

Curriculum Structure and Curriculum Content for the Academic year 2023-2025

School of Civil Engineering

Program: M.Tech. -Structural Engineering
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Vision and Mission of KLE Technological University

Vision

KLE Technological University will be a national leader in Higher Education—recognised globally for innovative culture, outstanding student experience, research excellence and social impact.

Mission

KLE Technological University is dedicated to teaching that meets highest standards of excellence, generation and application of new knowledge through research and creative endeavors.

The three-fold mission of the University is:

- To offer undergraduate and post-graduate programs with engaged and experiential learning environment enriched by high quality instruction that prepares students to succeed in their lives and professional careers.
- To enable and grow disciplinary and inter-disciplinary areas of research that build on present strengths and future opportunities aligning with areas of national strategic importance and priority.
- To actively engage in the Socio-economic development of the region by contributing our expertise, experience and leadership, to enhance competitiveness and quality of life.

As a unified community of faculty, staff and students, we work together with the spirit of collaboration and partnership to accomplish our mission.

Vision and Mission Statements of the School / Department

Vision

To be the most preferred branch of engineering through the highest order of excellence in teaching-learning and research with social commitment and responsibility.

Mission

- To create an outstanding learning experience through rigorous curriculum of theory and practice that develops students' technical and professional skills to succeed in a wide range of careers.
- To Continually advance research through a culture of discovery, creativity, and innovation to benefit humankind
- To serve as highly capable resources to society, the profession through professional organizations, consultancy and continuing education.

Program Educational Objectives/Program Outcomes and Program-Specific Objectives

Program Educational Objectives -PEO's
Conceive, realize and design civil engineering infrastructure that is the backbone of growth and prosperity of mankind.
Plan, construct and maintain the built environment meeting the demands of humanity.
Assess the impact of civil engineering activities on economy, environment and society at large.
Work in team with moral, ethical and professional responsibilities.
Cultivate the aptitude for continuous learning and learn to adapt to the changing needs of the society.
Program Outcomes-PO's
Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.
Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member

and leader in a team, to manage projects and in multidisciplinary environments.

Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Objectives -PSO's

Proficiency in a specialized area: Demonstrate proficiency in one of the following specialized areas of Civil Engineering i) Construction Materials and Management ii) Structural and Geotechnical Engineering iii) Environmental, water resources and Transportation Engineering

Ability to apply principles of civil engineering for the entire life cycle of the project ranging from initial design to the closure of the project.

Ability to identify and analyze various properties of construction materials and their applications in design and construction of various structures.

Curriculum Structure-Overall

Course with course code	I	II	III	IV
	Theory of Elasticity (4-0-0)	Design of Tall Structures (4-1-0)	Internship/Industrial Training(0-0-8)	Major Project/Project Work Phase II (0-0-20)
	Structural Dynamics (4-1-0)	Finite Element Method (4-0-0)	Minor Project/Project Work Phase I (0-0-10)	
	Design of SpecialRC Structures (4-1-0)	Stability of Structures (4-0-0)		
	Numerical Methods and Programming (4-0-0)	Program Elective-1 (4-0-0)		
	Design of Bridges (4-0-0)	Program Elective-2 (4-0-0)		
	Program Elective (4-0-0)	Structural Simulation Laboratory (0-0-1)		
	CAAD Lab (0-0-2)	Design Project 2-0-1		
	Recent Topics onTechnology Trends (1-0-0)			
	Credits	25	18	20

Curriculum
Structure-Semester wise
Semester - I

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1.	20ESEC701	<u>Theory of Elasticity</u>	PC	4-0-0	4	04	50	50	100	3 hours
2.	20ESEC702	<u>Structural Dynamics</u>	PC	4-1-0	5	06	50	50	100	3 hours
3.	15ESEC703	<u>Design of Special RC Structures</u>	PC	4-1-0	5	06	50	50	100	3 hours
4.	19ESEC701	<u>Numerical Methods and Programming</u>	PC	4-0-0	4	04	50	50	100	3 hours
5.	-	Program Elective	PE	4-0-0	4	04	50	50	100	3 hours
6.	15ESEP701	<u>Computer Aided Analysis and Design Laboratory</u>	PC	0-0-2	2	04	80	20	100	3 hours
7.	15ESET701	Recent Topics on Technology Trends	PC	1-0-0	1	01	100	-	100	-
TOTAL				21-2-2	25	29				

Semester - II

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1.	22ESEC701	<u>Design of Tall Structures</u>	PC	4-1-0	5	06	50	50	100	3 hours
2.	20ESEC705	<u>Finite Element Method</u>	PC	4-0-0	4	04	50	50	100	3 hours
3.	20ESEC706	<u>Stability of Structures</u>	PC	4-0-0	4	04	50	50	100	3 hours
4.	-	Program Elective-I	PE	4-0-0	4	04	50	50	100	3 hours
5.	-	Program Elective-II	PE	4-0-0	4	04	50	50	100	3 hours
6.	18ESEP701	<u>Structural Simulation Laboratory</u>	PC	0-0-1	1	02	80	20	100	3 hours
7.	19ESEP702	<u>Design Project</u>	PC	2-0-1	3	03	50	50	100	3 hours
TOTAL				22-1-2	25	27				

Semester- III

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1.	21ESEI801	Internship	PW	0-0-8	8	8	50	50	100	3 hours
2.	21ESEW801	Minor Project	PW	0-0-10	10	10	50	50	100	3 hours
		TOTAL		0-0-18	18	18				

Semester- IV

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	19ESEW802	MajorProject/Project Work Phase II*	PW	0-0-20	20	20	50	50	100	3 hours
		TOTAL		0-0-20	20	20				

List of Program Electives

Sr.No	Name of the Course	Course Code
1.	<u>Design of Bridges</u>	18ESEE701
2.	<u>Advanced Materials of Construction</u>	15ESEE702
3.	<u>Fire Resistance of Structures</u>	20ESEE701
4.	<u>Theory of Plates and Shells</u>	20ESEE702
5.	<u>Design of Industrial Steel Structures</u>	15ESEE703
6.	<u>Structural Reliability</u>	15ESEE704
7.	<u>Mathematical Thinking and Logical Reasoning</u>	15ESEH701
8.	<u>Design of Foundations</u>	15ESEE706
9.	<u>Structural Optimization</u>	15ESEE707
10.	Principles and Practices of Engineering Education	15ECRC701
11.	<u>Structural Health Monitoring</u>	20ESEE703

Curriculum Content- Course wise

Program: Master of Technology (Structural Engineering)		Semester: I
Course Title: Theory of Elasticity		Course Code:20ESEC701
L-T-P: 4-0-0	Credits: 04	Contact Hours:50
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:04	Examination Duration: 3Hrs	
Unit I		
1.Stress		
Introduction, Continuum, Stress at a point, Stress components in rectangular and cylindrical coordinates; Equilibrium equations; Stress on an oblique plane; Stress transformation; Stress invariants, Principal stresses and principal planes; Deviatoric stresses; Maximum shear stresses; Octahedral stresses		
		10 hrs
2. Strain		
Strain at a point, notations, geometrical interpretation of strain; Strain- deformation relations; Strain compatibility equations; Strain transformation; Strain invariants, Principal strains and Principal planes; Deviatoric strains; Octahedral strains		
		06 hrs
3. Stress Strain Relations		
Linearity and nonlinearity – material, geometric, contact, Stress strain relations for an isotropic material; Plane stress and Plane strain problems; Stresses in terms of displacements; Equilibrium equations in terms of displacements; Compatibility equations in terms of stresses; St. Venant's principle		
		04 hrs
Unit II		
4. Two Dimensional Problems in Rectangular Coordinates		
Airy's stress function; Bi harmonic equation for plane stress and plane strain; Polynomial stress functions; Cantilever beam subjected to load at the free end – stresses and displacements; Simply supported beam subjected to uniformly distributed load – stresses and displacements		
		06 hrs
5. Two Dimensional Problems in Polar Coordinates		
General equations in polar coordinates; Transformation from rectangular to polar coordinates; Bi harmonic equation; Axisymmetric problems – Thick cylinder subjected to radial pressure, Rotating disk; Non-axisymmetric problems – Plate with a circular hole, Concentrated force at a point of a straight boundary.		
		08 hrs
6. Torsion of Prismatic Bars		
Assumptions, St. Venant's solution; Prandtl's solution; Torsion of bars with different sections – elliptic, equilateral sections; Membrane analogy method; Torsion of narrow rectangular sections; Torsion of thin walled sections		
		07 hrs
Unit III		
7. Theories of Failure		
Mechanism of plastic deformation; Theories of failure – Maximum principal stress, Maximum shearing stress, Maximum elastic strain, Octahedral shearing strain, Maximum elastic energy, Energy of distortion; Significance of the theories of failure; Use of factor of safety in design; Mohr's theory of failure; Stress space and strain space.		
		09 hrs

Text Books

- 1 Timoshenko, S.P. and Goodier, J.N., Theory of Elasticity, 3ed. McGraw- Hill Book Co., New York, 2017.
- 2 Valliappan, S., Continuum Mechanics Fundamentals, Oxford & IBHPublishing Co., New Delhi, 1981.
Srinath, L.S., Advanced Mechanics of Solids, 3ed., Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2017.

Reference Books:

1. Boresi, A.P., Sidebottom, O.M., Seely, F.B. and Smith, J.O., Advanced Mechanics of Materials, 4ed. John Wiley & Sons,, New York, 1985.
2. Sadd, M.H., Elasticity – Theory, Applications and Numeric, Academic Press, 2014.

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Program: Master of Technology (Structural Engineering)		Semester: I
Course Title: Structural Dynamics		Course Code:20ESEC702
L-T-P: 4-1-0	Credits: 3	Contact Hours: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours:50	Examination Duration: 3hrs	
Unit I		
1. Introduction Nature of dynamic forces, Sources of vibration; Mathematical modelling; Elements of vibrating systems and their characteristics, Equivalent properties of combination of elements; Equation of motion by D'Alembert's principle, Principle of virtual displacements, Rayleigh's energy method; Classification of vibration 05 hrs		
2.Free Vibration of SDOF Systems Equation of motion; Response of undamped and damped SDOF systems; Critical damping; Logarithmic decrement – single and multiple cycles; Energy dissipation 06 hrs		
3.Harmonically Excited Vibration of SDOF Systems Equation of motion; Response of damped SDOF systems to harmonic excitation, Steady-state response; Dynamic amplification factor; Quality factor and bandwidth, Half-power bandwidth method for estimation of damping; Response to harmonic displacement of support; Response of a system under rotating unbalance. 08 hrs		
Unit II		
4. Vibration of SDOF Systems under Arbitrary Excitation Impulse, Unit impulse, Response of a SDOF systems subjected to unit impulse; Response to arbitrary excitation – Duhamel integral; Response and response spectrum of undamped SDOF systems for selected forces – Step force, Time delayed step force, Rectangular pulse, Linear force, Blast load, Triangular pulse; Direct integration methods – Constant average acceleration and Linear acceleration methods; Newmark method 09 hrs		
5. Multi Degree of Freedom Systems Undamped free vibration of two degree of freedom systems – equations of motion, characteristic equation, natural frequencies and mode shapes; Matrix form of equations of motion, Eigenvalue problem; Orthogonality of normal modes; Ortho normalization of normal modes; Free vibration of MDOF systems for given initial conditions; Forced vibration of MDOF systems; Modal analysis equation; Material and modal damping 09 hrs		
Unit III		
6.Continuous Systems Equation of motion; Undamped free vibration of beams with different support conditions – Simply supported, Cantilever, Propped cantilever and Fixed beams. 05 hrs		
7.Vibration Control State space formulation, structural control systems – passive, semi-active, active & hybrid systems with numerical problems for SDOF only. 08 hrs		
Text Books 1.Rao, S.S., Mechanical Vibrations, 5ed., Addison-Wesley Publishing Co., Reading, Massachusetts, 2010. 2.Paz, M., Structural Dynamics, 4ed., CBS Publishers & Distributors, New Delhi, 1997		

3. Chopra, A.K., Dynamics of Structures, 4ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2011.
4. Craig, R.R., Structural Dynamics – An Introduction to Computer Methods, John Wiley & Sons, New York, 1983.
5. Thomson, W.T. and Dahleh, M.D., Theory of Vibration, with applications, 5ed., Pearson Education Inc., 2008.

Reference Books:

1. IS:1893-2002 (Part 1), Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi, 2002.
2. IS:13920-1993, Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, Bureau of Indian Standards, New Delhi, 1993.
3. IS:4326-1993, Earthquake Resistant Design and Construction of Buildings – Code of Practice, Bureau of Indian Standards, New Delhi, 1993

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Program: Master of Technology (Structural Engineering)		Semester: I
Course Title: Design of Special RC Structures		Course Code:15ESEC703
L-T-P: 4-1-0	Credits: 5	Contact Hours:4hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours:50	Examination Duration: 3hrs	
Unit I 1.Design of Special Type of Slabs Introduction to Design of waffle slab, grid floor, sunken slab and difference in structural behaviour among them. Advantages of grid floors over conventional slab designs, Design of grid floor by approximate methods as per IS 456-2000 code provisions 10 hrs 2. Design of Continuous Beams Introduction to RCC Continuous beam, Design of continuous beams by Is 456-2000 code provisions, Using SP 16 Charts and considering redistribution moments 10 hrs		
Unit II 3.Design of Curved Beams Introduction to curved beams, Analysis of bending and torsional moments in circular beams, Moments in, Design of RCC circular beams, Design of RCC semi-circular beam supported on three columns equally spaced 10 hrs 4.Design of Bunkers and Silos Introduction to storage structures, Difference between bunkers and Silos, Parts of square and rectangle bunkers, Analysis and design of square or rectangular bunkers, Analysis and design of circular bunkers, Design examples for above bunkers. Design of silos for storage of cement, Parts of chimney and design factors, Design examples 10 hrs		
Unit III 5. Yield Line Analysis of Slabs Introduction to Yield line analysis of slabs, Assumptions, Characteristics and features of yield lines, Sign conventions for yield lines, Yield line patterns, Moment capacity across yield lines, Ultimate loads on slabs, analysis of yield lines by virtual work and equilibrium methods, Design flat slab using yield line theory 10 hrs		
Text Books 1. Bhavikatti, S. S., Advance R.C.C. Design (R.C.C. Volume-II), Vikas Publishing House PVT., Ltd., New Delhi, 2008. 2. Dr. Krishna Raju, N., Design of Reinforced Concrete Structure (IS: 456-2000), 2ed., CBS Publishers and Distributors, New Delhi, 2010		
Reference Books: 1. Jain, A.K., Reinforced Concrete, New Chand and Bros, Roorkee, 1993. 2. Pillai, U and Menon, D., Design of Concrete Structures, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011. 3. Mac Gregor, Mechanics Analysis and Design, Tata McGraw Hill Publishing Company Limited, New Delhi.1970.		

Program: Master of Technology (Structural Engineering)		Semester: I
Course Title: Numerical Methods and Programming		Course Code: 15ESEC703
L-T-P: 4-0-0	Credits: 4	Contact Hours: 6hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 3hrs	
Unit I 1. Modelling, Computers and Error Analysis Mathematical modelling, Analytical and numerical solutions, Computer programs, Algorithms, flow charts, Approximations, Round-off errors, Accuracy and precision, Machine epsilon 04 hrs 2. Linear Algebra Systems of linear algebraic equations, Uniqueness of solution, Ill-conditioned systems, Direct methods – Gauss elimination method, Gauss-Jordan method, LU decomposition by Crout method and Cholesky method; Iterative methods – Gauss Seidel method; Determinants and matrix inversion. 10 hrs		
Unit II 3. Design of Curved Beams Introduction to curved beams, Analysis of bending and torsional moments in circular beams, Moments in, Design of RCC circular beams, Design of RCC semi-circular beam supported on three columns equally spaced 10 hrs 4. Design of Bunkers and Silos Introduction to storage structures, Difference between bunkers and Silos, Parts of square and rectangle bunkers, Analysis and design of square or rectangular bunkers, Analysis and design of circular bunkers, Design examples for above bunkers. Design of silos for storage of cement, Parts of chimney and design factors, Design examples 10 hrs		
Unit III 5. Yield Line Analysis of Slabs Introduction to Yield line analysis of slabs, Assumptions, Characteristics and features of yield lines, Sign conventions for yield lines, Yield line patterns, Moment capacity across yield lines, Ultimate loads on slabs, analysis of yield lines by virtual work and equilibrium methods, Design flat slab using yield line theory 10 hrs		
Text Books 1. Bhavikatti, S. S., Advance R.C.C. Design (R.C.C. Volume-II), Vikas Publishing House PVT., Ltd., New Delhi, 2008. 2. Dr. Krishna Raju, N., Design of Reinforced Concrete Structure (IS: 456-2000), 2ed., CBS Publishers and Distributors, New Delhi, 2010		
Reference Books: 1. Jain, A.K., Reinforced Concrete, New Chand and Bros, Roorkee, 1993. 2. Pillai, U and Menon, D., Design of Concrete Structures, Tata McGraw Hill Publishing		

Company Limited, New Delhi, 2011.

3. Mac Gregor, Mechanics Analysis and Design, Tata McGraw Hill Publishing Company Limited, New Delhi.1970.

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Course Title: Computer Aided Analysis and Design Lab		Course Code: 15ESEP701
L-T-P: 0-0-2	Credits: 2	Contact Hours: 4hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 48	Examination Duration: 3hrs	
1. Structural Analysis using SAP software a. Introduction to SAP 2000 user interface. b. Modelling and analysis of RC framed building including interpretation of results using SAP2000 c. Modelling and analysis of steel industrial frame including interpretation of results using SAP2000 d. Modelling and analysis of structures using OpeSees		12hrs
2. RC Design using MS Excel a. Design of singly reinforced rectangular beam section. b. Design of doubly reinforced rectangular beam section. c. Design of singly reinforced T- beam section. d. Design of column subjected to axial compression and uniaxial bending. e. Design of isolated footing. f. Design of Cantilever retaining wall. g. Design of Counterfort retaining wall. h. Design of Intz water tank.		36 hrs
Reference Books: <ol style="list-style-type: none"> 1. Computers and Structures Inc., Getting Started with SAP 2000 2. Computers and Structures Inc., CSI Analysis Reference Manual for SAP 2000, ETABS and SAFE 3. Computers and Structures Inc., Introductory Tutorial for SAP 2000 4. Jain, A.K. Reinforced Concrete Limit State Design, 7ed., Nemi Chand & Bros., Roorkee, 2012 		

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Program: M.Tech. Structural Engineering		Semester: II
Course Title: Design of Tall Structures		Course Code: 22ESEC701
L-T-P: 4-2-0	Credits: 05	Contact Hours: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 04	Examination Duration: 3Hrs	
Unit I 1. Introduction 10 Hrs Design philosophy, loading, sequential loading, materials and design mixes. Loading and Movement: Gravity loading: Dead and live load, methods of live load reduction, Impact, Gravity loading, Construction loads. 2. Structural Systems 10 Hrs Factors affecting growth, Height and structural form; High rise behavior, Rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall frames, tubular, cores, Outrigger –braced and hybrid mega system.		
Unit II 3. Lateral Load Estimation 09 Hrs Static and dynamic approach, Analytical and wind tunnel experimentation method for wind. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading. 4. Analysis and Design 11 Hrs Modeling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift and twist, computerized general three dimensional analyses.		
Unit III 5. Stability of Tall Buildings 07 Hrs 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. Structural elements: sectional shapes, properties and resisting capacities, design, deflection, cracking, pre-stressing, shear flow. Design for differential movement, creep and shrinkage effects, temperature effects and fire. 6. Disaster Management 03 Hrs Techno legal aspect, techno-legal and techno-financial work; Model town and country planning legislation, land use zoning regulations, development control regulations and building bye-laws; Registration, qualification and duties of professionals, disaster response policy, effects of building services.		
Text Books: 1 B. S. Taranath, <i>Structural Analysis and Design of Tall Buildings</i> , 2nd ed. New York, NY, USA: McGraw Hill, 2016. 2 W. Schueller, <i>High Rise Building Structures</i> , 2nd ed. New York, NY, USA: John Wiley, 2020.		
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- 3 B. S. Smith and A. Coll, *Tall Building Structures: Analysis and Design*, 2nd ed. New York, NY, USA: John Wiley, 2010.
- 4 T. Y. Lin and D. Stotesbury, *Structural Concepts and Systems for Architects and Engineers*, 3rd ed. New York, NY, USA: John Wiley, 2014.
- 5 L. S. Beedle, *Advances in Tall Buildings*, 2nd ed. New Delhi, India: CBS Publishers and Distributors, 2018.
- 6 Y. P. Gupta, *Proceedings of the National Seminar on High Rise Structures: Design and Construction Practice for Middle Level Cities*, 2nd ed. New Delhi, India: New Age International Limited, 2015.

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Program: M.Tech. Structural Engineering		Semester: II
Course Title: Finite Element Method		Course Code: 20ESEC705
L-T-P: 4-0-0	Credits: 04	Contact Hours: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 04	Examination Duration: 3Hrs	
Unit I		
1. Overview of Matrix Method of Structural Analysis		08 Hrs
Development of stiffness matrices with reference to system and element coordinates for different types of elements. Analysis of continuous beams.		
2. Introduction to Finite Element Method		02 Hrs
Introduction, Basic concepts on finite element analysis, Introduction to nodes, elements, and shape functions, Steps in Finite Element Analysis, Key concepts and Terminologies.		
3. Element Properties		05 Hrs
Natural Co-ordinates, Triangular Elements, Rectangular Elements, Introduction to weighted integrals, Integration by parts- Review, Gradient and Divergence Theorems, Functions.		
4. Finite Element Formulation Technique		05 Hrs
Virtual work and variational principle (Rayleigh-Ritz Method), Weighted integrals and weak formulation, different types of weighted integral methods such as Galerkin Method, Petrov-Galerkin Method, Collocation Method, and Method of Least-squares.		
Unit II		
5. Second order boundary value problem		10 Hrs
FEA formulation of second order boundary value problem, development of element level equations, Assembly of element level equations and implementation of boundary conditions, Assembly process and Connectivity matrix.		
6. Applications of second order boundary value problem		10 Hrs
Radially symmetric problems, one dimensional heat transfer problem, Euler-Bernoulli beam, Shear deformable beam, Plane Frame elements, Eigenvalue problem's, Introduction to time dependent problems.		
Unit III		
7. Computer Implementation		10 Hrs
Structure of FEM program for FEM analysis, Description of different modulus in FEM software (ABAQUS), Introduction to different types of analysis, Pre- and post-processing. Comparison of manually solved problems with software results.		
Text Books:		
1 Reddy J.N., An Introduction to Finite Element Method, 3ed., McGraw- Hill Publishing Company Inc, New York, 2017.		
2 Krishnamoorthy C. S., Finite Element Analysis, Tata McGraw-Hill Education Pvt. Ltd, New Delhi, 2004.		
3 Bhavikatti, S.S., Structural Analysis Volume-I and II, Vikas Publishing House Pvt. Ltd., Bangalore, 2003.		

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Program: M.Tech. Structural Engineering		Semester: II
Course Title: Stability of Structures		Course Code: 20ESEC706
L-T-P: 4-0-0	Credits: 04	Contact Hours: 50
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 04	Examination Duration: 3Hrs	
Unit I		
1. Introduction to Stability of Structures		04 Hrs
Basic definitions of stability, Methods of solution, Rigid body assemblages with one and two degrees of freedom.		
2. Buckling of axially loaded members		06 Hrs
Buckling loads for members with different end conditions: hinged-hinged, fixed-free, fixed-hinged, fixed-fixed; Struts with elastic supports, Framed columns, Portal frames: columns hinged at the base, columns fixed at the base.		
3. Stability of Beam Columns		10 Hrs
Basic equation of equilibrium, Beam-column with concentrated loads, Beam column with an interior moment, Beam-column subjected to distributed loads.		
Unit II		
3. Stability of Frames		12 Hrs
Stability functions – distinct and auxiliary stability functions; Stability stiffness influence coefficients, Stiffness matrix including axial force effects, Critical load for frames without sidesway; Critical load for frames with sidesway.		
4. Energy Criteria and Energy Based Methods		08 Hrs
Energy criterion; Timoshenko's method; Rayleigh-Ritz method; Galerkin method.		
Unit III		
5. Buckling of Members having Open Sections		10 Hrs
Shear centre; Torsional buckling – members subjected to torsion, members subjected to axial force; Lateral buckling of beams – torsional buckling due to flexure, torsional buckling due to flexure and axial force; Lateral buckling of beams subjected to lateral loads – cantilever beam, simply supported beam.		
Text Books:		
<ol style="list-style-type: none"> 1 Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, 2ed., McGraw Hill Book Co., New York, 1961. 2 Simites, G.J. and Hodges, D.H., Fundamentals of Structural Stability, Butterworth & Heinemann, 2006. 3 Gambhir, M.L., Stability Analysis and Design of Structures, Springer, 2009. 4 ManickaSelvam, V.K., Elements of Matrix and Stability Analysis of Structures, 6ed., Khanna Publishers, New Delhi, 2004. 5 Srinath, L.S., Advanced Mechanics of Solids, 3ed., Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2017. 		

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Program: M.Tech Structural Engineering		Semester: II
Course Title: Structural Simulation Lab		Course Code: 18ESEP701
L-T-P: 0-0-2	Credits: 02	Contact Hours: 4hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 30	Examination Duration: 3Hrs	

Demonstrations

1. Introduction to Ansys modeling, material properties, meshing and element types.
2. Introduction to Loading, Boundary conditions and post processing.

Experiments

1. Compute the Shear force and bending moment diagrams for the beam loaded centrally with concentrated load and find the maximum deflection. Assume rectangular c/s area of 100 mm * 100mm, Young's modulus of 210 MPa, Poisson's ratio 0.27.
2. Compute the Shear force and bending moment diagrams for the 3D beams, with concentrated loads, UDL, Direct Moment and UVL and find the maximum deflection. Assume rectangular c/s area of 100 mm * 100mm, Young's modulus of 210 MPa, Poisson's ratio 0.27.
3. Analysis of Reinforced Concrete beam subjected to concentrated loading at center with different boundary conditions.
4. Determine the nodal deflections, reaction forces, and stress for the truss system shown below ($E = 200\text{GPa}$, $A = 3250\text{mm}^2$).
5. Analyse the plate of 20mm thick with circular hole at the centre of the plate with 3D element, the dimensions of the plate are 150mmX100mm and circular hole is of the diameter 10mm. Determine the stress concentration at preferred points.
6. Analyze a 2D portal frame subjected to mechanical loading as shown in the lab session and arrive at stress resultants and deflections at preferred points.
7. A pipe of 100mm external dia. And 20mm thickness carries water at a pressure of 20MPa. Determine the maximum and minimum intensities of hoop stresses in the section of pipe. Also plot the variation of hoop and radial stresses across the thickness of pipe. Case a) Solid rotating disc Case b) Hollow rotating disc
8. Obtain the first ten natural frequencies of the Fixed-Fixed beam shown in figure and compare them with theoretical values. Also plot their mode shapes, Modulus of elasticity, $E = 2.068 \times 10^{11} \text{ N/m}^2$, Poisson's ratio = 0.3, Density = 7830 Kg/m^3

Text Books:

- 1 Introduction to Finite Element Analysis Using ANSYS by S. Moaveni, 3rd ed., Pearson, 2014.
- 2 Finite Element Analysis: Theory and Application with ANSYS by S. M. Moaveni, 4th ed., Pearson, 2015.
- 3 The Finite Element Method and Applications in Engineering Using ANSYS by E. Madenci and I. Guven, 2nd ed., Springer, 2015.
- 4 Practical Finite Element Analysis by N. S. Gokhale, S. S. Deshpande, S. V. Bedekar, and A. N. Thite, 1st ed., Finite to Infinite, 2008.

- 5 ANSYS Workbench 2021: A Tutorial Approach by S. Tickoo, 1st ed., CADCIM Technologies, 2021.

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Program: M. Tech Structural Engineering		Semester: II
Course Title: Design Project		Course Code: 19ESEP702
L-T-P: 0-0-	Credits:	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3hrs	
<p>Collection of information: Geotechnical details such as strata, depth of foundation etc. Approved architectural drawings showing different floor plans, elevations, section at critical locations and working drawings of stairs. Materials to be used in construction, such as floor finish, weather proof course, partition walls, false ceiling etc. The type of loads, gravity loads, wind and earth quake loads etc. Types of Lifts and capacity of lifts. Loads due to water tanks. Building services such as a/c ducting.</p> <p>Analysis of Buildings: Modelling of a single storey building; Modelling of a multi-storeyed building (Assigning of member properties, Sizes, Supports, and Orientation etc.) Creating of various loads/load Combinations and assigning. Analysis of building models. Printing support reactions, forces on various members. Printing deflected shapes of buildings and Building model etc.</p> <p>Design of Building Components: Preparation of Excel sheets for the design of beam; (i) Singly reinforced rectangular beam (ii) Doubly reinforced beam (iii) T-Beam (iv) L-Beam, Column; (i) Design of Short Columns (ii) Design of Long Columns, Design of footings; (i) Isolated footings (ii) Combined footings and Design of slabs. Preparation of sketches showing the reinforcement details of the above components.</p> <p>Functional and architectural design of a building from, but not restricted to one of the following category: Educational institutions, Administration buildings, Industrial buildings, Commercial buildings, Public facilities such as bus terminus, rail station, hospitals, cinema halls, auditorium etc.</p> <p>Expected Deliverables: Identify project details, structural design drawings and calculations.</p>		
Reference Books: <ol style="list-style-type: none"> 1. Jain, A.K., <i>Reinforced Concrete Limit State Design</i>, Nem Chand and Brothers, Roorkee, 2. Swami Saran, <i>Analysis and Design of Substructures – Limit State Design</i>, 2ed., Oxford & IBH Publishing Co., 2006. 3. Varghese, P.C., <i>Design of Reinforced Concrete Foundations</i>, PHI Learning, 2009. 4. IS 875(Part 1):1987 Code of practice for design loads (other than earthquake) for buildings and structures – Dead loads, Bureau of Indian Standards, New Delhi 5. IS 875(Part 2):1987 Code of practice for design loads (other than earthquake) for buildings and structures – Imposed loads, Bureau of Indian Standards, New Delhi 6. IS 456:2000 Plain and reinforced concrete – Code of practice, Bureau of Indian Standards, New Delhi 7. IS 1893 (Part 1):2016, Criteria for earthquake resistant design of structures – General provisions and buildings, Bureau of Indian Standards, New Delhi 		

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Program: M. Tech Structural Engineering		Semester: II
Course Title: Design of Bridges		Course Code: 18ESEE701
L-T-P: 4-0-0	Credits: 5	Contact Hours: 6hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 3hrs	
Unit – I 1.Introduction Historical development of Bridges, site investigations, types of bridges and their suitability 3 hrs 2.Bridge Loadings Loads and stresses- various loads to be considered while designing bridges. IRC Loading standards. Impact factor., International bridge standards. ILD for SF and BM under moving loads 3 hrs 3.Design of Solid Deck slab bridges Design of Solid deck slab bridge, MOST standard drawings 8 hrs 4.Culverts Types of culverts, Design of box culvert for IRC class loading. 6 hrs		
Unit II 1. Design of T - beam bridge Design of T -beam bridge for class AA tracked vehicle Design of interior deck slab panel by Piegaude' s theory. Design of longitudinal girder by Courbon's theory, approximate design of cross girder. Drawing of T -Beam bridge for given site particulars. 14hrs 2. Rigid Frame Bridges Design of rigid frame bridges 6 hrs		
Unit III 1. Prestressed Concrete Bridges Concept of Prestressing, Advantages of PSC bridges, Design of PSC bridges (Rectangular and I –sections), Cable profiles, Stress calculations, Design of End blocks, 10 hrs		
Text Books 1. Victor, D.J. Essentials of Bridge Engineering, Oxford - IBH Publishers, New Delhi, 2006. 2. Krishna Raju, N., Design of Bridges, Oxford - IBH Publishers, New Delhi, 2007.		
Reference Books: 1. Jagadish, T.R. and Jayaram, M.A. Design of Bridge Structures, Prentice Hall of India, New Delhi, 2006. 2. Rajagopalan, N., Bridge Superstructure, Narosa Publishers, New Delhi, 2006.		

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Program: Master of Technology (Structural Engineering)		Semester: I
Course Title: Advanced Materials of Construction		Course Code: 15ESEE702
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 3hrs	
Unit – I 1. Microstructure of Concrete Concrete making materials- cement, aggregates, admixtures (both mineral and chemical). Microstructure of concrete, Fresh concrete and its rheology, Mechanical, deformational behaviour of hardened concrete. Laboratory testing of Concrete. Creep and Shrinkage of Concrete.		
		20 hrs
Unit II 2. Special type of Concrete and their properties Proportioning of Mixes- Normal Concrete, High Strength/Performance Concrete, Roller Compacted Concrete, Self-Compacting Concrete and Reactive Powder Concrete. Durability of Plain and Reinforced Concrete. Types of Reinforcements.		
		20 hrs
Unit III 3. Polymers and Fibres Corrosion of Reinforcing Steel- Electro-chemical process, measures of protection. Polymers, fibres, adhesives and sealants- types and their uses.		
		10 hrs
Text Books 1. Mehta, P. K., and Paulo, J. M. Monteiro, Concrete Microstructure, Properties, and Materials, 3ed., Tata McGraw Hill, 2006.		
Reference Books: 1. Neville, A. M., Properties of Concrete, 4ed., Longman, 1995. 2. Sidney Mindess and J. Frances Young, Concrete, PH NJ, 1981.		

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Program: Master of Technology (Structural Engineering)		Semester: I
Course Title: Fire Resistance of Structures		Course Code: 20ESEE701
L-T-P: 4-0-0	Credits: 4	Contact Hours: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 3hrs	
Unit I 1. Introduction Overview, Fire Safety in Buildings, Fire Safety Objectives, Process of Fire Development, Fire Resistance, Controlling Fire Spread, Building Construction for Fire Safety 3hrs 2. Fire and Heat transfer Fuels, Combustion, Fire Initiation, t-squared fires, Heat Transfer. 4hrs 3. Room Fires and Fire Severity 4hrs Pre flashover, Flashover and Post flashover fires, Fire Severity and Fire Resistance, Equivalent Fire Severity. 4. Fire Resistance 3hrs Introduction, Fire Resistance Tests, Listings, Fire Resistance by Calculation, Fire Resistance of Assemblies.		
Unit II 5. Design of Structures Exposed to Fire Overview of design of structures at normal temperature, Structural Design in Fire Condition, Material properties in fire, Design of individual members exposed to fire, Design of structural assemblies exposed to fire. 6. Design of Concrete Structures Exposed to Fire Behaviour of concrete structures exposed to fire, Concrete and Reinforcing temperatures, Mechanical properties of concrete at elevated temperatures, Design of concrete members exposed to fire.		
Unit III 3. Design of Steel Structures Exposed to Fire Behavior of steel structures exposed to fire, Steel temperatures, Protection systems, Mechanical properties of steel at elevated temperatures, Design of steel members exposed to fire.		
Reference Books: <ol style="list-style-type: none"> 1. Bhavikatti S.S., <i>Theory of Plates and Shells</i>, 2ed., New Age International, New Delhi, 2014. 2. Bairagi, N.K., <i>A Text Book of Plates Analysis</i>, Khanna Pub. New Delhi, 1986. 3. Bairagi, N.K., <i>Shells Analysis</i>, Khanna Pub. New Delhi, 1990. 4. Chandrashekhar, K., <i>Theory of Plates</i>, Universities Press Ltd, 2001. 5. Ramaswamy, G.S., <i>Design and Construction of Concrete Shell Roofs</i>, CBS Publisher & Distributors, New Delhi – 1986. 6. Szilard, R., <i>Theory and analysis of plates - classical and numerical methods</i>, Prentice Hall, 1994 		

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Program: M. Tech Structural Engineering		Semester: II
Course Title: Theory of Plates & Shell Structures		Course Code: 20ESEE702
L-T-P: 4-0-0	Credits: 5	Contact Hours: 6hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 3hrs	
Unit – I		
Theory of plates. Small deflection of laterally loaded thin rectangular plates- Navier's and Levy's solution - Solutions of plates for various loading and boundary conditions. Symmetric loading of circular plates with various edge conditions for both solid and annular plates. Energy methods and Finite Difference methods for rectangular plates. 20 hrs		
Unit II		
2. Theory of Shells: Introduction to differential geometry of curves and surfaces – classification of shells- beam theory. Membrane theory- bending theory for symmetric shells. Membrane theory for shells of revolutions - domes - hyperboloid of revolution. Design of domes, hyperbolic paraboloid. 20 hrs		
Unit III		
3. Analysis and design of folded plates by Whitney's and Simpson's methods. Membrane theory for hyperbolic paraboloid, elliptic paraboloid and conoids. 10 hrs		
Reference Books:		
<ol style="list-style-type: none"> 1. Bhavikatti S.S., <i>Theory of Plates and Shells</i>, 2ed., New Age International, New Delhi, 2014. 2. Bairagi, N.K., <i>A Text Book of Plates Analysis</i>, Khanna Pub. New Delhi, 1986. 3. Bairagi, N.K., <i>Shells Analysis</i>, Khanna Pub. New Delhi, 1990. 4. Chandrashekhar, K., <i>Theory of Plates</i>, Universities Press Ltd, 2001. 5. Ramaswamy, G.S., <i>Design and Construction of Concrete Shell Roofs</i>, CBS Publisher & Distributors, New Delhi – 1986. 6. Szilard, R., <i>Theory and analysis of plates - classical and numerical methods</i>, Prentice Hall, 1994 7. Timoshenko, S.P. and Woinowsky-Krieger, <i>Theory of Plates and Shells</i>, McGraw- Hill Book Co., New York, 1959. 		

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Program: M. Tech Structural Engineering		Semester: II
Course Title: Design of Industrial Steel Structures		Course Code:15ESEE703
L-T-P: 4-0-0	Credits: 04	Contact Hours:50
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:04	Examination Duration: 3Hrs	
Unit I		
1. Plastic Methods of Analysis 12 Hrs		
Stress strain relation for steel, Formation of plastic hinges, redistribution of moments; Section modulus, Fully plastic moment for selected shapes of cross section; Theorems of plastic collapse; Collapse load for beams & frames; Factors affecting fully plastic moment of a section.		
2. Plastic Methods of Design 10 Hrs		
Plastic design of continuous beams; Trial and error method; Method of combining mechanisms; Plastic moment distribution for design of portal frames and pitched roof frames; Design of continuous beams.		
Unit II		
3. Minimum weight design 08 Hrs		
Minimum weight design; Design for strong column-weak beam and strong beam-weak column; Theorems of minimum weight design.		
4. Design of Bunkers, Silos and Chimneys 12 Hrs		
Design of bunkers, silos and chimneys.		
Unit III		
5. Design of Frames for Industrial Structures 04 Hrs		
Design of frames for gravity and wind loads.		
6.Design of Light Gauge Structural Steel Sections 06 Hrs		
Design of light gauge structural steel sections for axial, flexural and combined axial compression and flexure.		
Text Books:		
<ol style="list-style-type: none"> 1 Ramchandra, Design of Steel Structures, Vol. II, 7ed., Standard Book House, New Delhi, 1991, 2 Limit state design of steel structures, vol II, Dr B C Punmia, Laxmi Publications, New Delhi 3 Neal, B.G., The Plastic Methods of Structural Analysis, 2ed., Chapman & Hall, London, 1963. 4 Baker, J.F., Horne, M.R. and Heyman, J., The Steel Skeleton, Vol. II - Plastic Behaviour and Design, ELBS & Cambridge University Press, London, 1961. 5 Duggal, S.K., Limit State Design of Steel Structures, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010. 		

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Program: M.Tech Structural Engineering		Semester: II
Course Title: Structural Reliability		Course Code:15ESEE704
L-T-P: 4-0-0	Credits: 04	Contact Hours:50
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:04	Examination Duration: 3Hrs	
Unit I		
1. Concepts of structural safety.		03 hrs
Introduction to safety, Safety concepts in Different Design Philosophies, Introduction to probability based design concepts		
2. Basics statistics		03 hrs
Introduction, Data reduction, Histograms, Sample correlation.		
3.Probability Theory		05 hrs
Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distributions, Extreamal distributions		
4. Resistance distribution and parameters		05 hrs
Introduction, statistics of properties of concrete and steel, Statistics of strength of Bricks and Mortar, Dimensional variations, Characterization of variables of compressive strength of concrete in structures and yield strength of steel, allowable stresses based on specified reliability.		
5. Probabilistic Analysis of loads		05 hrs
Gravity load, Introduction, load as a stochastic process. Wind load- Introduction, wind speed, return period, estimation of life time design wind speed, probability model of wind load.		
Unit II		
6. Basic Structural Reliability		07 hrs
Introduction, Computation of structural reliability.		
7.Monte Carlo study of Structural Safety		04 hrs
Monte Carlo methods and Applications		
8. Level - 2 Reliability methods		08 hrs
Introduction, Basic variables and failure surface, First order second moment methods like Hasofer and linds method, Non- normal distributions, Determination of B for present designs, correlated variables.		
Unit III		
9. Reliability Based Design		10 hrs
Introduction, Determination of partial safety factors, safety checking, Formats Development of reliability. Based design criteria. Optional safety factors, Summary of results of study for Indian standards. - R. C. C. Designs.		
Text Books:		
1 Ranganathan, R., <i>Structural Reliability Analysis and Design</i> , 1ed. Jaico Book House, FMCD2009 / 2.0		



2006.

Reference Books:

1. Aggarwal, K.K., *Reliability Engineering*, Apress Springer (India) Pvt. Ltd., 2007.
2. Andrzej, S. N and Kevin, R. C., *Reliability of Structures*, 2ed., McGraw Hill Company, KOGA, 2012.
3. Srinath, L.S., *Reliability Engineering*, 4ed., East West Books (Madras) Pvt. Ltd., 2005.

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Program: M.Tech Structural Engineering		Semester: II
Course Title: Design of Foundations		Course Code:15ESEE706
L-T-P: 4-0-0	Credits: 04	Contact Hours:50
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:04	Examination Duration: 3Hrs	
Unit I		
1. Soil Exploration		04 Hrs
Subsurface exploration programme for industrial structures, Interpretation of soil parameters. Tests on disturbed and undisturbed soil samples, Soil exploration report.		
2. Shallow Foundation		15 Hrs
Design Criteria. Types of shallow foundations. Bearing capacity theories. Bearing capacity from field tests. Use of different foundation models. Design of individual and combined footings. Design of raft foundations for industrial structures Conventional methods. Modulus of subgrade reaction. Beams on elastic foundations. Analysis of footings by – finite difference .		
Unit II		
3. Pile Foundations		10 hrs
Load carrying capacity of pile. Design of pile and pile groups. Batter piles and under reamed piles. Design of pile cap. Design of axially and laterally loaded piles.		
4. Well Foundations		04 hrs
Shapes of wells. Components of well .Lateral stability of well foundation. Design aspects of components of well foundation.		
5.Machine Foundations		07 hrs
Design criteria for machine foundations. Basic terminologies. Vibration analysis. Methods of analysis. Determination of soil parameters. Foundations for reciprocating machines. Foundations for impact type of machines. Vibration isolation.		
Unit III		
6. Foundations for Special Structures		06 hrs
Foundations for tall structures - Water tanks, Chimneys, Antenna towers and Radar units.		
7.Special types of Foundations		04 hrs
Shells in foundations - Hyperbolic - Paraboloid shells.		
Reference Books:		
1 Bowles, J. E., <i>Foundation Analysis and Design</i> , 5ed., Mc Graw Hill company New York, 1996.		
2 Brahma, S. P., <i>Foundation Engineering</i> , Tata McGraw Hill Company New Dehli, 1985.		
3 Murthy, V.N.S., <i>Advanced Foundation Engineering</i> , CBS Pub. New Delhi., 2007.		
4 Nainan Kurian., <i>Modern Foundations Introduction to Advanced Techniques</i> , Tata McGraw Hill Company, New Dehli, 1982.		
5 Swami Saran, <i>Analysis and Design of Substructures: Limit State Design</i> , 2ed, oxford and		



IBH publishing co. Pvt. Ltd., 2006.

- 6 Srinivasulu, P. and Vaidyanathan, C.V., *Hand Book of Machine Foundations*, Tata McGraw Hill Company New Dehli , 2002.
- 7 Tomlinson, M.J., *Pile Design and Construction Practice*, 6ed, CRC Press, 2014
- 8 Varghese. P.C., *Foundation Engineering*, PHI Pub. New Delhi. 2005.
- 9 Winterkorn, H. F. and Fang H. Y., *Foundation Engineering Hand Book*, 2ed, Van Nostrand Reinhold Company, 1991.
- 10 N.H. Som, and Das S.C., *Theory and Practice of Foundation Design*, PHI, Learning Pvt Ltd., New Delhi, 2009.

IS Codes :

1. IS 2911 (Part 1/Sec 3) : 2010 - *Design And Construction Of Pile Foundations*
2. IS: 2950 (Part I) -1981 (Reaffirmed 2008) - *Code Of Practice For Design And Construction Of Raft Foundations*

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Program: M.Tech Structural Engineering		Semester: II
Course Title: Structural Optimization		Course Code:15ESEE707
L-T-P: 4-0-0	Credits: 04	Contact Hours:50
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:04	Examination Duration: 3Hrs	
Unit I		
1. Introduction		03 hrs
Engineering applications, optimum design methods, Mathematical statement – Terminology and basic concepts, Classification of optimization problems, Optimization Techniques		
2. Classical Optimization Techniques		04 hrs
Single variable optimization, Multivariable optimization, Lagrange multiplier method and constrained variation method – Kuhn tucker conditions		
3. Linear Programming		06 hrs
Standard form, Simplex method, two phase simplex method, revised simplex method		
4. Non-Linear Unconstrained Optimization Search Techniques		06 hrs
One dimensional problems - elimination and Interpolation methods, Hooke and Jeeve's method, Descent methods, Newton's method, Davidon Powell Fletcher method.		
Unit II		
5. Non-Linear Constrained Optimization Search Techniques		10 hrs
Feasible Direction method, Interior and Exterior penalty function method – sequential linear programming techniques		
6. Dynamic and Geometric Programming		07 hrs
Multistage decision concert, principles of optimality, calculus and tabular method of Dynamic Programming, solution of a constrained geometric programming problem.		
Unit III		
7. Non-Traditional Search Techniques		07 hrs
Genetic Algorithm, Neural Network based Optimization and Optimization of Fuzzy system.		
8. Application to Structural Optimization		07 hrs
R.C. Structures, Steel Structures and stress concentration minimization problems.		
Reference Books:		
1. Rao, S.S., <i>Engineering Optimization Theory and Application</i> , New Age International (P) Ltd. Publishers, 2008.		
2. Fox, R.L., <i>Optimization Methods for Engineering Design</i> , Addison – Wesley Publishing Company, 1971.		
3. Bhavikatti, S.S., <i>Fundamentals of Optimum Designs in Engineering</i> , New Age		



Publishers, 2010.

4. Ravindran, A, Ragsdel, K.M., Reklaitis, G.V., *Engineering Optimization Methods and Applications*, 2ed., Wiley India Pvt. Ltd., 2006.
5. Bishma Rao GSS., *Optimization Techniques*, Scitech Pub., 2003.
6. Mohan C. and Kusum Deep, *Optimization Techniques*, New Age International (P) Ltd., 2009.

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Program: M.Tech Structural Engineering		Semester: II
Course Title: Mathematical Thinking & Logical Reasoning		Course Code:15ESEH701
L-T-P: 4-0-0	Credits: 04	Contact Hours:50
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:04	Examination Duration: 3Hrs	
Unit I		
Arithmetical Reasoning and Analytical Thinking		
1. Arithmetical Reasoning		10 hrs
2. Analytical Thinking		04 hrs.
3. Syllogistic Logic		03 hrs
Unit II		
Verbal and Non – Verbal Logic		
4. Verbal Logic		09 hrs
5. Non-Verbal Logic		06 hrs
Unit III		
Lateral Thinking		
7. Lateral Thinking		08 hrs
Text Books		
1.	A Modern Approach to Verbal and Non – Verbal Reasoning – R. S. Aggarwal, Sultan Chand and Sons, New Delhi	
2.	Quantitative Aptitude – R. S. Aggarwal, Sultan Chand and Sons, New Delhi	
Reference Books:		
1	Verbal and Non – Verbal Reasoning – Dr. Ravi Chopra, MacMillan India	
2	Lateral Thinking – Dr. Edward De Bono, Penguin Books, New Delhi	

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Program: M.Tech. Structural Engineering		Semester: II
Course Title: Structural Health Monitoring		Course Code: 20ESEE703
L-T-P: 4-0-0	Credits: 04	Contact Hours: 40
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 04	Examination Duration: 3Hrs	
Unit I		
1. Introduction		08 Hrs
Factors affecting Health of Structures, Causes of Distress, Regular Maintenance. Concepts, Various Measures, Structural Safety in Alteration.		
2. Structural Audit		08 Hrs
Assessment of Health of Structure, Collapse and Investigation, Investigation Management, Assessment by NDT techniques, SHM Procedures.		
Unit II		
3. Static Field Testing		08 Hrs
Types of Static Tests, Simulation and Loading Methods, Behavioral / Diagnostic tests - Proof tests, Sensor systems and hardware requirements, Static Response Measurement- strain gauges, LVDTs, dial gauges - case study.		
4. Dynamic Field Test		08 Hrs
Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Forced vibration method, Impact hammer and shaker testing, Hardware for Data Acquisition Systems, Network of sensors, Data compression techniques, Remote Structural Health Monitoring.		
Unit III		
5. Introduction To Retrofitting and Repairs of Structures		08 Hrs
Introduction to retrofitting of structures, Retrofitting of structural elements, Techniques, Material used for retrofitting, Case Studies, piezo-electric materials and other smart materials, electro-mechanical impedance (EMI) technique, adaptations of EMI technique		
Text Books:		
<ol style="list-style-type: none"> 1 Structural Health Monitoring Daniel Balageas, Claus-Peter Fritzen and Alfredo Güemes, John Wiley-ISTE, London, 2006. 2 Health Monitoring of Structural Materials and Components - Methods with Applications, Douglas E Adams, John Wiley & Sons, New York, 2007. 		

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