jacketing (RCC, Plate, Fiber ,Wrap), Bonded Overlays, Reinforcement Addition, Strengthening the Substructures, Increasing the Load Capacity of Footing, Strengthening of Masonry Structure. **(06 Lectures)**

Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References:

- Johnson. S.M., "Deterioration, maintenance and repair of structures", McGraw-Hill book company, New York, 1965.
- R. T. Allen and S. C. Edwards, "Repair of concrete structures", Blakie and Sons, UK, 1987.
- Denison Campbell, Allen and Harold Roper, "Concrete structures", Materials, Maintenance and Repair, Longman Scientific and technical UK, 1991.
- SP25-84, "Hand book on causes and prevention of cracks on buildings", Indian standards.
- M. S. Shetty, "Concrete Technology- Theory and Practice", S. Chand and Company, New Delhi, 1992.
- Gambhir, "Concrete Technology".
- Santhakumar, A.R., " Training Course notes on Damage Assessment and repair in Low Cost Housing "," RHDC–NBO " Anna University, July, 1992.
- Raikar, R.N., "Learning from failures – Deficiencies in Design ", Construction and Service – R & D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.

Outcomes:

Upon completion of the course the students will be able to:

- Understand factors of Serviceability and Durability of Structures.
- Determine crack width, effect of crack on materials, effect of moisture on structures.
- Understand methods for protection of steel structures and masonry structures.
- Understand various materials and methodologies used for repairing of structures.
- Understand and implement techniques used for repairing and maintenance of structure.
- Understand procedure to strengthen the existing structures and structural elements.

Elective IV

CVSE-E4/01 Design of Tall Structures

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Design Loads

Gravity Loads, Dead Load and Live Load Reduction, Construction Loads, Wind Load, Equivalent Lateral Force, Combination of Loadings, Design Philosophy: Working Stress Design and Limit State Design **(06 Lectures)**

Module 2: Structural Systems and its Behaviour

Height and Structural Forms, Rigid Frames, Braced Frames, In-Filled Frames, Shear Walls, Coupled Shear Walls, Tubular Structures, and Hybrid Mega Systems. **(06 Lectures)**

Module 3: Tall Buildings

Approximate Analysis, Detail Analysis and Reduction Techniques, Analysis of Member Forces, Drift, and Twist, Buckling Analysis, P-Delta Analysis, Translational and Torsional Instability, Design for Differential Movements, Creep and Shrinkage, Structural Control and Energy Dissipation Devices. **(06 Lectures)**

Module 4: Chimneys

Design Factors, Thermal Stresses, Components, Platform and Safety Ladders, Steel Stacks, Refractory Linings, Caps and Foundations. **(06 Lectures)**

Module 5: Cooling Towers

Types, Components, Analysis and Design. **(06 Lectures)**

Module 6: Transmission Towers

Types of Loads, Tower Configuration, Analysis and Design. **(06 Lectures)**

Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References

- B. S. Taranath, Structural Analysis and Design of Tall Building, CRC press, 2011.
- B. S. Smith and A. Coull, Tall Building Structures: Analysis and Design, Wiley, 1991.
- S. N. Manohar, Tall Chimneys: Design and Construction, Tata Mcgraw-Hill, 1985.
- A. R. Shanthakumar and S. S. Murthy, Transmission Line Structures, Tata Mcgraw-Hill, 1990.
- IS: 6533 (Part 2): 1989, - Code of Practice for Design and Construction of Steel Chimneys
- IS 4998 (Part 1): 1992, -Criteria for Design of Reinforced Concrete Chimneys.

Outcomes:

Upon completion of the course the students will be able to:

- Identify and calculate magnitude of various loads acting on tall buildings.
- Understand various forms of structures, moment and force resisting systems in a structure.
- Identify various factors causing movements /twists in the building and their analysis and design.
- Understand various types of chimneys, their components, Analyse and design of chimneys.
- Understand various types of Cooling Towers, their components & feasibility, analyse and design a Cooling Tower.
- Understand various types of transmission towers, their components and suitability, analyse and design a transmission tower.

Elective IV

CVSE-E4/02 Earthquake Engineering

& Design of Earthquake Resistant Structures

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction to Seismology

Elements of Seismology, Terminology, structure of Earth, Causes of an earthquake, seismic waves, magnitude and intensity, seismograph, strong motion earthquake, strong motion earthquake, accelerogram, Elastic Rebound Theory, Theory of Plate Tectonics and Movement of Indian Plate, Seismic Zoning Maps of India and Comparative Study, Response Spectra, Strong Motion Characteristics.   **(06 Lectures)**

Module 2: Earthquake Response of Systems

Structural dynamics: Free and forced vibrations of single degree of freedom systems, un-damped and viscously damped vibrations, equations of motion, Duhamel integral. Response Spectrum Theory: construction of Design Response Spectrum, effect of foundation and structural damping on design spectrum, design spectrum of IS 1893, evaluation of lateral loads.   **(06 Lectures)**

Module 3: Earthquake Risk Analysis

Earthquake Effects on the Structures, Classification of Loads, Seismic Methods of Analysis, Seismic Design Methods, Seismic Damages during Past Earthquakes and Effect of Irregularities and Building Architecture on the Performance of RC Structures, Mathematical Modeling of Multi-Storied RC Buildings with Modeling of Floor Diaphragms and Soil-Foundation, Winkler model.

(06 Lectures)

Module 4:

Analysis of Seismic Forces on Building as per latest IS: 1893 by Equivalent Static Lateral Load Method and Response Spectrum Method, Introduction to Time History Method and Performance Based Analysis.   **(06 Lectures)**

Module 5:

Introduction to Ductility, Factors Affecting Ductility, Ductility Requirements, Types of Ductility, Provisions as per latest IS 13920, Seismic Design and Ductile Detailing of Beam, Column, Beam Column Joint, Shear Wall, Elevated RC Circular Water Tanks.   **(06 Lectures)**

Module 6:

Seismic Retrofitting, Sources of Weakness in RC Framed Buildings, Classification of Retrofitting Techniques, Conventional and Non-Conventional Methods, Comparative Study of Various Methods and Case Studies, Introduction to Base Isolation Systems, IS Code Provisions for Retrofitting of Masonry Structures, Failure Modes of Masonry Structures and Repairing Techniques.

(06 Lectures)

Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References

- P. Agarwal and M. Shrikhande – Earthquake Resistant Design of Structures, Prentice-Hall Publications.
- IS:1893 – Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi.
- IS:13935 – Repair and Seismic Strengthening of Buildings – Guidelines, 1993
- IS:4326 – Earthquake Resistant Design and Construction of Buildings – Code of Practice, 1993
- IS:13828 – Improving Earthquake Resistance of Low Strength Masonry Buildings, 1993
- IS:13827 - Improving Earthquake Resistance of Earthen Buildings, 1993
- IS:13920 – Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Force, 1993
- IS: 3370- Indian Standard code of practice for concrete structures for storage of liquids, Bureau
- of Indian Standards, New Delhi.
- Clough and Penzin – Dynamics of Structures, Mc-Graw Hills Publications.

- Jai Krishna, A.R. Chandrashekharan and B Chandra – Elements of Earthquake Engineering, South Asian Publishers Pvt. Ltd.
- Joshi P S et al. - Design of Reinforced Concrete Structures for Earthquake
- Resistance Published by Indian Society of Structural Engineers, 2001.

Outcomes:

Upon completion of the course the students will be able to:

- Understand Engineering Seismology and Seismic zones in India.
- 2. Understand earthquake response of SDoF Linear systems and instrumentation in measurement of earthquakes.
- Understand factors resisting earthquake forces, and earthquake risk analysis.
- Perform Seismic Analysis of buildings as per IS 1893.
- Understand, analyse and Design structural elements and its ductile detailing using IS 13920.
- Understand Various Retrofitting methods for RC framed structure and masonry structures.

Elective IV

CVSE-E4/03 Structural Audits

Teaching Schemes: 3 Lect. hrs/week; **Evaluation Scheme:** Theory: 60; Mid-semester Exam 20; Class Assessment 20

Course Contents

Module 1: Introduction to Structural Audit

Introduction to Structural Audit, Objectives, Bye-laws, Importance, Various Stages involved, Visual inspection: scope, coverage, limitations, Factors to be keenly observed.

Detailed Study of:

RC frame and Masonry building: Structural and non structural system, Structural elements concrete and its texture, sag and deflection in members, cracks: types and its fatality, Architectural features like balconies, cornices, etc their vulnerabilities, Probable damages in Structural and non structural walls, Plaster and paint Leakages and seepages, Plinth importance and how it affects suitability of building, Electric wiring: various damages and their fatality.

Steel Structures: Corrosion, Connection defects, Connection strength, yielded member.   **(06 Lectures)**

Module 2: Causes and types of deterioration in Structures

Causes of deterioration in RC frame and Masonry building: Permeability of concrete, capillary porosity, air voids, Micro cracks and macro cracks, corrosion of reinforcing bars, sulphate attack, alkali silica reaction,.

Causes of deterioration in Steel Structures: Uniform deterioration, pitting, crevice, galvanic, laminar, Erosion, cavitations, fretting, Exfoliation, Stress, Causes of corrosion in various members, causes of defects in connection (bolted and welded), Cracks.

(06 Lectures)

Module 3: Non Destructive Testing

Concrete Strength Assessment: Rebound hammer, Ultrasonic Pulse velocity, Penetration resistance, Pull out test, Chemical test: Carbonation test, Chloride test, Corrosion potential assessment: Cover meter survey, half cell potential, resistivity measurement, Fire damage assessment: Differential thermal analysis, X ray diffraction, Structural Integrity and soundness assessment: Radiography, Impact echo test, dynamic testing of structure, Interpretation and evaluation of test results.   **(06 Lectures)**

Module 4: Strength Evaluation of Existing Structure

Reserve strength, identification of critical sections, structural system and its validation, evaluation of damage in concrete and reinforcement, evaluation of building configuration. **(06 Lectures)**

Module 5: Approach to conduct Structural Audits

Guidelines of Statutory Bodies, Legal aspects, Responsibility of calling Structural Audit, Scope of Investigation, Involvement of Original Consultants & Representatives of Statutory Bodies, Frequency of Structural Audits. **(06 Lectures)**

Module 6: Structural Audit Report

Draft Structural audit report for up-gradation of existing building, Audit for continuation of usage of old Buildings, Audit for Buildings damaged due to Flood, Earthquakes, Fire, Storms/cyclones, Landslides, Cloud Burst, Tsunamis and accidental events such as blasts/ wilful damages. **(06 Lectures)**

References

• Indian Standard codes related with non destructive testing, Government Resolutions related to Structural Audits (BMC Act, etc.), Field manuals and reports by Expert Consultants.

Outcomes:

Upon completion of the course the students will be able to:

• Gain the knowledge of Bye laws, procedure of Structural audit and study the typical problems in structures.

• Aware of causes and types of deterioration in structures.

• Develop skills for use of various Non destructive tests required during auditing of structures.

• Strength evaluation of existing structures.

• Acquire knowledge of legal procedure to conduct structural audits.

• Prepare a Structural audit report.

Elective V

CVSE-E5/01 Research Methodology (Open Elective)

Teaching Schemes: 4 Pract. hrs/week; **Evaluation Scheme:** Class Assessment 25; Oral Examination 25.

Course Contents

Module 1:

Introduction, meaning of research, objectives, types and role of scientific and engineering related research in advancing the knowledge, defining a research problem, formulation of a hypothesis, research design and features of good design, methods of data collection, approaches and techniques for data acquisition, processing, analyses and synthesis, Designing a questionnaire, Interpretation of results, Report Writing, Aspects of literature review, Different ways of communication and dissemination of research results. **(06 Lectures)**

Module 02:

Descriptive Statistics, Probability and Distribution: Basic statistical concepts, Measures of central tendency and dispersion, Elements of Probability, Addition and multiplication theorems of probability, Examples, probability distributions, Binomial, Poisson and normal distributions. **(06 Lectures)**

Module 03:

Sampling Techniques: Random sampling, simple random sampling and stratified random sampling, Non-sampling errors.

(06 Lectures)

Module 04:

Correlation and Regression: Product moment correlation coefficient and its properties. Simple linear regression and multiple linear regressions, Statistical Inference: Statistical hypotheses, Error Types, level of significance, Chi-square Test and F distributions. Central limit theorem, Tests for the mean, equality of two means, variance, large sample tests for proportions, Confidence interval.

(06 Lectures)

Module 05:

Design of Experiments: Analysis of variance. Data Classification, Completely randomized, randomized block, Factorial experiments, Yates technique.   **(06 Lectures)**

Module 06:

Multivariate Data Analysis: Multivariate normal distributions. Mean vector, variance, covariance matrix and correlation matrix, Step wise regression, Selection of best subject of variables, Classification and discrimination problems, Factor analysis, Principal component analysis. Data analysis using software's.   **(06 Lectures)**

Term Work

Student shall critically read recent three to four journal articles within the broader field of their prospective specializations to identify research and knowledge gaps and accordingly formulate specific research questions. On the basis of these research questions student will retrieve additional relevant information and prepare well-articulated and content rich introductory problem description as well as proposed research methodology notes. This shall be assessed jointly by the subject teacher and research guide of the student.

References

- Gupta S. C. and Kapoor V. K, "Fundamentals of Mathematical Statistics", Sultan Chand & Company New Delhi.
- Gupta S. C. and Kapoor V. K, "Fundamentals of Applied Statistics", Sultan Chand & Com. N.Delhi.
- Montogomery D. C., "Probability and Applied Statistics for Engineers", Wiley Int.Student Edition
- Walpole Ronald E, Myers Raymond H and Myers Sharon L, "Probability & Statistics for Engineers and Scientists", 6th Edition, Prentice Hall.
- Ross S. M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edi, Elsevier
- Miller and Freund: Probability and Statistics for Engineers", EEE
- Johnson R. and Wichern, "Applied Multivariate Statistical Analysis", 3rd Edi, Prentice Hall India
- Douben K. J., "Research Methodologies – Principles and Guidelines of Applied Scientific Research", UNESCO-IHE Lecture Notes LN0317/06/01, Delft, the Netherlands.
- Holtom D. and E. Fisher, "Enjoy Writing Your Science Thesis - a Step by Step Guide to Planning and Writing Dissertations and Theses for Undergraduate and Graduate Science Students", Imperial College Press. ISBN 1-86094-207-5, London, UK.
- Kumar R., "Research Methodology- a Step-by-step Guide for Beginners", Sage Publi.. ISBN 0-7619-6213-1. London, UK.

Outcomes:

Upon completion of the course the students will be able to:

- Understand concept of research, its types, methods, detailed procedure to identify and solve a research problem.
- Understand various mathematical techniques useful in research work.
- Understand various sampling techniques useful in research work.
- Understand various techniques for correlating and predicting different parameters with each other based on data collected.
- Design the experiments for research work.
- Analyse and interpret the data, results and to conclude the final results.

Elective V

CVSE-E5/02 Soil Dynamics & Machine Foundations (Open Elective)

Teaching Schemes: 4 Pract. hrs/week; **Evaluation Scheme:** Class Assessment 25; Oral Examination 25

Course Contents

Module 1: Theory of Vibrations(06 Lectures)

Basic Definitions- Free and Forced Vibrations with and without Damping for Single Degree Freedom Systems- Resonance and its Effect, Magnification, Logarithmic Decrement, Transmissibility, Natural Frequency of Foundation – Soil system, Barkan's and IS methods, pressure bulb concept, Pauw's Analogy.   **(06 Lectures)**

Module 2: Wave Propagation

 Elastic Waves in Rods, Waves in Elastic Half Space, Dynamic Soil Properties, Field and Laboratory Methods of Determination – Uphole, Down Hole and Cross Hole Methods, Cyclic Plate Load Test, Block Vibration Test, Determination of Damping Factor.

(06 Lectures)

Module 3: Machine Foundations

Machine Foundations: Types, Design criteria, permissible amplitudes and bearing pressure.   **(06 Lectures)**

Module 4: Block Foundation

Block foundation: Degrees of freedom - analysis under different modes of vibration.   **(06 Lectures)**

Module 5: Two DoF Systems

Analysis of Two Degree freedom systems under free and forced vibrations -Principles of Design of Foundations for reciprocating and impact machines as per IS code.   **(06 Lectures)**

Module 6: Vibration Isolation

Vibration Isolation: Types and methods, Isolating materials and their properties.   **(06 Lectures)**

Guidelines for Assignments: Minimum six assignments consisting theoretical as well as numerical aspects of the Course shall be performed by the candidate.

Guidelines for Class Test: Class Test shall cover Syllabus of any Three Modules.

References:

- P.Srinivasulu, G.V.Vaidyanathan, Handbook of Machine Foundations, Tata McGraw Hill.
- Barken, Dynamics of Bases and Foundations, McGraw Hill Publishing Co., New York.
- Richart, Hall and Woods, Vibration of Soils and Foundations, Prentice Hall, Eaglewood Cliffs, New Jersy, USA.

Outcomes:

Upon completion of the course the students will be able to:

- Understand the fundamentals of wave propagation in soil media.
- Apply theory of vibrations to solve dynamic soil problems & to calculate the dynamic properties of soils using laboratory and field tests.
- Analyze the behaviour of a machine foundation resting on the surface and embedded foundation.
- Analyze the block foundation under different modes of vibrations.
- Understand the principles of design of foundations for reciprocating and impact machines as per IS code.
- Acquainted with types, methods & materials for vibration isolation systems.

CVSE-E5/03 Solution Procedures in Civil Engineering (Open Elective)

Teaching Schemes: 4 Pract. hrs/week; **Evaluation Scheme:** Class Assessment 25; Oral Examination 25

Course Contents

Module 1: Classical Analysis Procedures

Basics of equilibrium and stability, Basic assumptions of Analysis, Concepts of Modelling, Basis of Idealization, Limitations of hand computations. **(06 Lectures)**

Module 2: Advanced Computational Tools

Comparative study of various engineering software available, Limitations and strengths, Linear, Nonlinear analysis provisions, Data Processing using Spreadsheet Applications, Statistical Computational Tools, Interpretation of results **(06 Lectures)**

Module 3: Numerical Computations

Basis of Computations, Operations on Computer, Solution of Simultaneous Equations, Methods for Roots of Equations, Solution of Ordinary Differential Equations, Numerical Integration **(06 Lectures)**

Module 4: Finite Element Analysis

Discretization, Implementation of FEM -Calculation of Element Stiffness, Mass and Equivalent Nodal Loads, Assemblage of Structures Matrices, Boundary Conditions, Solutions of the overall problem, Calculations of Element Stresses, Computer Program Organization, Introduction to Non Linear Analysis, Formulation of a Geometrically Non-linear Problem, Non-linear material behavior, General Formulation of a Physically Nonlinear Problem, Introduction to Dynamic Analysis by FEM, Formulation of Dynamic Properties, Free Vibration, Steady-State and Transient Response Analysis for simple Problems. **(06 Lectures)**

Module 5: Experimental stress analysis

Model Analysis, Structural similitude, Use of models, Scale effect, Structural and Dimensional analysis, Buckingham Pi Theorem, Indirect model analysis, Use of Begg's and Eney's Deformeters, Moment indicators, Design of models for direct and indirect analysis, Structural modeling and testing **(06 Lectures)**

Module 6: Computer Implementation of Solution Procedures

Implementation of above methods by algorithm development leading to programming in Fortran / C / C++ / Matlab or any other suitable platform **(06 Lectures)**

References

- Reddy C. S., "Basic Structural Analysis", Tata McGraw Hill.
- Wang C.K., "Statically Indeterminate Structures", McGraw Hill
- Scheid F, "Numerical Analysis (Schaum's series)", Tata Mc-Graw Hill
- Krishnamoorthy C.S, "Finite Element Analysis", Tata McGraw Hill
- Heteny M; Handbook of Experimental Stress Analysis, John Wiley and Sons, New
- Chapra. S. C. &Canale R. P., "Numerical Methods for Engineers", by, Tata Mc-Graw Hill
- Zienkiewicz O.C, "Finite Element Method in Engineering Science", McGraw HillBook Co
- Cook R.D., et.al "Concepts and Applications of Finite Element Analysis", John Wiley & Sons (Asia) Pvt Ltd.
- Dally, Riley, "Experimental Stress Analysis", McGraw Hill Book Co., New York

Outcomes:

Upon completion of the course the students will be able to:

- To study the basics of structural analysis and limitations of different methods.
- Acquire knowledge of linear and nonlinear analysis tools.
- Understand numerical method based tools to solve mathematical model.

- Understand and implement computer based numerical methods to analyze various structures.
- Understand experimental stress analysis concepts and modelling techniques.
- Develop algorithms and programs to analyse different structures using various programming languages.

Semester- III

Project Management and Intellectual Property Rights

Teaching Schemes: Self Study; **Evaluation Scheme:** Class Assessment 25; Oral Examination 25

Course Content

Project Management

Module 1: Introduction to Project Management

Brief history of project management, Role of a Project Manager, benefits of project management, Project vs. operation, Project lifecycle: Initiating, Planning, Executing, Controlling, and Closing processes. Project Integration Management - Project plan development, Project plan execution, and Overall change control.   **(06 Lectures)**

Module 2: Beginning a Project

Project Selection, Defining criteria, Project selection methods, Sacred Cow, Comparative Benefit Model (CBM), Quality functional deployment (QFD), Scope Definition, Project Charter development   **(06 Lectures)**

Module 3: Risk Management

Project Risk Management Processes, Types of Risk, Risk Defined, Risk Factors, Risk Factors Risk identification, Qualitative risk analysis, Quantitative risk analysis, Risk planning, Risk control.   **(06 Lectures)**

Module 4: Professional Responsibility (Ethics)

Ensuring Integrity and Professionalism, Project Management Knowledge Base, Enhancing Individual Competence, Balancing Stakeholder Interests, Interactions with Team Members and Stakeholders, Templates, Tools and Techniques.   **(06 Lectures)**

Intellectual Property Rights

Module 5: Introduction to Intellectual Property Rights

Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.

International Scenario

International cooperation on Intellectual Property, Procedure for grants of patents, Patenting under PCT.   **(06 Lectures)**

Module 6: Patent Rights

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Recent Developments in IPR

Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies.   **(06 Lectures)**

References

- PMBOK® Guide 5th Edition, ISBN 978-1935589679
- Managing Across Cultures: The 7 Keys to Doing Business with a Global Mindset 1st Edition, ISBN 978-0071605854
- The PMP Exam: How to Pass on Your First Try 5th Edition, ISBN 978-0982760857
- The PMP Exam: Quick Reference Guide 5th Edition, ISBN 978-0982760895

- T. Hegazy, Computer-based construction project management, Prentice Hall, New Jersey, 2002.
- S. M. Levy, Project management in construction, 5 th ed., McGraw Hill, New York, 2007.
- PMI, A guide to the project management body of knowledge, 3 rd ed., Project Management Institute, Pennsylvania, 1996.
- Prabuddha Ganguly, "Intellectual Property Rights",Tata Mc-Graw Hill.
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley "Intellectual Property in New Technological Age".

CVSEPS1 Project Stage I

Evaluation Scheme: Class Assessment 25; Oral Examination 25

Dissertation Stage I and Synopsis Approval Presentation:

It is a course requirement under the guidance of faculty Supervisor. PG student from second year is required to do innovative and research oriented applied work related to various theory and laboratory courses. Dissertation work may cover analytical formulation, experimentation or survey based project or combination of these. Student are encouraged to undertake an interdisciplinary type project.

- **Synopsis:**

It is expected from the student to carry out exhaustive literature survey with consultation of his/her Supervisor for not less than 15 reputed national, international journal and conference papers. Student should present the Synopsis Submission Presentation (SSP) with literature survey report to justify about the research gap, innovativeness, applicability, relevance and significance of the work. Student shall undertake project work after approval of synopsis.

- **Dissertation Stage I presentation:**

It is expected that student shall present preliminary results from his/her work during the semester with report as per prescribed format. If student is not showing satisfactory performance, then he/she will be given grace period of 2 weeks. After 2 weeks student will be again evaluated with grade penalty. Minimum 02 ISE presentations should be delivered by the student during semester.

Semester- IV

CVSEPS2 Project Stage II

Evaluation Scheme: Class Assessment 25; Oral Examination 25

Based on the guidelines and progress of stage II works, all the desired work should be completed and final dissertation report will be prepared and presented during examination. It is desirable that student presents/publishes the research paper in peer reviewed conference/research journals. If student is not showing satisfactory performance, then he/she will be given grace period of 4 weeks. After 4 weeks student will be again evaluated with grade penalty.