KLE Technological University | Creating Value, Leveraging Knowledge

Curriculum Structure and Curriculum Content for the Academic Batch **2021-2023**
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

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 the 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-POs
PO1: An ability to independently carry out research /investigation and development work to solve practical problems.
PO2: An ability to write and present a substantial technical report/document.
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO4: Ability to use modern computational tools in modeling, simulation and analysis of Design Engineering related problems with an understanding of their limitations.
PO5: An ability to select and integrate products and processes that account for long-term consumer satisfaction and environmental conservation.

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Curriculum Structure-Overall

	I	II	III	IV
Course with course code	Theory of Elasticity (4-0-0)	Earthquake Resistant Design Of 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 Special RC Structures (4-1-0)	Stability of Structures (4-0-0)		
	Numerical Methods and Programming (4-0-0)	Program Elective-1 (4-0-0)		
	Program Elective (4-0-0)	Program Elective-2 (4-0-0)		
	CAAD Lab (0-0-2)	Structural Simulation Laboratory (0-0-1)		
	Recent Topics on Technology Trends (1-0-0)	Design Project 2-0-1		
Credits	**25**	**25**	**18**	**20**

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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	Theory of Elasticity	PC	4-0-0	4	04	50	50	100	3 hours
2.	20ESEC702	Structural Dynamics	PC	4-1-0	5	06	50	50	100	3 hours
3.	15ESEC703	Design of Special RC Structures	PC	4-1-0	5	06	50	50	100	3 hours
4.	19ESEC701	Numerical Methods and Programming	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	Computer Aided Analysis and Desig Laboratory	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				

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Semester - II

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1.	20ESEC703	Earthquake Resistant Design of Structures	PC	4-1-0	5	06	50	50	100	3 hours
2.	20ESEC705	Finite Element Method	PC	4-0-0	4	04	50	50	100	3 hours
3.	20ESEC706	Stability of Structures	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	Structural Simulation Laboratory	PC	0-0-1	1	02	80	20	100	3 hours
7.	19ESEP702	Design Project	PC	2-0-1	3	03	50	50	100	3 hours
TOTAL				**22-1-2**	**25**	**27**				

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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	Major Project / Project Work Phas 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.	Design of Bridges	18ESEE701
2.	Advanced Materials of Construction	15ESEE702
3.	Fire Resistance of Structures	20ESEE701
4.	Theory of Plates and Shells	20ESEE702
5.	Design of Industrial Steel Structures	15ESEE703
6.	Structural Reliability	15ESEE704
7.	Mathematical Thinking and Logical Reasoning	15ESEH701
8.	Design of Foundations	15ESEE706
9.	Structural Optimization	15ESEE707
10.	Principles and Practices of Engineering Education	15ECRC701
11.	Structural Health Monitoring	20ESEE703

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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 o polar coordinates; Bi harmonic equation; Axisymmetric problems – Thick cylinder subjected to radial pressure, Rotating disk; Non-axisymmetric problems – Platewith 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.

Back

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 analysisequation; 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 – Codeof Practice, Bureau of Indian Standards, New Delhi, 1993

Back

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.

Back

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 **12hrs**

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

2. RC Design using MS Excel **36 hrs**

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.

Reference Books:

1. Computers and Structures Inc., Getting Stated 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

Back

Program: M. Tech. Structural Engineering		Semester: II
Course Title: Earthquake Resistant Design of Structures		**Course Code:20ESEC701**
L-T-P: 4-1-0	**Credits: 05**	**Contact Hours:50**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:04	**Examination Duration: 3Hrs**	

Unit I

1. Engineering Seismology **10 Hrs**

Introduction, Reid's elastic rebound theory, Theory of plate tectonics; Seismic waves; Earthquake size – Intensity, Magnitude, Isoseismal map, Energy released in an earthquake; Local site effects; Seismicity of India; Classification of earthquakes.

2. Earthquake Load Specification **12 Hrs**

Response spectra, Design response spectrum; Equivalent static method; Response spectrum method; Time history analysis

Unit II

3. Design of Plan Asymmetric Buildings **08 Hrs**

Static and dynamic approach, Analytical and wind tunnel experimentation method for wind. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading.

4. Earthquake Resistant Design of Masonry Buildings **11 Hrs**

Elastic properties of structural masonry; Lateral load analysis of masonry buildings

Unit III

5. Design of Reinforced concrete buildings for earthquake resistance **08 Hrs**

Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS1893. Structural behavior, design and ductile detailing of shear walls

6. Techniques for Earthquake Resistance **04 Hrs**

Base Isoloation, Passive and active control systems .

Text Books:

1 Agarwal P. and Shrikhande M., *Earthquake Resistant Design of Structures*, Pentice-Hall of India Pvt. Ltd., New Delhi, 2011.

2 Chopra, A.K., *Dynamics of Structures*, 4ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2011.

3 Duggal, S.K., *Earthquake Resistant Design of Structures*, Oxford University Press, New Delhi, 2013.

IS Codes:

1. IS:1893-2016 (Part 1), Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi, 2016.
2. IS:13920-2016, Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, Bureau of Indian Standards, New Delhi, 2016.
3. IS:4326-2013, Earthquake Resistant Design and Construction of Buildings – Codeof Practice, Bureau of Indian Standards, New Delhi, 2013

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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.

Back

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:

1 Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, 2ed., McGraw Hill Book Co., New York, 1961.

2 Simitses, 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.

Back

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 = 200GPa, A = 3250mm2).
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 x 10^{11} 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.

Back

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**	

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.

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.

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.

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.

Expected Deliverables: Identify project details, structural design drawings and calculations.

Reference Books:

1. Jain, A.K., *Reinforced Concrete Limit State Design*, Nem Chand and Brothers, Roorkee,
2. Swami Saran, *Analysis and Design of Substructures – Limit State Design*, 2ed., Oxford & IBH Publishing Co., 2006.
3. Varghese, P.C., *Design of Reinforced Concrete Foundations*, 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.

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, Pr c votection systems, Mechanical properties of steel at elevated temperatures, Design of steel members exposed to fire.

Reference Books:

1. Bhavikatti S.S., *Theory of Plates and Shells*, 2ed., New Age International, New Delhi, 2014.
2. Bairagi, N.K., *A Text Book of Plates Analysis*, Khanna Pub. New Delhi, 1986.
3. Bairagi, N.K., *Shells Analysis*, Khanna Pub. New Delhi, 1990.
4. Chandrashekhar, K., *Theory of Plates*, Universities Press Ltd, 2001.
5. Ramaswamy, G.S., *Design and Construction of Concrete Shell Roofs*, CBS Publisher & Distributors, New Delhi – 1986.
6. Szilard, R., *Theory and analysis of plates - classical and numerical methods*, 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:

1. Bhavikatti S.S., *Theory of Plates and Shells*, 2ed., New Age International, New Delhi, 2014.
2. Bairagi, N.K., *A Text Book of Plates Analysis*, Khanna Pub. New Delhi, 1986.
3. Bairagi, N.K., *Shells Analysis*, Khanna Pub. New Delhi, 1990.
4. Chandrashekhar, K., *Theory of Plates*, Universities Press Ltd, 2001.
5. Ramaswamy, G.S., *Design and Construction of Concrete Shell Roofs*, CBS Publisher & Distributors, New Delhi – 1986.
6. Szilard, R., *Theory and analysis of plates - classical and numerical methods*, Prentice Hall,1994
7. Timoshenko, S.P. and Woinoisky-Krieger, *Theory of Plates and Shells*, 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:

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., *Structural Reliability Analysis and Design*, 1ed. Jaico Book House, 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., *Foundation Analysis and Design,* 5ed., Mc Graw Hill company New York, 1996.

2 Brahma, S. P., *Foundation Engineering,* Tata McGraw Hill Company New Dehli, 1985.

3 Murthy, V.N.S., *Advanced Foundation Engineering*, CBS Pub. New Delhi., 2007.

4 Nainan Kurian., *Modern Foundations Introduction to Advanced Techniques,* Tata McGraw Hill Company, New Dehli, 1982.

5 Swami Saran, *Analysis and Design of Substructures: Limit State Design*, 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 Flether 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., *Engineering Optimization Theory and Application*, New Age International (P) Ltd. Publishers, 2008.
2. Fox, R.L., *Optimization Methods for Engineering Design,* Addison – Wesley Publishing Company, 1971.

3. Bhavikatti, S.S., Fundamentals of Optimum Designs in Engineering, 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:

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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