COURSE STRUCTURE - SCHEME OF INSTRUCTIONS AND EXAMINATION

M.E. CIVIL ENGINEERING

[STRUCTURAL ENGINEERING]

(TWO YEAR FULL TIME COURSE)

MASTER OF ENGINEERING TWO YEAR POST GRADUATE COURSE

(Applicable for the batches admitted from 2016-17)

AFFILIATED TO

GOA UNIVERSITY

GOA COLLEGE OF ENGINEERING

FARMAGUDI PONDA, GOA

Sawaikar
28/01/16
Dr. Ulhas G Sawaikar
Chairman, BoS - Civil

FIRST YEAR

Semester-I

Subject Code	Subject	Hours per week			Scheme of Examination				
					Theory (Hrs)	Marks/Credits			
		L	T	P		Theory	Sessional	Oral	Total Marks/Credits
MSE 1.1	Computational Methods and Numerical Techniques	4	-	-	3	100/4	50/2	-	150/6
MSE 1.2	Advanced Structural Analysis & Computer Applications	4	-	-	3	100/4	50/2	-	150/6
MSE 1.3	Finite Element Techniques	4	-	-	3	100/4	50/2	-	150/6
MSE 1.4	Design of Sub-Structures	4	-	-	3	100/4	50/2	-	150/6
MSE 1.5	Elective –I	4	-	-	3	100/4	50/2	-	150/6
MSE 1.6	Structural Engg. Lab -I	---	--	8	--	-	-	50/2	50/2
	Total	**20**	**Nil**	8		**500/20**	**250/10**	**50/2**	**800/32**

Semester-II

Subject Code	Subject	Hours per week			Scheme of Examination				
					Theory (Hrs)	Marks/Credits			
		L	T	P		Theory	Sessional	Oral	Total Marks/Credits
MSE2.1	Theory of Plates and Shells	4	-	-	3	100/4	50/2	-	150/6
MSE 2.2	Structural Dynamics & Earthquake Engineering	4	-	-	3	100/4	50/2	-	150/6
MSE 2.3	Advanced Design of Concrete Structures	4	-	-	3	100/4	50/2	-	150/6
MSE 2.4	Advanced Design of Steel Structures	4	-	-	3	100/4	50/2	-	150/6
MSE 2.5	Elective -II	4	-	-	3	100/4	50/2	-	150/6
MSE 2.6	Structural Engg. Lab -II	---	--	8	--	-	-	50/2	50/2
	Total	**20**	**Nil**	8		**500/20**	**250/10**	**50/2**	**800/32**

Sawaikar 28/1/16 (Dr. Ulhas Sawaikar) (Prof. Satyesh Kakodkar) (Dr. Nisha P. Naik) (Dr. Neena Panandik

Semester-III

Subject Code	Subject	Hours per week			Scheme of Examination				
		L	T	P	Theory (Hrs)	Marks/Credits			
						Theory	Sessional	Oral	Total Marks/Credits
MSE3.1	Internship*	-	-	20	-	-	300/12	100/4	400/16
MSE 3.2	Project*	-	-	12	-	-	50/2	-	50/2
	Total	-	-	-	-	-	**350/14**	**100/4**	**450/18**

Semester-IV

Subject Code	Subject	Hours per week			Scheme of Examination				
		L	T	P	Theory (Hrs)	Marks/Credits			
						Theory	Sessional	Oral	Total Marks/Credits
MSE 4.1	Elective-III	4	-	-	3	100/4	50/2	-	150/6
MSE 4.2	Dissertation*	-	-	28	-	-	200/8	150/6	350/14
	Total	**4**	-	-	-	**100/4**	**250/10**	**150/6**	**500/20**

*** Detailed in syllabus**

NOTE: One National Journal / Two Conferences papers (published / accepted for publication) is a pre-requisite for submission of the dissertation.

ELECTIVE –I (MSE1.5)

MSE 1.5.1 Theory of Elasticity
MSE 1.5.2 Repairs and Rehabilitation of Structures
MSE 1.5.3 Mechanics of Composite Materials
MSE 1.5.4 Structural Stability
MSE 1.5.5 Matrix Methods of Structural Analysis

ELECTIVE-II (MSE 2.5)

MSE 2.5.1 Design of Tall Structures
MSE 2.5.2 Structural Design of Bridges
MSE 2.5.3 Design of Pre-stressed concrete structures
MSE 2.5.4 Design of Offshore Structures
MSE 2.5.5 Reliability Analysis of Structures

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ELECTIVE-III (MSE 4.1)

MSE 4.1.1 Experimental Methods in Structural Engineering
MSE 4.1.2 Structural Health Monitoring
MSE 4.1.3 Design of Concrete Infrastructural and Industrial structures
MSE 4.1.4 Construction Methods and Equipments
MSE 4.1.5 Earth Pressure and Retaining Structures

Sawaikar 28/01/16
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DETAILED SYLLABUS

M.E. CIVIL ENGINEERING [STRUCTURAL ENGINEERING]

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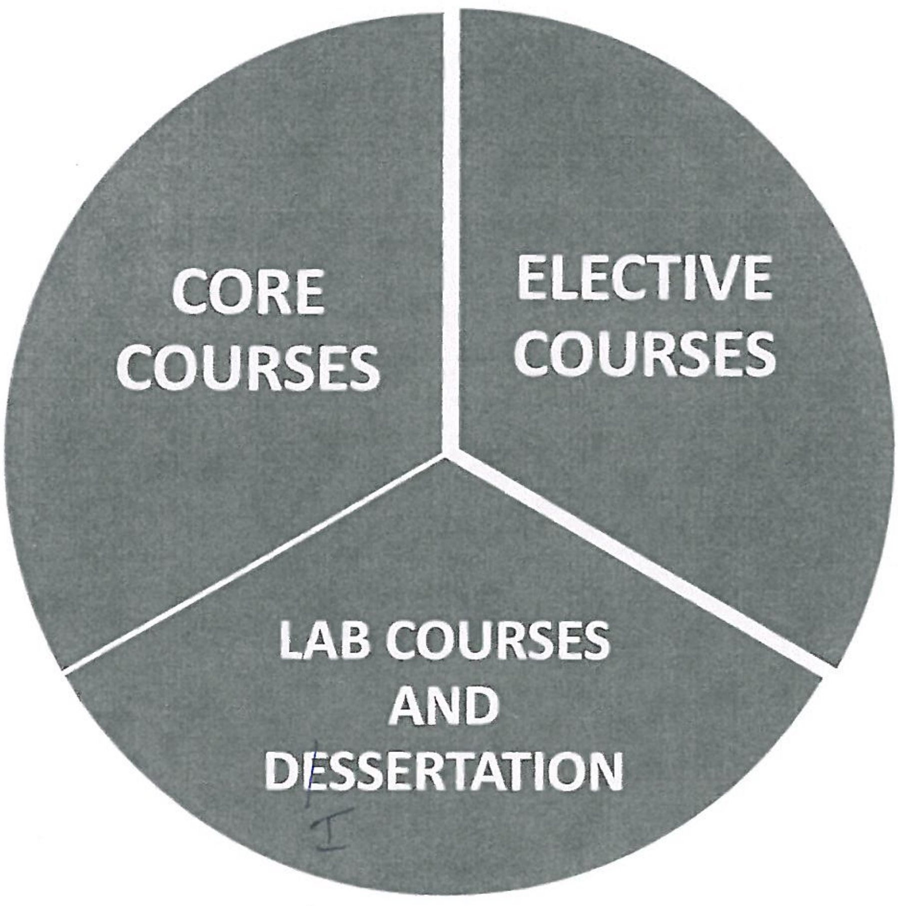
CORE
COURSES
ELECTIVE
COURSES
LAB COURSES
AND
DESSERTATION

CORE COURSES

MSE 1.1 Computational Methods and Numerical Techniques

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Mathematical Model**
   Purpose of modeling, types of model, steps in modeling process - problem definition, purpose definition, conceptualization, selection computer code, model design, calibration, validation, errors in engineering calculations (sources of errors, significant digits, rounding off, propagation of maximum error, propagation of variance, bias & precision)

2. **Interpolation and Extrapolation**
   Newton's Interpolation-forward and backward, Lagrange's Interpolation, , Hermite Interpolation, Spline Interpolation- Cubic, Inverse Interpolation, Extrapolation, Civil Engineering Application- Elevation Contour Map, Isohyetal Map, Noise Map, etc.

3. **Roots of an Equation, Numerical Differentiation, Numerical Integration and Solution of Ordinary Differential Equations**
   Roots of an Equation: Newton Raphson method, Modified Newton Raphson method and successive approximation method. Numerical Integration: Trapezoidal rule, Simpson's rule (⅓ rd, ⅜ th), Gauss quadrature method 2-point, 3-point, Double integration: Trapezoidal rule, Simpson's rule (⅓ rd), Numerical solutions of ordinary differential equations: method of Euler, Taylor and Runge-Kutta procedures. Civil Engineering Application- Earthwork volume estimation, Estimation of pile capacity, etc.

4. **Curve Fitting and Errors**
   Curve fitting (Interpolation, function that fits given values - approximate and exact, find function where reaches min/max or a specific value, linear regression, higher order polynomial, Gaussian, quantifying errors in curve fitting). Civil Engineering Application- population Forecasting Methods, Reduction Rate Parameters for design of Treatment Units, atmospheric dispersion of pollutant (Gaussian Dispersion Model) , Dispersion at sea outfall, etc.

(Dr. Nisha P. Naik) (Dr. Neena Panandiker)

5. **Finite Difference and Finite Element Method**

   Finite Difference Method, Boundary value problems of exact differential equations limited to second order only, PDE's-Parabolic-explicit. Crank Nicholson method, Hyperbolic equations, Elliptic equations. Finite Element Method (limited to 1D elements).: Basic understanding of finite element method including elements types and their formulation. Civil Engineering Application- Groundwater modeling, Flood routing, Self Purification of Streams (Streeter Phelps Equation), Finite element methods for simple beam and truss problem, 1 D consolidation problem, etc.

6. **Optimization**

   Concept of optimization, linear programming, application to structural engineering.

Texts/References

1. Hamming R. W., Numerical Methods for Scientist and Engineers, McGraw Hill, 1998.
2. Scarborough J. B., Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd., 2000.
3. Jain K. K., Iyengar S. R. K and Jain R. K., Numerical Methods - Problem and Solutions, Wiley India Pvt. Ltd, 2001.
4. Hayter A. J., Probability and Statistics, Duxbury, 2002.
5. Mathews J. H. and Fink K. D., Numerical Methods using MATLAB, Pearson Education, 2004.
6. Capri S. C. and Canale R. P., Numerical Methods for Engineers, 6th Edition, McGraw Hill, 2010.
7. Hildebrand F. B., Introduction to Numerical Analysis, Dover Publications, 1987.
8. Rajasekaran S., Numerical Methods in Science and Engineering, A Practical Approach. S. Chand & Company Ltd., New Delhi 2003.
9. Sastry S. S., Introductory Methods for Numerical Analysis, 5th Edition, Prentice Hall of India Private Ltd., New Delhi, 2012.
10. Akai T. J., Applied Numerical Methods for Engineers, John Wiley & Sons, 1994.

(Dr. Nisha P. Naik)

MSE 1.2 Advanced Structural Analysis & Computer Applications

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Introduction**
   Methods of structural analysis, Matrix methods of analysis for discrete structures ,Structural idealization, Basic components of structural analysis
2. **Virtual Work Principles Based on Virtual Displacements**
   Virtual Work, The Principle of Virtual Displacements, Application to Rigid Bodies,Application to Deformable Bodies
3. **Direct Stiffness Method for 2D and 3D Structures**
   Element Stiffness Matrix Formulation - Axial / Flexural / Shear / Torsional Deformations, Truss, Beam (Bernoulli Euler / Timoshenko), and Frame Elements, Direction Cosines - Transformation in 2D & 3D,Loads between Nodal Points, Formation of Global Analysis Equations, Assembly of Global Stiffness Matrix, Solution of System of Equations, Internal Force Recovery, Handling initial and thermal strain conditions, Augmented Stiffness Matrix, Displacement boundary conditions and calculating support reactions
4. **Special Techniques in Direct Stiffness Method**
   Member End Releases, Rigid end - zones , Axis Transformation, Static Condensation, Imposition of Constraint Conditions ,Different Modeling Techniques for Computer Application
5. **Approximate Analysis of Statically Indeterminate Structures**
   Vertical Loads on Building Frames , Use of Inflection Points, Moment Coefficients for continuous frames , Lateral Loads on Building Frames ,Portal or Cantilever Methods
6. **Influence Lines**
   Influence lines for determinate structures , Influence line analysis for indeterminate structures

TEXT BOOKS/REFERENCES (AN INCOMPLETE LISTING)

1. Wang, C. K., Matrix Methods of Structural Analysis, 2nd Ed., International Textbook, Scranton,Pa., 1970.
2. Meek, J. L., Matrix Structural Analysis, McGraw-Hill, New York, 1971.
3. Weaver, W., Jr., and Gere, J. M., Matrix Analysis of Framed Structures, 2nd Ed., Van Nostrand Reinhold, New York,1980
4. Holzer, S. H., Computer Analysis of Structures, Elsevier, New York, 1985.
5. Hoit, M. I., Computer Assisted Structural Analysis and Modeling, Prentice Hall, 1995.
6. Fleming, J. F., Analysis of Structural Systems, PrenticeHall, 1997.
7. Felton, L. P., Nelson,R. B., Matrix Structural Analysis, Wiley, 1997.

8. Hoit, M., Computer Analysis of Structures, Wiley, 1999.
9. McGuire, W., Gallagher, R. H., and Ziemian, R.D., Matrix Structural Analysis, 2nd Edition,Wiley,NewYork, 2000.
10. SAP 2000/STAADPRO Structural AnalysisProgram Manual,
11. Uang, C. M., Leet, K. M., Fundamental Structural Analysis, McGraw-Hill, 2001.
12. Wilson, E.L., Three Dimensional Static and Dynamic Analysis of structures, A Physical approach with Emphasis on Earthquake Engineering, Computers and Structures, Inc., Berkeley, California, 2002.
13. West, H. H., Geschwinder, L. F., Fundamentals of Structural Analysis, 2nd Ed., Wiley, 2002.
14. Ghali, A., Neville A.M., and Brown, T.G., Structural Analysis, Fifth Edition, Spoon Press, 2006.
15. McCormac, J.C., Structural Analysis, Fourth Edition, Wiley,2007.
16. Kassimali, A., Matrix Analysis of Structures, 2nd Ed., Cengage 2012

MSE 1.3 Finite Element Techniques

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Introduction**
   Concept of an element, various element shapes displacement models, foundation of finite element method using principle of virtual displacements, derivation of element stiffness and loads for pin-jointed bar element, beam element, triangular plate element (in-plane forces), rectangular plate element (in-plane forces), quadrilateral plate element (in-plane forces), triangular and rectangular plate elements in bending.

2. **Variational Formulation of Finite Element Method (FEM)**
   Isoparametric elements: local vs natural co-ordinate system, line, triangular quadrilateral and tetrahedral elements, interpolation displacement models. Formulation of isoparametric finite element matrices in local and global coordinate system.

3. **Implementation of FEM**
   Discretization of the structure, calculation of element stiffness, mass and equivalent nodal loads. Assemblage of structure matrices. Boundary conditions, solutions of the overall problem. Calculations of element stresses and computer program organization.

4. **Non-linear Analysis**
   Geometric non-linearity, geometric stiffness of an axial element. Stability of bar, spring system. General formulation of geometrically nonlinear problem. Geometric stiffness of beam - column and triangular elements. Introduction to non-linear material behavior, non-linear spring, introduction to elasto-plastic analysis, elasto-plastic analysis of a truss. 2-D element formulations, general formulation of a physically non-linear problem.

5. **Dynamic Analysis**
   Formulation of inertial properties. Lumped mass vs. Consistent mass matrices, condensation and assembly of mass matrices. Formulation of damping properties – free vibration, steady – state and transient response analysis for simple problems. Formulation and solution of problems in structural mechanics using the above mentioned methods.

6. **Programming and Organization of FEM Programs**
Static-linear analysis, non-linear and dynamic analysis, mesh generation aspects, equation solving techniques, input/output plotting.

Texts/References

1. Desai C. and Abel J., Introduction to the Finite Element Method, East West Press Pvt. Ltd., 1972.
2. Shames I. H. and Dym C. J., Energy and Finite Element Methods in Structural Mechanics, McGraw Hill, New York, 1985.
3. Cook R. D., Malkan D. S. and Plesta M. E., Concepts and Application of Finite Element Analysis - Third Edition, John Wiley and Sons Inc., 1989.
4. Rajasekaran. S., Finite Element Analysis in Engineering Design, Wheeler Publishing, 1993.
5. Bathe K. J., Finite Element Procedures in Engineering Analysis, Prentice Hall, 1996.
6. Reddy J. N., Introduction to Finite Element, McGraw Hill Book Co., 2006.
7. ZienkiWiez O. C., The Finite Element Method in Engineering Science, McGraw Hill Book Co., 2006.
8. Krishnamoorthy C. S., Finite Element Analysis: Theory and Programming, McGraw Hill Book Co., 2007.
9. Desai Y. M., Eldho T. I. and Shah A. H., Finite Element Method with Applications in Engineering, Dorling Kindersely Pvt. Ltd., Licensees of Pearson Education in South Asia. 2011.
10. Logan D. L., A First Course in the Finite Element Method, Third Edition, Thomson Asia Pte Ltd, 2002.
11. Desai C. S., Kundu T., Introductory Finite Element Method, CRC Press, 2001.
12. Chandrupatla T. R. and Belegundu A. D., Introduction to Finite Elements in Engineering, Method, Third Edition Prentice-Hall India Private Ltd., 2002.
13. Gupta O. P., Finite and Boundary Element Methods in Engineering, Oxford & IBH Publishing Co. Pvt. Ltd, 2000.
14. Buchanan G. R., Theory and Problems of Finite Element Analysis. Schaum's Outline Series, McGraw Hill International Edition, 1995.

MSE1.4 Design of Sub Structures

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

Shallow Foundations: Soil investigation – Basic requirements of foundation – Types and selection of foundations. Bearing capacity of soil - plate load test – Design of reinforced concrete isolated, strip, combined and strap footings, mat foundation.

Pile Foundations: Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles – different shapes of piles cap – structural design of pile cap.

Well Foundations: Types of well foundation – Grip length – load carrying capacity – construction of wells – Failures and Remedies – Design of well foundation – Lateral stability.

Machine Foundations: Introduction – Types of machine foundation – Basic principles of design of machine foundation – Dynamic properties of soil – vibration analysis of machine foundation – Design of foundation for Reciprocating machines and Impact machines – Reinforcement and construction details – vibration isolation.

Special Foundations: Foundation on expansive soils – choice of foundation – under-reamed pile foundation. Foundation for concrete Towers, chimneys – Design of anchors- Reinforced earth retailing walls. Combined Piled Raft Foundations.

Soil-Foundation Interaction : Idealized soil, foundation and interface behaviour. Elastic models of soil behaviour; Elastic-plastic and time dependent behaviour of soil. Beams and plates on elastic foundation; numerical analysis of beams and plates resting on elastic foundation.

References:

1. Bowles .J.E., "Foundation Analysis and Design", Mc.Graw Hill Publishing co., New York, 1986.
2. Swamy Saran, Analysis and Design of substructures, Oxford and IBH Publishing Co. Pvt. Ltd., 2006.
3. Tomlinson M J, "Foundation Design and Construction", Longman, Sixth Edition, New Delhi, 1995.
4. Varghese P C, "Design of Reinforced Concrete Foundations" – PHI learning private limited, New Delhi – 2009.
5. Advanced Foundation Design by P C Verghese, Prentice Hall
6. Sreenivasalu & Vaidhyanathan, Handbook of Machine Foundations, Tata McGraw Hill

MSE. 2.1 Theory of Plates and Shells

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Introduction to Plates Theory**
   Thin and thick pates, small and large deflection theory of thin plate-assumptions, moment-curvature relations, stress resultants, governing differential equation for bending of rectangular plates, various boundary conditions.

2. **Small Deflection Theory for Laterally Loaded Thin Rectangular Plates**
   Navier's and Levi's solution for distributed and concentrated loads, use of numerical technique for the solution of plates, concept of influence surface, study of simply supported plate with continuous edge moments.

3. **Symmetrical Bending of Circular Plates**
   Small deflections under axi-symmetric transverse loads, differential equations of equilibrium, different support conditions, plates with overhangs, plates with coaxial circular opening.

4. **Potential Energy Principle**
   Solution of thin plates with various boundary conditions and loadings.

5. **Shear Deformation Theory**
   Introduction to shear deformation theories.

6. **Introduction to Shells**
   Introduction to structural behavior of thin shells, membrane and bending actions. Mathematical representation of a shell surface, principal curvatures, Gauss curvature, Classification of shells.

7. **Membrane Theories of Shell**
   Membrane theories of thin shells stress resultants, application to cylindrical shells under symmetric loads and surfaces of revolution under axi-symmetric loads.

8. **Cylindrical Shells**
   Bending theory of open circular cylindrical shells with special emphasis on approximate theories of Finsterwalder and Shorer theories: Introduction to DKJ, Flugge and other exact

theories: Different boundary conditions for single and multiple shells.

Texts/References

1. Timoshenko S. P. and Woinowsky-Krieger S., Theory of Plates and Shells, McGraw-Hill, 1959.
2. Ramaswamy G. S., Design and Construction of Concrete Shell Roofs, CBS Publishers & Distributors, 1986.
3. Kelkar V. S. and Sewell R. T., Fundamentals of the Analysis and Design of Shell Structures, Prentice Hall International, 1987.
4. Ugural A. C., Stresses in Plates and Shells, McGraw-Hill, 1999.
5. Varadan T. K. and Bhaskar K., Analysis of Plates, Narosa Publishing House, 1999.

MSE. 2.2 Structural Dynamics & Earthquake Engineering

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Introduction**
   Definitions of the problems in dynamics: Static VS Dynamic loads, Different types of dynamic loads. Introduction to soil structure interaction and hydrodynamics.

2. **Single Degree of Freedom (SDOF) Systems**
   Undamped vibration of SDOF System, natural frequency and period of vibration, damping in structures, viscous damping and Coloumb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement. Forced vibration, response to periodic loading, response to pulsating forces dynamic load factors.

3. **Response of Structure**
   General dynamic load, Duhamel's Integral, Numerical Evaluation of Dynamic Response of SDOF systems, Response of structure in frequency domain subjected to general periodic and non- periodic impulsive forces of short duration.

4. **Generalized SDOF and MDOF System**
   Distributed mass system idealized as SDOF system, use of Rayleigh's method. Response of SDOF system subjected to ground motion, lumped mass multi degree of freedom (MDOF) system, coupled and uncoupled systems.

5. **Frequencies of Vibration and Mode Shapes**
   Orthogonally principle, Vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes. Energy methods and use of Lagrange's method in writing equations of motions decoupling of equations. Forced vibration of MDOF system, Modal analysis. Application to Multistory rigid frames.

6. **Earthquake and Ground Motion**
Seismicity of a region, causes of earthquake. Measurement of Earthquake ground motion, Seismogram. Characterization of ground motion, earthquake response shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra, peak structural spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration. Response spectrum characteristic.

7. **Earthquake Responses on Structures**
Types of earthquake excitation, lumped SDOF elastic systems, translational excitation, lumped MDOF elastic systems, multi-storey buildings with symmetric plans, multi-storey buildings with unsymmetrical plans, torsional response of symmetric plan building, combining maximum model responses using mean square response of a single mode, SRSS and CQCC combination of modal responses. I.S. code provisions for seismic analysis of buildings and water towers, approximate method of earthquake analysis -seismic coefficient method and its limitations, response spectrum method, time history analysis.

8. **Case Studies**
Review of damages during past earthquakes and remedial measures, seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joint.

Texts/References

1. Biggs J. M., Introduction to Structural Dynamics, McGraw Hill, 1964.
2. Paulay T. and Priestly M. N. J., Aseismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons, 1991.
3. Taranath B. S., Structural Analysis and Design of Tall Buildings, McGraw Hill Book Company, New York, 1999.
4. Chopra A. K., Dynamics of Structures, Pearson Education, 2001.
5. Paz M., Structural Dynamics: Theory and Computation, Kluwer Academic Publication, 2004.
6. Agarwal P. and Shrikhande M., Earthquake Resistant Design of Structures, Prentice Hall of India, 2006.
7. Karmer S. L., Geotechnical Earthquake Engineering, Prentice Hall PTR, 1996.
8. Duggal S. K., Earthquake Resistant Design of Structures, Oxford University Press, 2007.
9. Roy. D. and Rao G., Elements of Structural Dynamics: A New Perspective, John Wiley and Son, 2012.

MSE. 2.3 Advanced Design of Concrete Structures

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Design Methods**
   Stress strain characteristics of concrete and reinforcing steel review of elastic theory, ultimate strength theory and limit state approach for design of structures. Review of resolution of structures into structural members. Review of load transfer mechanisms, redundancies and alternate load paths in structures. Introduction to the concept of limit design of structural components and yield line analysis of slabs and its application to the prevailing codes of practice. Study of limit states of collapse and serviceability. Application of these concepts to design of structural components.

2. **Design of High Rise Buildings**
   Criteria for design of high rise structures with or without basements. Input parameters for the structure and its foundation. Analysis, design and detailing of High Rise Buildings and their raft foundations using latest software tools available.

3. **Design of PT Slabs**
   Study of the behavior of flat slabs. Criteria for design of one/two way PT Slabs. Analysis, design and detailing of PT Slabs using software tools available.

4. **Design of Retaining Structures**
   Review of Retaining Wall and Water Tank Design principles. Design of Silos and Bunkers. Design and detailing of Retaining Walls of Basements of High Rise Structures.

5. **Introduction to Pre-stressed Concrete**
   Basic concept and general principles of prestressed concrete, materials used and their properties, methods, technique of prestressing and system of prestressing, loss of prestress, historical perspective on prestressed concrete, basics of bridge design.

6. **Analysis of Prestressed Concrete Section for Flexure**
   Loading stages and computation of section properties, critical sections under working loads for pre-tensioned and post-tensioned members, load balancing method of analysis of pre-stressed concrete beams.

7. **Design of Pre-Stressed Concrete Section for Flexure**
   General philosophy of design, design approaches in working stress method and limit state method, critical conditions for design, limit state of collapse in flexure, permissible stresses in concrete and steel.

8. **Analysis and Design of Pre-Stressed Concrete Members for Shear and Torsion**
   Calculation of principal tension under working load, permissible principal tension, shear strength calculation under limit state of collapse for both cracked and un-cracked in flexure End zone stresses in pre-stressed concrete members:
   - Transfer of pre-stress in pre-tensioned members: Pretension transfer bond, transmission length, end zone reinforcement.
   - Anchor zone stresses in post-tensioned members: stress distribution in end block, anchor zone reinforcement.

Texts/References

1. Park R. and Paulay T., Reinforced Concrete Structures, John Wiley & Sons, 1975.
2. Purushothaman P., Reinforced Concrete Structural Elements, Tata McGraw-Hill, 1984.
3. Kong and Evans, Reinforce and Prestressed Concrete Structures, ELBS, 1995.
4. Nilson A. H., Design of Concrete Structures, McGraw-Hill, 1997.
5. Pillai S. U. and Menon D., Reinforced Concrete Design, Tata McGraw-Hill, 2003.
6. Varghese P. C., Advanced Reinforced Concrete Design, Prentice-Hall of India, 2005.
7. IS: 456-2000, Plain and Reinforced Concrete Code of Practice.
8. IRC: 6-2000 Standard Specifications and Code of Practice for Road Bridges, The Road Congress.
9. IS: 875(Part3)- 2007: Wind Loads on Buildings and Structures.
10. ACI 318:2008 – Building Code Requirements for Structural Concrete, American Concrete Institute, 2008.
11. Evans R. H. and Bennett E. W., Prestressed Concrete, Champman and Hall, London, 1958.
12. Lin T. Y., Design of Prestressed Concrete Structures, John Wiley and Sons Inc., 1981.
13. Sinha N. C. and Roy S. K., Fundamentals of Prestressed Concrete, S. Chand and Co., 1998.
14. Krishna Raju, Prestressed Concrete, Tata McGraw Hill Publishing Co., 2000.
15. Rajagopalan N., Prestressed Concrete, Narosa Publications, New Delhi, 2008.
16. IS: 1343- 1980: Code of Practice for Prestressed Concrete.
17. IRC 112- 2011 Code of Practice for Concrete Road Bridges.

MSE. 2.4 Advanced Design of Steel Structures

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

Introduction: Properties of Structural Steel, Corrosion, Fire Protection, Indian Standard Specifications and Sections, Design Requirements & Design Process, Analysis Procedures & Design Philosophy, Introduction to Limit State Design, Other Design Requirements.

Moment Connections: Simple, Semi-rigid and Rigid Connections, Connection Configurations, Angle Cleat Connections, End-plate Connections, Semi-rigid Connections, Moment-rotation Characteristics.

Industrial Buildings: Structural Configurations, Functional and Serviceability Requirements, Industrial Floors, Roof Systems, Plastic Analysis and Design of Portal Frames, Crane Gantry Girders, Design for Wind Actions, Design for Earthquake Actions

Multi-Storeyed Buildings: Structural Configurations, Steel-Concrete Composite Floor Systems, Loading, Analysis for Gravity Loads, Lateral Load Resisting Systems, Analysis for Lateral Loads, Dual Systems, Advanced Structural Forms.

Tanks: Introduction- Types of Tanks, Load and Load Combination, Design Aspects of cylindrical Tanks, Design Aspects of Rectangular Tanks, Wind and Earthquake effects, Staging Design

Towers: Classification of Types of Towers, Loads and Load Combinations, Wind Effects on Towers, Methods of Analysis, Design Approaches, Economy and Optimisation.

References:

1. Lynn S. Beedle, Plastic Design of Steel Frames, John Wiley and Sons, 1990.
2. Narayanan.R.et.al., Teaching Resource on Structural steel Design, INSDAG, Ministry of Steel Publishing, 2000.
3. Subramanian.N, Design of Steel Structures, Oxford University Press, 2008.
4. Wie Wen Yu, Design of Cold Formed Steel Structures, Mc Graw Hill Book Company, 1996.
5. M L Gambhir, Design of Steel Structures

MSE. 3.1 INTERNSHIP

Hours per week			Scheme of Examination				
L	T	P	Theory (Hrs)	Marks /Credits			
				Theory	Sessional	TW/O	Total/Credits
-	-	-	20	-	300/12	100/4	400/16

An internship is an integral part of M.E. in Structural Engineering. It provides real world experience in the profession, enables correlation of class room learning with its application in industry. It Broadens understanding of the types of employment available in the field; Helps students discover their individual interests, it enables build resume credentials for the students and develops relationships between college and industries.

The internship course requires that a student be employed in the field of Engineering for a minimum of 20 hours per week for at least 14 weeks. However, it is preferred that a student be employed for 40 hours per week during the entire semester he/she is off track. The student will be registered for the internship course/exam after completing the "Internship" and other requirements mandated by the university. The internship formalities be completed and started within the first month of the semester.

As a result of the internship, it is expected that the student will

1. Develop practical engineering skills and judgment
2. Communicate effectively
3. Discover their own interests within the field of Civil/Structural Engineering
4. Build resume credentials to help them compete for full time positions

Grading of internship will of following format.

- Final internship Report 30%
- Employer Evaluation 70%
- TOTAL 100%

Students expected to submit Interim reports periodically throughout the internship as specified by the instructor and should be submitted by email.

A final written report will be due the end of the internship (i.e. the last week of classes for the semester to allow time for grading reports and submitting final grades). The final report should address the following:

1. Projects and Duties performed during the semester
2. Learning that occurred as a result of the internship
3. Regarding the engineering profession
4. Regarding the particular industry
5. Regarding the organization/company
6. Technical Skills that were developed
7. Individual interests and preferences that were discovered
8. Goals and plans regarding future professional development

Each student is required to live by the University student Code of conduct and the Dress and Grooming standards while employed in an internship.

MSE. 3.2 PROJECT

Hours per week			Scheme of Examination				
L	T	P	Theory (Hrs)	Marks /Credits			
				Theory	Sessional	TW/O	Total/Credits
-	-	12	-	-		50/2	50/2

Pre-requisites: Both I & II Semester course work of I Year should be completed

There is no prescribed syllabus. Students are required to search, collect and review various research articles published in chosen area of research. A student has to select a topic for his dissertation, based on his/her interest and the available facilities at the commencement of dissertation work. Students are required to submit a dissertation report on the research work carried out by him/her.

Reading:

1. Journal Publications.
2. Conference / Seminar Proceedings.
3. Handbooks / Research Digests/Codebooks

MSE. 4.2 DISSERTATION

Hours per week			Scheme of Examination				
L	T	P	Theory (Hrs)	Marks /Credits			
				Theory	Sessional	TW/O	Total/Credits
-	-	28	-	-	200/8	150/6	350/14

Dissertation: The topic of dissertation must be primarily of Structural Engineering related either theoretical or experimental or both which a student has to carry out under the supervision of a faculty member/s of the Department

The nature of the project could be analytical, computational, experimental, or a combination of the three. The project report is expected to show clarity of thought and expression, critical appreciation of the existing literature, and analytical, Computational, experimental aptitudes of the student

The dissertation will be assessed by two examiners appointed by the University. The examination shall consists of a defense presented by the student on his/her work in the presence of other interested teachers and students and two examiners appointed by university.

NOTE: One National Journal / Two Conferences papers (published / accepted for publication) is a pre-requisite for submission of the dissertation.

Reading:

1. Structural Engineering Journals.
2. Research Articles / Reports available on Internet.
3. Structural Engineering Textbooks, Handbooks and Codebooks

ELECTIVE COURSES

MSE. 1.5 .1 Theory of Elasticity (Elective -I Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Basic concepts of deformation of deformable bodies**

   Notations of stress and strain in a 3D field Transformations of stresses and strains in Cartesian and polar co-ordinates- Equilibrium equations in two and three dimensions in Cartesianco-ordinates.

2. **Plane stress and plane strain problems**

   Two dimensional problems in Cartesian co-ordinates as applied in beam bending, using Airy's stress function - Polar co-ordinates.

3. **Equations of equilibrium and compatibility**
   Two dimensional problems in polar co-ordinates-Stress concentration in holes.

4. **Energy principle**
   Theorem of minimum potential energy and complementary potential energy

5. **Torsion of various shaped bars**
   Prandtl's membrane analogy- energy method- Torsion of rolled Profiles- Stress concentration at re-entrant corners.

6. **Introduction to yield criteria for metals**, graphical representation of yield criteria, Flow laws of plastic mass

7. **Plastic strain relations**-Application to thick cylinders - Hollow spheres -Torsion

Text and references

1. Timoshenko and Goodier, "Theory of Elasticity", 3rd Edition, McGraw Hill, 2010.
2. C.T. Wang, "Applied Elasticity", McGraw Hill, 1953.
3. L.S. Srinadh, "Advanced Mechanics of Solids", TMH Publishing Company Limited, 1992.
4. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, 1997.

MSE. 1.5. 2 Repairs and Rehabilitation of Structures (Elective -I Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Maintenance and Repair Strategies**

   Maintenance, repair and rehabilitation, facets of maintenance, importance of maintenance various aspects of inspection, assessment procedure for evaluating a damaged structure, causes of deterioration.
2. **Serviceability and Durability of Concrete**

   Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking. - effects due to climate, temperature, chemicals, corrosion - design and construction errors - effects of cover thickness and cracking.
3. **Materials and Techniques for Repair**

   Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement and polymers coating for rebars loadings from concrete, mortar and dry pack, vacuum concrete, gunite and shotcrete, epoxy injection, mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels and cathodic protection.
4. **Repairs to Structures**

   Repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure using FRP.

Texts/References

1. Allen R. T. and Edwards S. C., Repair of Concrete Structures, Blakie and Sons, UK, 1987.
2. Raikar R. N., Learning from Failures Deficiencies in Design, Construction and Service - R&D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.
3. Campbell D., Allen and Roper H., Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical UK, 1991.
4. Palaniappan N., Estate Management, Anna Institute of Management, Chennai, 1992.

5. Shetty M. S., Concrete Technology Theory and Practice, S. Chand and Company, New Delhi, 1992.
6. Santhakumar A. R., Training Course notes on Damage Assessment and Repair in Low Cost Housing , RHDC-NBO, Anna University, July 1992.
7. CPWD Repair Manual

MSE. 1.5.3 Mechanics of Composite Materials (Elective -I Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Introduction**
   Definition of fiber reinforced composites, applications and various reinforcement and matrix materials.
2. **Mechanics of a Lamina**
   Linear elastic stress-strain relations, elastic constants based on micromechanics, plane stress constitutive relations, transformation of stresses and strains transformation of material coefficients, thermal stresses and strains.
3. **Laminated Composites**
   Types of laminated composites, displacement field approximations for classical laminate theory, laminate strains, stress resultants, stiffness matrices, stresses and strains due to applied loads, introduction to first order shear deformation theory.
4. **Failure Theories of a Lamina**
   Maximum stress failure theory, maximum strain failure theory, Tsai-Hill failure theory, Tsai-Wu failure theory.
5. **Mechanical Properties Determination**
   Tensile properties, compressive properties, flexure properties, in-plane shear properties, inter-laminar shear strength.

Texts/References

1. Jones R. M., Mechanics of Composite Materials, McGraw-Hill, Kogakusha Ltd., Tokyo, 1975.
2. Agarwal B. D. and Broutman L. J., Analysis and Performance of Fiber Composites, John-Wiley and Sons, 1980.
3. Kaw A. K., Mechanics of Composite Materials, CRC Press, Florida, 1997.
4. Hyer M. W., Stress Analysis of Fiber-Reinforced Composite Materials, McGraw Hill, 1999.
5. Mukhopadhyay M., Mechanics of Composite Materials and Structures, University Press, India, 2004.
6. Daniel and Ishai, Engineering Mechanics of Composite Materials, Oxford University Press, 2005.

7. Christensen R. M., Mechanics of Composite Materials, Dover Publications, New York, 2005.
8. Mota Soares C. A., Mota Soares C. M., and Freitas Manuel J.M., Mechanics of Composite Materials and Structures (Proceedings), Springer Science & Business Media, 1999.

MSE. 1.5 .4 Structural Stability (Elective -I Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. Buckling of Columns - Introduction - Methods of finding critical loads, critical loads for straight columns with different end conditions and loading - Inelastic buckling of axially loaded columns - Energy methods - Prismatic and non-prismatic columns under discrete and distributed loadings - General Principles of elastic stability of framed structures .

2. Mathematical Treatment of Stability Problems - Critical loads for discrete systems - Discrete Eigen value problem - Buckling of continuous systems - Continuous Eigen value problem - Orthogonality relation - Methods of converting continuous Eigen value problem to a discrete problem

3. Buckling of Thin Walled Members of Open Cross Section - Torsion of thin-walled bars - Warping - Non-uniform torsion - Torsional buckling under axial loading - Combined bending and torsion buckling.

4. Lateral Buckling of Beams - Beams under pure bending - Cantilever and simply supported beams of rectangular and I sections - I Beams under transverse loading - Energy methods - Solution of simple problems

5. Buckling of Rectangular Plates - Plates simply supported on all edges and subjected to constant compression in one or two directions - Plates simply supported compression in one or two directions - Plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides.

6. Buckling of shells - Introduction to buckling of axially compressed cylindrical shells

Texts/References

1. Timoshenko and Gere, "Theory of Elastic Stability", 2nd Edition, Tata McGraw Hill, 2010
2. Stephen H. Crandall, "Engineering Analysis - A Survey of Numerical Procedures", Krieger Publishing Co.,1986
3. Bleich," Buckling of Metal Structures", McGraw Hill Book Co., New York, 1952.
4. Alexander Chajes, "Principles of Structural Stability Theory", Prentice Hall Inc., 1974
5. N.G.R Iyengar, "Structural Stability of Columns and Plates", Ellis Horwood Ltd, 1988.
6. A.H. Chilver, "Thin Walled Structures", Chatto and Windus Ltd., 1967.
7. Coxhl, "The Buckling of Plates and Shells", H.L. Pergaman press, 1963

MSE 1.5.5 Matrix Methods of Structural Analysis (Elective -I Course)

Hours per week			Scheme of Examination			
				Marks /Credits		
L	T	P	Theory (Hrs)	Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. Generalized Measurements - Degrees of freedom - Constrained Measurements - Behavior of structures - Principle of superposition- Stiffness and flexibility matrices in single, two and n-co-ordinates - Structures with constrained measurements.

2. Stiffness and flexibility matrices from strain energy - Betti's law and its applications- Determinate and indeterminate structures - Transformation of element matrices to system matrices - Transformation of system vectors to element vectors.

3. Flexibility method applied to statically determinate and indeterminate structures – Choice of redundant -Transformation of redundant-Internal forces due to thermal expansion and lack of fit.

4. Displacement method - Internal forces due to thermal expansion and lack of fit - Application to symmetrical structures - Code system in the stiffness methods – Computer program for the code system - Comparison between stiffness and flexibility methods.

5. Analysis by substructures using the stiffness method and flexibility method with tridiagonalization- Analysis by Iteration method - frames with prismatic members – non-prismatic members.

Texts/References

1. Moshe, F., Rubenstein, Matrix Computer Analysis of Structures, Prentice Hall, New York, 1966.
2. Kanchi, Matrix Structural Analysis, Wiley Eastern Ltd., Newdelhi 1981
3. Rajasekaran S, Computational Structural Mechanics, Prentice Hall of India. New Delhi, 2001

MSE 2.5.1 Design of Tall Structures (Elective -II Course)

Hours per week			Scheme of Examination			
			Theory (Hrs)	Marks /Credits		
L	T	P		Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Design Principles and Loading**
   Design philosophy, loading, sequential loading, materials - high performance, concrete - fibre reinforced concrete - light weight concrete - design mixes. Gravity loading, wind loading, earthquake loading, effect of creep, shrinkage and p – delta, combination of loading-working stress design-limit state design-plastic design.

2. **Behaviour of Various Structural Systems**
   Factors affecting growth, height and structural form. High rise behaviour, rigid frames, braced frames, infilled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, futrigger - braced and hybrid mega systems.

3. **Structural Form and Modelling for Analysis**
   Structural form-braced frame structures-rigid frame structures-in filled frame structures-flat plate and flat slab structures-shear wall structures-wall frame structures-framed tube structures- outrigger braced structures-suspended structures-core structures-space structures-hybrid structures. Floor systems reinforced concrete one way slabs on beams and slabs on beams or walls-one way pan joists and beams one way slabs on beams and girders-two way flat plate-two way flat slab-waffle flat slabs-two way slab and beam. Floor systems-steel framing-one way beam system-two way beam system-three way beam system-composite steel-concrete floor systems.

4. **Analysis and Design**
   Modelling for approximate analysis, accurate analysis and reduction techniques, analysis of buildings as total structural system considering overall integrity and major subsystem interaction, analysis for member forces, drift and twist, computerized general three dimensional analysis.

5. **Structural Elements**

   Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow, design for differential movement, creep and shrinkage effects, temperature effects and fire resistance.

6. **Stability of Tall Buildings**

   Overall buckling analysis of frames, wall-frames, approximate methods, second order effects of gravity of loading, p-delta analysis, simultaneous first-order and p-delta analysis, translational, torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation.

Texts/References

1. Beedle. L. S., Advances in Tall Buildings, CBS Publishers and Distributors, Delhi, 1986.
2. Lin T.Y. and Stotes B. D., Structural Concepts and Systems for Architects and Engineers, John Wiley, 1988.
3. Smith B. S. and Coul A., Tall Building Structures - Analysis and Design, John Wiley and Sons, Inc., 1991.
4. Gupta Y. P., Proceedings of National Seminar on High Rise Structures- Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi,1995.
5. Taranath B. S., Structural Analysis and Design of Tall Buildings: Steel and Composite Construction, CRC Press, 2011.
6. Kheir K. and Ali M., The Future of the City: Tall Buildings and Urban Design, WIT Press, 2013.

MSE 2.5.2 Structural Design of Bridges
(Elective -II Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

Short Span RC Bridges: Types of bridges and loading standards - Choice of type - I.R.C. specifications for road bridges – Design of RCC solid slab bridges -analysis and design of slab culverts , Tee beam and slab bridges.

Design Principles of Long Span RC Bridges: Continuous girder bridges, box girder bridges, balanced cantilever bridges – Arch bridges – Box culverts.

Prestressed Concrete Bridges: Flexural and torsional parameters – Courbon's theory – Distribution co-efficient by exact analysis – Design of girder section – maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable Zone in girder – check for stresses at various sections – check for diagonal tension – Diaphragms – End block – short term and long term deflections.

Steel Bridges: General – Railway loadings – dynamic effect – Railway culvert with steel beams – Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners.

Bearings and Substructures: Different types of bearings – Design of bearings – Design of piers and abutments of different types – Types of bridge foundations – Design of foundations.

Reference Books

1. D. Johnson Victor - Essentials of Bridge Engineering Fifth Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
2. T.R. Jagadeesh, M.A. Jayaram - Design of Bridge Structures, Prentice-Hall of India
3. N. Krishna Raju - Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
4. David Lee – Bridge Bearings and Expansion Joints,E & FN Spon
5. V.K. Raina – Concrete Bridge Practice Analysis, design and Economics, Tata McGraw Hill
6. IRC Codes – IRC: 5, IRC: 6, IRC: 18, IRC: 27, IRC: 45, IRC: 78, IRC: 83
7. Joseph E. Bowles – Foundation Analysis and Design, McGraw-Hill International Edition
8. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, 2008.
9. Nainan P. Kurian – Design of Foundation Systems, Narosa Publishing House

MSE. 2.5.3 Design of Pre-stressed concrete structures (Elective -II Course)

Hours per week			Scheme of Examination			
				Marks /Credits		
L	T	P	Theory (Hrs)	Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Introduction to Pre-stressed Concrete**
   Basic concept and general principles of prestressed concrete, materials used and their properties, methods, technique of prestressing and system of prestressing, loss of prestress, historical perspective on prestressed concrete, basics of bridge design

2. **Analysis of Prestressed Concrete Section for Flexure**
   Loading stages and computation of section properties, critical sections under working loads for pretensioned and post-tensioned members, load balancing method of analysis of prestressed concrete beams.

3. **Design of Pre-Stressed Concrete Section for Flexure**
   General philosophy of design, design approaches in working stress method and limit state method, critical conditions for design, limit state of collapse in flexure, permissible stresses in concrete and steel.

4. **Analysis and Design of Pre-Stressed Concrete Members for Shear and Torsion**
   Calculation of principal tension under working load, permissible principal tension, shear strength calculation under limit state of collapse for both cracked and uncracked in flexure End zone stresses in pre-stressed concrete members:
   (i) Transfer of pre-stress in pre-tensioned members: Pretension transfer bond, transmission length, end zone reinforcement.
   (ii) Anchor zone stresses in post-tensioned members: stress distribution in end block, anchor zone reinforcement.
5. **Design of Prestressed Concrete Members**
   Design of simply supported pretensioned and posttensioned slabs and beams. introduction to application of prestressing to continuous beams and portal frames, linear transformation and concordancy of cables.

6. **Deflections of Prestressed Concrete Members**
   Importance of control of deflection, factors influencing deflection, short term and long term deflection. Deflection of simply supported beam.

7. **Innovative Trends in Prestressed Concrete Construction**
   Introduction to external prestressing, concept of extradosing in PC bridges, prestressed concrete earthquake resistance structure.

Texts/References

1. Evans R. H. and Bennett E. W., Prestressed Concrete, Champman and Hall, London, 1958.
2. Lin T. Y., Design of Prestressed Concrete Structures, John Wiley and Sons Inc., 1981.
3. Sinha N. C. and Roy S. K., Fundamentals of Prestressed Concrete, S. Chand and Co., 1998.
4. Krishna Raju, Prestressed Concrete, Tata McGraw Hill Publishing Co., 2000.
5. Rajagopalan N., Prestressed Concrete, Narosa Publications, New Delhi, 2008.
6. IS: 1343- 1980: Code of Practice for Prestressed Concrete.
7. IRC 112- 2011 Code of Practice for Concrete Road Bridges.
8. FIB Bulletin 51: Structural Concrete – Textbook on behaviour, design and performance, Volume I, November 2009.
9. FIB Bulletin 52: Structural Concrete – Textbook on behaviour, design and performance, Volume II, January 2010.
10. FIB Bulletin 53: Structural Concrete – Textbook on behaviour, design and performance, Volume III, December 2009.

MSE. 2.5.4 Design of Offshore Structures (Elective -II Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Wave Theories**
   Wave generation process, small and finite amplitude wave theories.

2. **Forces on Offshore Structures**
   Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

3. **Offshore Soil and Structure Modelling**
   Different types of offshore structures, foundation modeling, and structural modeling.

4. **Analysis of Offshore Structures**
   Static method of analysis, foundation analysis and dynamics of offshore structures.

5. **Design of Offshore Structures**
   Design of platforms, helipads, jacket tower and mooring cables and pipe lines.

Texts/References

1. Brebia C.A and Walker S., Dynamic Analysis of Offshore Structures, New Butterworths, U.K. 1979.
2. Dawson T. H., Offshore Structural Engineering, Prentice Hall Inc Englewood Cliffs, N.J. 1983.
3. Chakrabarti S. K. Hydrodynamics of Offshore Structures, Computational Mechanics Publications, 1987.
4. Reddy D. V. and Arockiasamy M., Offshore Structures, Vol.1 and Vol.2, Krieger Publishing Company, Florida, 1991.
5. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.

MSE. 2.5.4 Design of Offshore Structures (Elective -II Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Wave Theories**
   Wave generation process, small and finite amplitude wave theories.

2. **Forces on Offshore Structures**
   Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

3. **Offshore Soil and Structure Modelling**
   Different types of offshore structures, foundation modeling, and structural modeling.

4. **Analysis of Offshore Structures**
   Static method of analysis, foundation analysis and dynamics of offshore structures.

5. **Design of Offshore Structures**
   Design of platforms, helipads, jacket tower and mooring cables and pipe lines.

Texts/References

1. Brebia C.A and Walker S., Dynamic Analysis of Offshore Structures, New Butterworths, U.K. 1979.
2. Dawson T. H., Offshore Structural Engineering, Prentice Hall Inc Englewood Cliffs, N.J. 1983.
3. Chakrabarti S. K. Hydrodynamics of Offshore Structures, Computational Mechanics Publications, 1987.
4. Reddy D. V. and Arockiasamy M., Offshore Structures, Vol.1 and Vol.2, Krieger Publishing Company, Florida, 1991.
5. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.

MSE. 4.1.1 Experimental Methods in Structural Engineering (Elective -III Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Introduction to General Experimentation**
   Role and limitations, properties of engineering materials, failure due to excessive stresses, buckling, fatigue, creep, impact, testing machines for standard tests.

2. **Force and Strain Measurement**
   Strain measurements, types of strain gauges, electrical resistance strain gauges, cross sensitivity factor, gauge indicators, analysis of strains at a point, measurement of dynamic strains, galvanometer and oscilloscope, basic concept of model analysis, model materials and their properties, dimensional analysis, means of application of forces, means of measurement of forces and displacements, calculation of displacement in prototypes.

3. **Photo Elasticity**
   Basic concepts, stress optic laws, Isoclinic's, Isochromatics, Material fringe value, application to determination of stress in beams, rings and discs.

4. **Non-Destructive Methods of Testing of Concrete**
   Basic concepts in Ultrasonic Testing, Schmidt Hammer, Magnetometer. Determination of strength and quality of concrete using above mentioned method. Determination of corrosion/ carbonation in R.C member, reviews of various other Non-destructive techniques for determining quality of concrete, concept of condition survey of a structure, load testing of structures, codal provisions for load testing and Non-destructive testing of concrete structures.

Texts/References

1. Frocht M. M., Photoelasticity, John Wiley, 1941.
2. Dally J. W. and Riley W. F., Experimental Stress Analysis, McGraw Hill Book Co. 1977.
3. Srinath L., Raghavan. M., Ingaiah K., Gargesha G, Pant B. and Ramachandra K., Experimental Stress Analysis, Tata McGraw Hill Company, New Delhi, 1984.

4. Singh S., Experimental Stress Analysis, Khanna Publishers, New Delhi, 1996.
5. Bungy J. H. and Millard S. G., Testing of Concrete in Structures, Blackie Academic and Professional Glasglow 2010.
6. Ramesh K., Digital Photoelasticity- Advanced Techniques and Applications, Springer-Verlag, Heidelberg, New York, 2000.
7. Ramesh K., Experimental Stress Analysis, IIT Madras, India, 2009.
8. Ganesan T. P., Model Analysis of Structures, Universities Press (India) Ltd., Hyderabad, 2000.
9. Ramesh, K., Digital Photoelasticity: advanced techniques and applications, Volume 1, Springer-Verlag, 2000.
10. Ramarutham, Experimental Stress Analysis, Dhanpatrai and Publishers.
11. Malhotra V. M., and Carin Nicholas J., Handbook on Nondestructive Testing of Concrete, Second Edition, CRC Press, New York, 2006.
12. Guideline for Structural Condition Assessment of Existing Buildings: An ASCE Standard: SEI/ASCE 11-19, By American Society of Civil Engineers, Structural Engineering Institute. New York, 2000.

MSE 4.1.2 Structural Health Monitoring (Elective -III Course)

Hours per week			Scheme of Examination			
				Marks /Credits		
L	T	P	Theory (Hrs)	Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. Introduction - Definition of SHM - Motivation for structural health monitoring - Assessment by NDT equipment's.

2. Static Testing - Static field testing- types of static tests- loading methods - Behavioural / Diagnostic tests - Proof tests - Static response measurement – strain gauges, LVDTs, dial gauges - case study.

3. Dynamic field testing - Types of dynamic tests - Stress history data - Dynamic load allowance tests - Ambient vibration tests - Forced Vibration Method - Dynamic response methods - Impact hammer testing - Shaker testing - Periodic and continuous monitoring.

4. Data Acquisition - Static data acquisition systems - Dynamic data acquisition systems - Components of Data acquisition system - Hardware for Remote data acquisition systems.

5. Remote Structural health monitoring - Remote Structural Health Monitoring - Importance and Advantages – Methodology - RF/PSTN/GSM/Satellite Communications - Networking of sensor - Data compression technique - Case Studies

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, "Structural Health Monitoring", John Wiley and Sons, 2006.
2. Douglas E Adams, "Health Monitoring of Structural Materials and Components - Methods with Applications", John Wiley and Sons, 2007
3. J.P. Ou, H. Li and Z.D. Duan, "Structural Health Monitoring and Intelligent Infrastructure Vol-1", Taylor and Francis Group, London, U.K, 2006
4. Victor Giurglutiu, "Structural Health Monitoring with Wafer Active Sensors", Academic Press Inc., 2007

MSE 4.1.3 Design of Concrete Infrastructural and Industrial structures (Elective -III Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Introduction**
   Stress strain characteristics of concrete and reinforcing steel review of elastic theory, ultimate strength theory and limit state approach for design of structures. Review of resolution of structures into structural members. Review of load transfer mechanisms, redundancies and alternate load paths in structures.

2. **Design Methods**
   Introduction to the concept of limit design of structural components and yield line analysis of slabs and its application to the prevailing codes of practice. Study of limit states of collapse and serviceability. Application of these concepts to design of structural components.

3. **Design of High Rise Buildings**
   Criteria for design of high rise structures with or without basements. Input parameters for the structure and its foundation. Analysis, design and detailing of High Rise Buildings and their raft foundations using latest software tools available.

4. **Design of PT Slabs**
   Study of the behavior of flat slabs. Criteria for design of one/two way PT Slabs. Analysis, design and detailing of PT Slabs using software tools available.

5. **Design of Retaining Structures**
   Review of Retaining Wall and Water Tank Design principles. Design of Silos and Bunkers. Design and detailing of Retaining Walls of Basements of High Rise Structures.

6. **Design of Superstructure of Segmental Bridges**
   Principles of analysis, design and detailing of segmental bridges. Study of prevailing code provisions and their application. Analysis and design of the superstructure using software tools available.

Texts/References

1. Park R. and Paulay T., Reinforced Concrete Structures, John Wiley & Sons, 1975.
2. Purushothaman P., Reinforced Concrete Structural Elements, Tata McGraw-Hill, 1984.
3. Kong and Evans, Reinforce and Prestressed Concrete Structures, ELBS, 1995.
4. Nilson A. H., Design of Concrete Structures, McGraw-Hill, 1997.
5. Pillai S. U. and Menon D., Reinforced Concrete Design, Tata McGraw-Hill, 2003.
6. Varghese P. C., Advanced Reinforced Concrete Design, Prentice-Hall of India, 2005.
7. IS: 456-2000, Plain and Reinforced Concrete Code of Practice.
8. IRC: 6-2000 Standard Specifications and Code of Practice for Road Bridges, The Road Congress.
9. IS: 875(Part3)- 2007: Wind Loads on Buildings and Structures.
10. ACI 318:2008 – Building Code Requirements for Structural Concrete, American Concrete Institute, 2008.
11. Specification for Structural Steel Buildings, American Institute of Steel Construction, 2005.
12. Eurocode EN 1990:2002+A1 – Basis of structural design, 2002.
13. Eurocode 2 Part 1-1, BS EN 1992-1-1 Common Rules for Buildings and Civil Engineering Structures, The Institution of Structural Engineers, 2004.
14. Eurocode 3 Part 1-1, BS EN 1993-1-1 Design of Steel Structures General Rules and Rules for Buildings, The Institution of Structural Engineers, 2004

MSE.4.1.4 Construction Methods and Equipments (Elective -III Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Equipment Economics**
   Equipment records, Cost of Capital, Elements of ownership Cost, Operating Cost, Replacement Decisions, Rent and Lease Considerations
2. **Planning for Earthwork Construction**
   Planning, Graphical Presentation of Earthwork, Earthwork Quantities, Mass Diagram, Pricing Earthwork Operations.
3. **Compaction and Stabilization Equipment**
   Compaction of Soil and rock, Types of Compacting Equipment, Dynamic Compaction, Stabilizing soils with Lime, Cement Soil Stabilization
4. **Mobile Equipment**
   Power Requirements, Required Power, Available power, Usable power, Performance Charts. Dozers, Scrapers, Excavators - Introduction, Performance Characteristics of Dozers, Pushing Material, Land Clearing, Scraper types, operation, Performance Charts, Production cycle, Hydraulic Excavators, Shovels, Hoes.
5. **Trucks and Hauling Equipment**
   Finishing Equipment - Trucks, productivity, Performance Calculations, Graders, Trimmers.
6. **Concrete and Concrete Equipment,**
7. **Cranes, Piles and Pile-Driving Equipment,**
8. **Planning for Building Construction**
   Concrete Mixtures, Batching of Concrete, Placing of Concrete.

Reading:

1. Peurifoy R.L, Ledbetter W.B, and Schexnayder C, "Construction Planning Equipment and Methods ", 5th Edition, McGraw Hill, Singapore, 1995.
2. Sharma S.C, "Construction Equipment and Management ", Khanna Publishers, 1988

MSE.4.1.5 Earth Pressure and Retaining Structures (Elective -III Course)

Hours per week			Scheme of Examination			
L	T	P	Theory (Hrs)	Marks /Credits		
				Theory	TW/O	Total/Credits
4	-	-	3	100/4	50/2	150/6

1. **Earth Pressure**
   Types, Rankine's theory, backfill features - soil type, surface inclination, loads on surface, soil layers, water level, Coulomb's theory, effects due to wall friction and wall inclination, graphical methods, earthquake effects.
2. **Rigid Retaining Structures**
   Types, empirical methods, stability analysis.
3. **Flexible Retaining Structures**
   Types, material, cantilever sheet piles, anchored bulkheads - free earth method, fixed earth method, moment reduction factors, anchorage.
4. **Braced Excavation**
   Types, construction methods, pressure distribution in sands and clays, stability - bottom heave, seepage, ground deformation.
5. **Reinforced Soil Walls**
   Elements, construction methods, external stability, internal stability.
6. **Laterally Loaded Piles**
   Short and long piles, free head and fixed head piles, lateral load capacity of single piles, lateral deflection, elastic analysis, group effect, lateral load test, codal provisions.
7. **Underground Structures in Soils**
   Pipes, conduits, trenchless technology, tunneling techniques-cut-and-cover method, shield tunneling.

Texts/References

1. Poulos H. G. and Davis E. H., Pile Foundation and Design. John Wiley & Sons, 1988.
2. Shamsher P. and Sharma H. D., Pile Foundations in Engineering, Wiley-Interscience, 1990.
3. Bowles J. E., Foundation Analysis and Designs, McGraw-Hill Book Co. 1995.
4. Clayton C. R. I., Woods R. I. and Milititskv J., Earth Pressure and Earth Retaining Structures, Third Edition, Taylor & Francis, 1995.
5. Terzaghi K. and Peck R. B., Soil Mechanics in Engineering Practice, Wiley and Sons, 1996.
6. Chang Y. O., Deep Excavation: Theory and Practice. CRC Press, 2006.
7. Nayak N. V., Foundation Design Manual, Dhanpat Rai Publishing Co., 2002.

LAB COURSES

S.E 1.6 Structural Engg. Lab -I

Hours per week			Scheme of Examination		
			Marks /Credits		
L	T	P	Theory	TW/O	Total/Credits
-	-	8	-	50/2	50/2

PART-I

1. Design the Concrete Mix based on IS and ACI methods for various grades.
2. Study of stress-strain curve of concrete.
3. Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture
4. Understand the behavior of beams under flexural loading.
5. Assess the properties of concrete using Rebound Hammer and Ultrasonic Pulse Velocity instruments.

PART-II

Minimum 6 experiments to be conducted

1. Roots of an equation using Newton – Raphson method.
2. Experiments on Interpolation, Newton's Interpolation- Forward, Backward, Hermite Interpolation, Spline Interpolation - Cubic, Inverse Interpolation, and Extrapolation.
3. Structural engineering application of Interpolation techniques: Stress contours, etc.
4. Experiments on numerical differentiation and integration.
5. Structural engineering application of numerical differentiation and integration, estimation of pile capacity, etc.
6. Experiments on curve fitting and errors.
7. Structural engineering applications of curve fitting and errors.
8. Solution of linear simultaneous equations using Gauss elimination.
9. Matrix inversion using GJ method
10. Linear regression line of given points.
11. Curve fitting using Polynomial Regression.
12. Eigen value extraction power method

Using MATLAB/ MATHCAD/ SCILAB/ FORTRAN/ C++.

S.E 2.6 Structural Engg. Lab -II

Hours per week			Scheme of Examination		
			Marks /Credits		
L	T	P	Theory	TW/O	Total/Credits
-	-	8	-	50/2	50/2

PART I

Minimum 5 experiments to be conducted

1. Evaluation of material properties (Modulus of elasticity E and Poisson's ratio μ) of metals using strain gauge.
2. Evaluation of bending moments in a cantilever beam using strain gauge transducer application.
3. Evaluation of torsional moments in a shaft using strain gauge transducer application.
4. Use of Schmitz hammer to estimate in-situ strength of concrete and estimate of depth of carbonation.
5. Use of UPV to estimate, E value, quality / density of concrete.
6. Use of half-cell potentiometer to estimate corrosion potential in RCC element.
7. Load test of RCC flexural elements.
8. Evaluation of bulking load of columns.

PART II

CAD in Structural Engineering

9. Spreadsheet concepts – Worksheet calculations in Civil Engineering –Regression & Matrix Inversion
10. Computer methods of Structural Analysis - Finite Element programming - Analysis through application packages. Like STAADPro and ANSYS
11. Design of Steel and RC Building Structures using application packages