RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2020 – 2021

(Batch of 2020 – 2022)

DEPARTMENT OF CIVIL ENGINEERING

I to IV SEMESTER M. Tech

Structural Engineering

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute:

Dr. M. S. Ramaiah a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 13 UG programs and 15 PG programs. All these programs are approved by AICTE. All the UG programs & 09 PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with 'A' grade by NAAC in 2014. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs till the year 2029. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 60% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility to all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology & Schneider Centre of Excellence. **M S Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 65 & world ranking 578 for the year 2020.**

The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology secured All India Rank 8th for the year 2020 for Atal Ranking of Institutions on Innovation Achievements (ARIIA), an initiative of Ministry of Human Resource Development (MHRD), Govt. of India.** MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. MSRIT is a member of DELNET, CMTI and VTU E-Library Consortium. MSRIT has a modern auditorium and several hi-tech conference halls with video conferencing facilities. It has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association. **As per the National Institutional Ranking Framework, MHRD, Government of India, M S Ramaiah Institute of Technology has achieved 59th rank among 1071 top Engineering institutions of India for the year 2020 and 1st rank amongst Engineering colleges (VTU) in Karnataka.**

About the Department:

The Department of Civil Engineering was started as the third department in the institute with an intake of 60 students in the year 1971. Structural Engineering was first Post Graduate program started in the year 1984 of the institute with an intake of 10 students. The UG and PG programs have been accredited by NBA for three years 2017-2020 and 2019-2022 respectively. After obtaining the autonomous status in the year 2007, the department focused towards providing state of the art curriculum development, offering electives of the present day need and techno innovative projects. These initiatives resulted in enhanced performance of the students in terms of increase in placement, increase in the number of students writing competitive examinations and pursuing higher education in the foreign universities.

Further Department of Civil Engineering was recognized as a research centre in the year 1994 leading to PhD/MSc in Civil Engineering under Bangalore University till 1994 and later it was brought under State Technological University VTU. The research centre has attracted 30 PhD research scholars to pursue their degree from this research centre and 17 research scholars have completed PhD degree. The areas of research include Structural Engineering, Transportation Engineering, Geo-Technical Engineering, Water resources Engineering and Environmental Engineering.

The Department has close interaction with number of industries and Government agencies through R&D, and consultancy works. It also has MOU's with industries and other institutes for improved interactions and coordination with outside world.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

- Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
- Establishing research clusters in emerging areas in collaboration with globally reputed organizations
- Establishing innovative skills development, techno entrepreneurial activities and consultancy for socio-economic needs

QUALITY POLICY

We at M. S. Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To become a premier Department to impart state-of-the-art technical knowledge and professional skills through effective learning process with research ambience to produce global quality Civil Engineers to develop sustainable society.

MISSION OF THE DEPARTMENT

To transform the young minds into employable professionals by providing contemporary technical knowledge and appropriate professional skills through suitable teaching learning process.

To provide rigorous training and acquaint the students with necessary skills and leadership qualities along with ethical values to address the complex and multi - faceted Civil Engineering Problems.

To provide opportunity to develop their potential by fostering intellectual curiosity to promote them for pursuing higher studies and research through exposure to the modern engineering tools and techno innovative projects.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

Mater of Technology (Structural Engineering) graduates of Civil Engineering program of M S Ramaiah Institute of Technology shall attain the following PEO"s within three to four years of graduation.

The graduate will;

PEO 1	Adopt for analysis and design of structural systems in consulting/ Government agencies.
PEO 2	Contribute for technical knowledge enhancement through teaching and research.
PEO 3	Demonstrate professional practice, communication skills and lifelong learning.

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.

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: An ability to adopt contemporary technology for the analysis and design of sustainable engineering systems.

PO5: An ability to simulate the model of the structure and predict its structural feasibility, culminating to a technical report for societal applications.

Curriculum Course Credits Distribution

Semester	Humanities & Social Sciences (HSS)	Basic Sciences/ Lab (BS)	Engineering Sciences/ Lab (ES)	Professional Courses- Core (Hard core, soft core, Lab) (PC-C)	Professional Courses - Electives (PC-E)	Other Electives (OE)	Project Work (PW)	Internship /other activities (IS/ECA)	Total semester load
First	--	--	--	13	8	--	--	1	22
Second	--	--	--	13	8	--	--	1	22
Third	--	--	--	6	8	--	6	2	22
Fourth	--	--	--	0	0	--	22	-	22
Total	--	--	--	32	24	--	28	4	88

SCHEME OF TEACHING FOR STUDENTS ADMITTED FROM 2018
M Tech (STRUCTURAL ENGINEERING)

1st SEMESTER

Sl No	Course Code	Subject	Category	Credits*				Contact Hours
				L	T	P	Total	
1	MSTR 11	Advanced mathematics	PS-C	4	0	0	4	56
2	MSTR 12	Advanced Structural Analysis	PS-C	3	1	0	4	56
3	MSTR 13	Mechanics of Deformable Bodies	PS-C	4	0	0	4	56
4	MSTR 14X	Elective I	PS-E	4	0	0	4	56
5	MSTR 15X	Elective II	PS-E	4	0	0	4	56
6	MSTRL16	Advanced Concrete Laboratory	PS-C	0	0	1	1	14
7	MSTR 17	Technical Seminar I	IS / EAC	0	0	1	1	14
						Total	**22**	**308**

Elective I

Sl No	Course Code	Subject	Category	L	T	P	Total	Contact Hours
1	MSTRE 141	Special Concrete	PS-E	4	0	0	4	56
2	MSTRE 142	Experimental Stress Analysis	PS-E	4	0	0	4	56
3	MSTRE 143	Computational Structural Mechanics	PS-E	4	0	0	4	56
4	MSTRE 144	Design of Industrial Structures	PS-E	4	0	0	4	56

Elective II

Sl No	Course Code	Subject	Category	L	T	P	Total	Contact Hours
1	MSTRE151	Advanced Design of Concrete Structures	PS-E	4	0	0	4	56
2	MSTRE152	Optimization Methods in Structural Engg	PS-E	4	0	0	4	56
3	MSTRE153	Design of Tall Structures	PS-E	4	0	0	4	56
4	MSTRE154	Construction Techniques and Mgmt	PS-E	4	0	0	4	56

2nd SEMESTER

Sl No	Course Code	Subject	Category	Credits*				Contact Hours
				L	T	P	Total	
1	MSTR 21	Theory of Plates and Shells	PS-C	4	0	0	4	56
2	MSTR 22	Structural Dynamics	PS-C	3	1	0	4	56
3	MSTR 23	Finite Element Methods in Structural Analysis	PS-C	3	1	0	4	56
4	MSTRE24X	Elective III	PS-E	4	0	0	4	56
5	MSTRE25X	Elective IV	PS-E	4	0	0	4	56
6	MSTRL 26	Advanced Computation Laboratory	PS-C	0	0	1	1	14
7	MSTR 27	Technical Seminar II	IS / EAC	0	0	1	1	14
						Total	**22**	**308**

Elective III

Sl No	Course Code	Subject	Category	L	T	P	Total	Contact Hours
1	MSTRE 241	Rehabilitation of Structures	PS-E	4	0	0	4	56
2	MSTRE 242	Valuation Engineering	PS-E	4	0	0	4	56
3	MSTRE 243	Steel- Concrete Composite Structures	PS-E	4	0	0	4	56
4	MSTRE 244	Composite and Smart materials	PS-E	4	0	0	4	56

Elective IV

Sl No	Course Code	Subject	Category	L	T	P	Total	Contact Hours
1	MSTRE 251	Advanced Design of Steel Structures	PS-E	4	0	0	4	56
2	MSTRE 252	Design of Concrete Bridges	PS-E	4	0	0	4	56
3	MSTRE 253	Design of Form Works	PS-E	4	0	0	4	56
4	MSTRE 254	Rock Mechanics and Tunneling	PS-E	4	0	0	4	56

3rd SEMESTER

Sl No	Course Code	Subject	Category	Credits*				Contact Hours
				L	T	P	Total	
1	MSTR 31	Design of Earthquake Resistant Structures	PS-C	3	1	0	4	56
2	MSTRE 32X	Elective V	PS-E	4	0	0	4	56
3	MSTRE 33X	Elective VI	PS-E	4	0	0	4	56
4	MSTRL 34	Dynamics and Earth Quake Engg. Laboratory	PS-C	0	0	1	1	14
5	MSTRL 35	Remedial Engineering Laboratory	PS-C	0	0	1	1	14
6	MSTR 36	Internship/Industrial Training	IS / EAC	0	0	2	2	28
7	MSTR 37	Dissertation Work – I	PW	0	0	6	6	84
						Total	**22**	**308**

Elective V

Sl No	Course Code	Subject	Category	L	T	P	Total	Contact Hours
1	MSTRE 321	Design of Substructures	PS-E	4	0	0	4	56
2	MSTRE 322	Soft Computing Tools	PS-E	4	0	0	4	56
3	MSTRE 323	Stability Analysis of Structures	PS-E	4	0	0	4	56
4	MSTRE 324	Reliability Analysis and Design of Structures	PS-E	4	0	0	4	56

Elective VI

Sl No	Course Code	Subject	Category	L	T	P	Total	Contact Hours
1	MSTRE 331	Masonry Structures	PS-E	4	0	0	4	56
2	MSTRE 332	Advanced Pre-Stressed Concrete	PS-E	4	0	0	4	56
3	MSTRE 333	Pre-Fabricated Structures	PS-E	4	0	0	4	56
4	MSTRE 334	Fracture Mechanics	PS-E	4	0	0	4	56

4th SEMESTER

Sl No	Course Code	Subject	Category	L	T	P	Total	Contact Hours
1	**MSTR 41**	**Dissertation Work - II**	**PW**	**0**	**0**	**22**	**22**	**308**

(L= Lecture T=Tutorial P=Practical) Grand Total of Credits: 88

ADVANCED MATHEMATICS

Course Code: MSTR11
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Linear Algebra: Solution of linear system of equations: Gauss-Jordon, Gauss-Siedel and LU decomposition methods. Eigenvalues and eigenvectors, Diagonalization, Solutions of system of ordinary differential equations by Matrix method.

UNIT - II

Vector spaces: Linear combination**,** Linear independence**,** Bases and dimensions**.** Linear transformations, Matrix transformation, Composition of Matrix transformations, Rotation about the origin, Dilation, Contraction and Reflection. Kernel and Range, Change of basis.

UNIT - III

Special functions: Introduction to Beta and Gamma functions. Bessel‟s functions, Legendre's, Laguerre's, Hermite's, Chebyshev polynomials and their properties. Expansion of an arbitrary function in terms of Bessel‟s functions, Legendre‟s and Chebyshev polynomials.

UNIT - IV

Calculus of variation: Variation of a function $f(x, y, y')$ and the corresponding functional, Extremal of a functional, Variational problem. Euler-Lagrange equation and its particular forms, examples. Standard variational problems, Isoperimetric problems.

UNIT - V

Boundary value problems: Finite difference approximations, classification of 2^{nd} order PDEs. Solution of one dimensional heat equation using Schmidt and Crank-Nicolson methods. Solution of one dimensional wave equation, two dimensional heat, wave, Laplace and Poisson equations using finite difference approximations. Application problems.

Text Books:

1. B. S. Grewal - Higher Engineering Mathematics - Khanna Publishers – 43^{rd} edition-2015.
2. Gareth Williams – Linear Algebra with Applications – Jones and Bartlett Press

– 8th edition – 2014.
3. Robert Weinstock – Calculus of variations with applications to Physics and Engineering – Dover Publications-1974.

Reference Books:

1. Erwin Kreyszig-Advanced Engineering Mathematics-Wiley-India publishers-10th edition- 2015.
2. Peter V. O"Neil – Advanced Engineering Mathematics – Thomson Brooks/Cole – 7th edition – 2011.
3. Mariano Giaquinta and Stefan Hildebrandt – Calculus of variations I – Springer – 2nd edition- 2004.
4. David C Lay – Linear Algebra and its Applications – 3rd Edition, Pearson Education.

Course Outcomes (COs):

Students will be able to

- Analyze the concept of various methods to solve the system of linear algebraic equations and the system of ODE"s by matrix differential equations.
- Find the Kernel and Range of Linear transformations.
- Solve the indefinite integrals using Beta and Gamma functions, express the polynomials in terms of Bessel's functions and Legendre polynomials.
- Apply the knowledge of different forms of Euler-Lagrange equation to solve the standard variation problems in engineering.
- Solve the standard second order PDEs numerically using various finite difference scheme.

ADVANCED STRUCTURAL ANALYSIS

Course Code: MSTR12
Credit: 3:1:0 **Contact Hours: 42+14**

Course Content

UNIT - I

CURVED BEAMS: Introduction to curved beams & assumptions, WINKLER BACH equation, Limitation, Radius of neutral surface of rectangular, triangular sections, Trapezoidal and circular sections, Stress distribution in open curved members. Hooks etc, Problems on Hooks, Problems continued, Stress distribution in closed rings, Stress distribution in chain links. Deformations of open, thin curved members, Problems on thin curved members, Deformations of closed thin curved members such as rings, Problems on closed rings

UNIT - II

BEAMS ON ELASTIC FOUNDATIONS: Differential equation of elastic line, Interpretation of constants of integration, Infinite beam with concentrated load, Infinite beam with moment & UDL, Infinite beam problems, Semi- infinite beams with Concentrated load and moment, Semi- infinite beam with fixed and hinged conditions, Problems on semi-infinite beams

UNIT - III

SHEAR CENTRE: Introduction, Shear Centre for Symmetrical Sections, Shear Centre for Unsymmetrical Sections. Derivation of shear centre for angles, channel, semicircular and built-up sections with numerical problems

UNIT - IV

UNSYMMETRICAL BENDING (ASYMMETRICAL BENDING): Introduction, Assumptions, Stresses in beams, simply supported and cantilever unsymmetrical beams subjected to inclined loading, Deflections of unsymmetrical simply supported and cantilever beams with numerical problems.

UNIT - V

STABILITY - BENDING OF PRISMATIC BARS : Governing differential equation for axial and lateral loads, Problems on axial and conc. loads, Problems on axial and UDL, Beam column with different end conditions, Problems on Beam columns, **Buckling of columns** Assumptions, Eulers theory of buckling Governing differential

equation, Columns with different end conditions, Columns with different end conditions, Columns with varying cross sections, and frames, Introduction to energy method and problems, Numerical method applied to column, Problems on Numerical methods.

TEXT BOOKS

1. Krishna Raju N & Gururaj D R "Advanced mechanics of solids and structures", NAROSA Publishers Company Delhi.
2. Srinath L.S. "Advanced Mechanics of Solids", Tenth Print, Tata McGraw Hill publishing company. New Delhi, 1994.

REFERENCE BOOKS:

1. Vazirani V N and Ratwani M M "Advanced theory of structures and Matrix Method". 5th Edition, Khanna publishers, Delhi 1995.
2. Hetenyi M."Beams on elastic foundation" 3rd printing, University of Michigan, USA, 1952.
3. Alexander Chatjes "Principles of Structural stability theory", Prentice – Hall of India, New Delhi, 1974.
4. Sterling Kinney "Indeterminate Structural Analysis", Oxford & IBH publishers

Course Outcomes (COs):

Students will be able to

- Obtain stresses and deformations of curved beams using equilibrium and strain energy principles
- Classify and solve load response behaviour of beams on elastic foundations with different end conditions
- Able t o explain and solve the problems related to shear centre of symmetrical & unsymmetrical sections
- Able to describe and solve the problems on unsymmetrical bending of beams.
- Bring out concept of stability and analysis stability of non-prismatic structural members with different boundary conditions

MECHANICS OF DEFORMABLE BODIES

Course Code: MSTR13
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Stress and Strain in Cartesian Coordinates: Analysis of stress (two and three dimension)-Body force, surface forces- Uniform state of stress – Principal stresses – Stress transformation laws- Differential equations of equilibrium – Analysis of strain (two and three dimension) Strain displacement relations- Compatibility equations – State of strain at a point – Strain transformations – Principal strain – Principle of superposition – Stress – Strain relations - Generalized Hook‟s law – Lame‟s constants – Methods of formulation of elasticity problems – Equilibrium equations in terms of displacements – Compatibility equations in terms of stresses – Boundary Value problems.

UNIT - II

Two dimensional problems in Cartesian coordinate system: Introduction: Plane stress and plane strain problems – Airy‟s stress function – Polynomials – Direct method of determining Airy‟s polynomial stress function-Solution of Biharmonic equation of Fourier series – St. Venant‟s principle.

UNIT - III

Two Dimensional Problems in Polar Coordinates: General equations in polar coordinates - Stress distribution symmetrical about an axis - Pure bending of curved bars- Strain components in polar coordinates – Displacements for symmetrical stress distribution - Rotating Disc - Bending of a curved bar by force at the end – Effect of circular hole on stress distribution- Concentrated force at a point of a straight boundary – Forces on wedges – A circular disc with diametric loading.

UNIT - IV

Torsion of Prismatic Bars: General solution of the problem by displacement (St.Venant‟s warping function) and force (Prandtl‟s stress function) approaches – Membrane analogy – Torsion of shafts of circular and noncircular (Elliptic, triangular and rectangular) cross sectional shapes – Torsion of thin rectangular section and hollow thin walled single and multicelled sections.

UNIT - V

Introduction of Plasticity: Introduction to stress – strain curve – ideal plastic body – Criterion of yielding – Rankine‟s theory- St.Venant‟s theory – Tresca‟s criterion – Beltrami‟s theory – Von- mises criterion – Mohr‟s theory of yielding – yield surface – Flow rule (Plastic stress – strain relation) Prandtl Reusss equations- Plastic work- Plastic potential – Uniqueness of stress distribution
– Elasto plastic problems of beams in bending – Thick hollow spheres and cylinders subjected to internal pressure – General relations – Plastic torsion – perfect plasticity – Bar of circular cross section – Nadai‟s sand heap analogy.

Text Books:

1. Sadhu Singh.”Theory of Elasticity” Khanna Publishers, N. Delhi, 1995.

Reference:

1. T.G. Sitharam and L.GovindaRaju, " Elasticity for Engineers", I.K International Publishers, New Delhi 2017.
2. Chow P.C and Pagano N.J “Elasticity, Tensor and Engg, Approaches”, D.Vannostrand co.,New York 1968.
3. Timoshenko S and Goodier,J.N “Theory of Elasticity”, McGraw Hill Book Co., 1951.
4. Chakrabarthy.T “Theory of Plasticity”, Mc. Graw Hill Book Co., New Delhi,1988.
5. MendelsonA.,”Plasticity Theory and Applications”, MacMillan Co., New York 1968.

Course Outcomes (COs):

Students will be able to

- Understand the basic knowledge of elasticity and its application to stresses and strain evaluation.
- Identify, formulate and solve engineering problems with respect to stress and strain through polynomials as applied to 2D and 3D elements in Cartesian coordinates.
- Identify, formulate and solve engineering problems with respect to stress and strain as applied to 2D and 3D elements in polar coordinates.
- Identify, formulate and solve engineering problems as applied to Torsion of Prismatic bars.
- Identify, formulate and solve engineering problems with respect to Plasticity

SPECIAL CONCRETES

Course Code: MSTRE141
Credit: 4:0:0 **Contact Hours: 56**

Course Content

Unit I

Review of conventional concrete - Introduction to concrete as a construction material. Significance of properties of concrete, Aggregates - Classification types and properties of Aggregates,, Artificial and recycled aggregates. Different types of Cements - composition and application. Hydration of Cement and Structure of hydrated Cement, Chemical and mineral admixtures.

Unit II

Microstructure of Mortar and concrete - Interfacial transition zone in concrete and its influence on strength, behavior and properties of concrete, Significance of properties of fresh and hardened concrete, Application of Nano materials in construction industry and micro fine cement. Durability of concrete - permeability, chemical attack, sulphate attack, alkali aggregate reaction, corrosion and carbonation of concrete.

Unit III

Neo Concrete: High density concrete: Materials, properties and Placement method of high density concrete, Light weight concrete- Introduction and classification, Properties of Light weight concrete. Fiber reinforced concrete- Fibers types and properties, Behavior of FRC, Ferro cement - materials, properties and application, Recycled concrete.

Unit IV

Progress in concrete Technology: Ready mixed concrete - manufacture, transporting, placing and precautions. Proportions, properties and uses of High strength Concrete, Self-consolidating concrete, Polymer impregnated concrete, High performance concrete and Roller compacted concrete, Porous concrete, Engineered cementations composites and smart concrete

Unit V

Special Concrete & Mix design: Pump able concrete and its applications. Concept of mix design, variables in proportioning, exposure conditions, and procedure of mix

design as per relevant codal provisions and numerical examples of mix design of Conventional concrete, Self compacting concrete, Geopolymer concrete.

Text Books:

1. P. Kumar Mehta and Paulo J. M. Monteiro, 2006. *Concrete* - Microstructure, Properties, and Materials, 3rd Edition, McGraw-Hill,
2. M L Gambhir, *Concrete Technology*, 2009, 4th Ed., McGraw-Hill

References:

1. Paul and Pama, 1978, Ferro Cement, AIT, Bangkok
2. Neville, A.M. 1995. Properties of Concrete, 4th ed. Addison Wesley Longman
3. Fafat Siddique, 2000, *Special Structural concrete*, Galgotia Publications

Course Outcomes (COs):

The students will be able to

- Define basic terminologies and describe the characteristics of basic ingredients of concrete
- Explain the micro mechanism of hydration process and will be able address mechanical & durable properties of concrete.
- Bring out different types of concrete along with their properties for the wide range of applications in the society
- Describe the commercial aspects of production, transportation and deliver system along with their merits and demerits.
- Design required grade of concrete using concrete mix design principles

EXPERIMENTAL STRESS ANALYSIS AND TECHNIQUES

Course Code: MSTRE142
Credit: 4:0:0 **Contact Hours: 56**

Course Content

Unit I

Strain measurement: Methods of Measurement, Calibration Load, calibration of testing machines, I.S. Course Code provisions, Measurement system, Strain measurement, Strain gauges, Principle, Types, Performance, Uses, Strain Rosettes, Wheast on Bridge, Photo Elasticity, Principle, Application, Moiré Fringe, Electronic load cells, Proving rings.

Unit II

Model Analysis: Model laws, Laws of similitude, Model materials, Model testing, Necessity for model analysis, Advantages, Applications, types of similitude, Scale effect in model, Indirect model study and direct model study, Limitations of model investigations, Structural problems demanding model studies, Usage of influence lines in model studies

Unit III

Measurement of Vibration and Wind Flow: Measurement of vibration, Vibration galvanometers, Vibrometer, Characteristics of Structural vibration, Pressure gauge, Velocity transducers, Seismic transducers, Linear Variable Differential Transformer, Cathode ray oscilloscope, XY Plotter, Wind Tunnels, flow meters, Venturimeter, Digital Data Acquisition systems.

Unit IV

Distress Measurement and Control: Diagnosis of distress in structures, Cracks in structures, Formation of cracks, Types of cracks, Causes of cracks, Crack measurement, Monitoring and measurement of crack movement, Corrosion of reinforcement in RCC, Half cell construction and use, Damage assessment, Controlled blasting for demolition.

Unit V

Non Destructive Testing Methods: Load testing on structures, In situ load testing, Ultimate load testing, Rebound hammer, Principle and Applications, Limitations, Ultrasonic testing, Principles and applications, Brittle coating, Principle and

Applications, Stress coat, All Temperature comparison of brittle coating, Evaluation of the coating

Text Books:

1. Dally J.W and Riley W.F."Experimental Stress Analysis", McGraw-Hill, Inc., New York,1991.
2. Srinath L.S. "Experimental Stress Analysis", Tata McGraw Hill publishing co., Ltd., New Delhi 1984.

References:

1. Rangan C.S. "Instrumentation – Devices and System", Tata McGraw-Hill publishing Co., Ltd New Delhi 1983.
2. Sadhu Singh, Experimental Stress Analysis", Khanna publishers, New Delhi 1996

Course Outcomes (COs):

The students will be able to

- Apply basic knowledge of different strain instruments in the civil engineering field and various methods of measurement of strain.
- Ability to do the Structural problems demanding model studies.
- Formulate and solve engineering problems with respect to Measurement of vibration and cracks that occur in civil engineering structures.
- Analyse structural system with modal analysis.
- Evaluate the strength properties by using NDT methods

COMPUTATIONAL STRUCTURAL MECHANICS

Course Code: MSTRE143
Credit: 3:1:0 **Contact Hours: 42+14**

Course Content

UNIT - I

Introduction: Structural Systems, Degrees of Static and Kinematic indeterminacies, Geometrical & Material non linearties, Concepts of Stiffness and Flexibility, Energy concepts in Structural Analysis, Strain Energies - Axial, Flexure & Shear, Real work and Complementary work, Principle of Virtual Displacement for a Rigid and Deformable body, Principles of Potential Energy, Minimum Potential Energy, Stationary Complementary Energy, Minimum Complementary Energy, Maxwell - Betti‟s Theorem of Reciprocal Displacement

UNIT - II

Element Flexibility Method: Flexibility matrices for Bar, Beam and Grid elements, Generation of System Flexibility Matrix using uncoupled Element Flexibility Matrices, Analysis of statically indeterminate structures - (i) Truss (ii) Continuous Beams (iii) Simple Rigid Frames and (iv) Grids

UNIT - III

Element Stiffness Method: Relationship between Element and System coordinates, Transformation of information from System Forces to Element Forces using Equilibrium equations, Contra gradient law, Stiffness matrices for Bar, Beam and Grid elements, Generation of System Stiffness Matrix using uncoupled Element Stiffness Matrices, Analysis of statically indeterminate structures - (i) Truss (ii) Continuous Beams (iii) Simple Rigid Frames and (iv) Grids

UNIT - IV

Direct Stiffness method: Local and Global coordinate systems, Direct Assembly of Structure Stiffness matrices of truss, beam and Grid elements, Analysis of statically indeterminate structures - (i) Truss (ii) Continuous Beams (iii) Simple Rigid Frames and (iv) Grids

UNIT - V

Storage Techniques: Half band, skyline storage, Equation solvers, Frontal solvers, Bandwidth consideration, Algorithms and flow charts, Solution of simultaneous equations using Gauss elimination, Gauss - Seidel and Cholesky methods, Uses of commercial packages

Text Books:

1. Weaver W and Gere J H, “Matrix Analysis of Framed Structures”, CBS Publications, New Delhi
2. Rajasekaran S, “Computational Structural Mechanics “, PHI, New Delhi

References:

1. Pundit and Guptha, “Theory of Structures”, Vol II, TMH Publications, New Delhi
2. A K Jain, “Advanced Structural Analysis”, Nemchand Publications, Roorkee
3. C S Reddy, „Basic Structural Analysis“, TMH Publications, New Delhi

Course Outcomes (COs):

Students will be able to

- Apply the concepts of flexibility and stiffness matrices
- Solve engineering problems with respect to flexibility matrices as applied to trusses, beams, rigid frames and grids
- Formulate engineering problems with respect to stiffness matrices as applied to trusses, beams, rigid frames and grids
- Solve engineering problems with respect to direct stiffness methods as applied to trusses, beams, rigid frames
- Solve engineering problems with respect to various storage schemes and standard commercial packages

DESIGN OF INDUSTRIAL STRUCTURES

Course Code: MSTRE144
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Planning and Functional Requirements: Classification of Industries and Industrial structures - planning for Layout Requirements regarding Lighting, Ventilation and Fire Safety - Protection against noise and vibration -Guidelines of Factories Act.

UNIT - II

Industrial Buildings: Steel and RCC -Gantry Girder, Crane Girders -Design of Corbels and Nibs – Design of Staircase.

UNIT - III

Power Plant Structures: Types of power plants –Containment structures -Cooling Towers -Bunkers and Silos –Pipe supporting structures

UNIT - IV

Transmission Line Structures and Chimneys: Analysis and design of transmission line towers - Sag and Tension calculations, testing of towers - Design of self supporting chimney, Design of Chimney bases.

UNIT - V

Foundation: Design of foundation for Towers, Chimneys and Cooling Towers - Machine Foundation

-Design of Turbo Generator Foundation.

Text Books:

1. Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, Industrial Buildings: A Design Manual, Birkhauser Publishers, 2004.
2. Manohar S.N, Tall Chimneys -Design and Construction, Tata McGraw Hill, 1985

REFERENCES:

1. Santhakumar A.R. and Murthy S.S., Transmission Line Structures, Tata McGraw Hill, 1992.
2. Srinivasulu P and Vaidyanathan.C, Handbook of Machine Foundations, Tata McGraw Hill, 1976

Course outcomes (COs):

The Students will be able to

- Get the knowledge of planning and functional requirements of industrial structures
- Design the components of industrial buildings with RC and Structural Steel.
- Design the components of power plant structures.
- Design transmission line and chimneys.
- Design different types of foundations for industrial structures.

ADVANCED DESIGN OF CONCRETE STRUCTURES

Course Code: MSTRE151
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Design of continuous beams, beams curved in plan and portal frames.

UNIT - II

Design of storage structures like silos, bunkers and design of chimney.

UNIT - III

Design of waffle slabs, grid floors and flat slabs.

UNIT - IV

Yield line and strip methods for analysis of slabs

UNIT - V

Art of dealing earthquake resistance constructions, expansion and construction joints in buildings.

Text Books:

1. Raju N.K "Advanced Reinforced concrete design", CBS Publishers
2. Punmia B.C. et al "Reinforced concrete design", , Vol II , Lakshmi Publishers

Reference Books:

1. Park R and PaulayT,John "Reinforced concrete structures", Wiley & Sons.
2. Fintel Mark "Hand book on Concrete Engineering", Van Norstrand Reinhold Co,
3. UnniKrishnan Pillai & DevdasMenon "Reinforced Concrete Design", TMH Publications.

Course Outcomes (COs):

The students will be able to

- Design of advanced concrete structures subjected to flexure, shear and torsion.
- Design a bunkers, silos and chimneys
- Design a grid slabs and flat slabs subjected to various load combinations with different boundary conditions.
- Analysis of slab using yield line theory and strip method.
- Dealing earthquake resistance constructions, expansion and construction joints in buildings.

OPTIMIZATION METHODS IN ENGINEERING DESIGN

Course Code: MSTRE152
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Introduction: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems. **Optimization Techniques:** Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.

UNIT - II

Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.

UNIT - III

Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods, constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems.

UNIT - IV

Geometric programming: Geometric programming, conversion of NLP as a sequence of LP/geometric programming.

UNIT - V

Dynamic programming: Dynamic programming conversion of NLP as a sequence of LP/ Dynamic programming. **Structural Optimization:** Formulation and solution of structural optimization problems by different techniques.

Text Book:

1. Rao S.S, “Optimization – Theory and Practice”, Wiley Eastern Ltd

References

1. Spunt, “Optimum Structural Design”, Prentice Hall
2. Uri Krisch, “Optimum Structural Design”, McGraw Hill
3. Richard Bronson, “Operation Research”, Schaum‟s Outline Series

Course outcomes (COs):

The Students will be able to

- Identify real-world objectives and constraints based on actual problem descriptions.
- Create mathematical optimization models.
- Work through proper solution techniques.
- Make recommendations based on solutions, analyses, and limitations of models.
- Search entire space of possibilities using Dynamic Programming to define optimum solution.

TALL STRUCTURES - BEHAVIOR AND DESIGN

Course Code: MSTRE153
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

INTRODUCTION: History, Advantages & disadvantages, Economics, Essential amenities, Lifts (elevator), Fire safety, Water supply, Drainage and garbage disposal, Miscellaneous services, Structural and foundation systems, Design criteria, Design philosophy, loading, Sequential loading, Materials, High performance Concrete, Fibre reinforced Concrete, Light weight Concrete, Design Mixes

UNIT - II

LOADING AND MOVEMENT: Gravity loading: Dead and Live load, methods of live load reduction, Impact, gravity loading, construction load. Wind loading: Static and Dynamic approach, Analytical and wind tunnel experimental method. Earthquake loading: Equivalent lateral force, Modal analysis, combinations of loading, Working stress design, Limit state design, Plastic design.

UNIT - III

BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS: 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 - IV

ANALYSIS AND DESIGN: 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 analysis. Structural elements: Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow, Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance.

UNIT - V

STABILITY OF TALL BUILDINGS: Overall buckling analysis of frames, wall-frames – Approximate methods, second order effects of gravity loading, P-Delta analysis, simultaneous first order and P-Delta analysis- Translational, Torsional

instability, out of plum effects, stiffness of member in stability, effect of foundation rotation

Text Books:

1. Taranath B.S., "Analysis & Design of Tall Building", McGraw-Hill Book Co, 1988.
2. Bryan S.S, and Alexcoull, "Tall Building Structures, Analysis and Design", John Wiley and Sons, Inc., 1991.

References:

1. Mark Fintel, "Handbook on Concrete Engineering", CBS Publishers, New Delhi

Course outcomes (COs):

The students will be able to

- Understand the design criteria, philosophy for fire safety, drainage and disposal systems for Tall buildings.
- Analyze the tall structures subjected to different types of dynamic loadings.
- Analyze the behavior of various structural systems with different boundary conditions.
- Design the different structural elements of tall buildings.
- Understand the stability of tall buildings using various theories

CONSTRUCTION TECHNIQUES AND MANAGEMENT

Course Code: MSTRE154
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT I

Sub Structure Construction:

Box jacking -Pipe jacking -Under water construction of diaphragm walls and basement -Tunneling techniques -Piling techniques -Driving well and caisson -sinking cofferdam -cable anchoring and grouting -Driving diaphragm walls, Sheet piles -Laying operations for built up offshore system -Shoring for deep cutting -Large reservoir construction -well points -Dewatering for underground open excavation.

UNIT II

Super Structure Construction for Buildings:

Vacuum dewatering of concrete flooring –Concrete paving technology –Techniques of construction for continuous concreting operation in tall buildings of various shapes and varying sections –Erection techniques of tall structures, Large span structures –launching techniques for heavy decks –in-situ prestressing in high rise structures, Post tensioning of slab-aerial transporting –Handling and erecting lightweight components on tall structures.

UNIT III

Construction of Special Structures:

Erection of lattice towers -Rigging of transmission line structures –Construction sequence in cooling towers, Silos, chimney, sky scrapers -Bow string bridges, Cable stayed bridges –Launching and pushing of box decks –Construction of jetties and break water structures –Construction sequence and methods in domes –Support structure for heavy equipment and machinery in heavy industries –Erection of articulated structures and space decks.

UNIT IV

Financial Management:

Working Capital Management –Compound Interest and Present Value methods –Discounted Cash Flow Techniques –Capital Budgeting.

Decision Theory:

Decision Theory –Decision Rules –Decision making under conditions of certainty, risk and uncertainty –Decision trees –Utility Theory.

UNIT V

Construction Management

Sources of lost time, productivity assessment tools such as productivity measurement system, work sampling, foreman delay survey; productivity improvement tools such as crew balance charts, process diagrams, Basic theories of motivation, leadership, communication and team behaviors adapted and applied to construction management; case studies

Text books:

1. Sankar, S.K. and Saraswati, S., Construction Technology, Oxford University Press, New Delhi, 2008
2. Vohra, Nd., Quantitative Techniques in Management, Third Edition, Tata McGraw-Hill Company Ltd, 2007.

References:

1. Jerry Irvine, Advanced Construction Techniques, CA Rocketr, 1984
2. Patrick Powers. J., Construction Dewatering: New Methods and Applications, John Wiley & Sons,1992.
3. Peter. H. Emmons, "Concrete repair and maintenance illustrated", Galgotia Publications Pvt. Ltd., 2001.Press, 2008.

Course outcomes (COs):

The student will be able to

- Apply the knowledge of latest construction techniques applied to engineering construction for substructure.
- Apply the knowledge of latest construction techniques applied to engineering construction for super structure.
- Apply the knowledge of latest construction techniques applied to engineering construction for special structures.
- Practice principles of financial management and decision theory.
- Practice principles of construction management

ADVANCED CONCRETE LABORATORY

Course Code: MSTRL16
Credit: 0:0:1 **Total session: 14 (Each of 3hrs)**

Course Content

1. Mix proportion and fresh properties of normal strength concrete
2. Mix proportion and fresh properties of high strength concrete
3. Mix proportion and fresh properties of self compaction concrete
4. Mix proportion and fresh properties of geo polymer concrete
5. Mechanical properties and Shear Strength of normal strength concrete
6. Mechanical properties and Shear Strength of high strength concrete
7. Mechanical properties and Shear Strength of self compaction concrete
8. Mechanical properties and Shear Strength of geo polymer concrete
9. Fracture test on concrete
10. Bond Strength of Neo Concrete

Text Books:

1. Shetty M.S, 'Concrete Technology ', S. Chand & Co. Ltd, New Delhi.
2. Mehta P.K, 'Properties of Concrete ', Tata McGraw Hill Publications, New Delhi.

Reference Books:

1. Neville AM, 'Properties of Concrete', ELBS Publications, London.
2. Relevant BIS codes.

Course outcomes (COs):

The students will be able to

- Characterize and mix design of normal and high strength concrete.
- Characterize and mix design of SCC and GPC.
- Conduct Strength properties of normal and high strength concrete.
- Conduct Strength properties of SCC and GPC.
- Conduct the fracture test and bond strength of concrete

THEORY OF PLATES AND SHELLS

Course Code: MSTR21
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

INTRODUCTION: General behaviour of plates, Assumptions, small deflection theory of thin plates, Governing differential equation for deflection of plate, Boundary conditions, Bending of Isotropic Rectangular plates: Navier solution for an all round simply supported rectangular plate subjected to uniformly distributed load, sinusoidal load and point load, Levy"s solution for a rectangular plate with different boundary conditions and subjected to uniformly distributed load

UNIT - II

BENDING OF CIRCULAR PLATES: Symmetrical bending of circular plates, simply supported solid circular plate subjected to an uniformly distributed load, an end moment and partially distributed load

UNIT - III

DESIGN OF FOLDED PLATE ROOFS: Structural behaviour of folded plates, Assumptions, Analysis of folded plates, Design of prismatic folded plate roofs as per ASCE task committee recommendations, Reinforcement details

UNIT - IV

INTRODUCTION TO THEORY OF SHELL STRUCTURES: Structural behaviour of thin shells, General classification of shell surfaces, Analysis of shells like conoid, hyperbolic and elliptic paraboloids.

UNIT - V

BENDING THEORY OF SHELLS: Introduction of differential geometry of curves and surfaces, classification of shells, beam theory, membrane theory, bending theory for symmetric shells, Membrane theory of shells of revolutions, domes, hyperboloid of revolution, Membrane theory for hyperbolic, elliptic paraboloid and conoids

Text Books:

1. Szilard R., "Theory and Analysis of Plates – Classical and Numerical Methods", Prentice Hall Inc 1995.

2. Timoshenko S. and Kreiger S.W., “Theory of Plates and Shells”., McGraw Hill Books Company, Newyork-1990.

References:

1. Chandrashekhara K, “Theory of Plates” Universities Press (India)Ltd., Hyderabad 2001.
2. Ansel C.Ugural, “Stresses in Plates and shells”, Second Edition, McGraw-Hill International Editions 1999.

Course Outcomes (COs):

The students will be able to

- Behaviour of rectangular plates by Navier and Levy‟s solution subjected to various types of loads.
- Evaluate the circular plates for different end conditions subjected to various types of loads.
- Analyze and design and detailing of folded plates.
- Analyze the components of various types of thin shells.
- Analyze the shells using bending and membrane theory

STRUCTURAL DYNAMICS

Course Code: MSTR22
Credit: 3:1:0 **Contact Hours: 42+14**

Course Content

Unit I

Introduction and Free vibrations of SDF systems

Objectives, Types of Dynamic Analysis, Types of Dynamic forces, Typical definitions in vibrations, Undamped and Damped free vibrations with viscous damping, Logarithmic decrement, Other types of damping, Energy dissipation in free vibration

Unit II

Forced vibrations of SDF systems

Forced vibration response to harmonic excitations, Vibration isolation, Transmissibility, Evaluation of damping, Vibration measuring instruments, Duhamel's integral and applications to undamped systems, Numerical methods

Unit III

Free vibrations of MDF systems

Formulation of equations of motion for shear buildings, Free vibration analysis of undamped systems using stiffness approach, Orthogonality conditions, Normal modes, Matrix iteration method, Damping in MDF systems and evaluation of damping matrices, Rayleigh's and Dunkerley's method to calculate fundamental frequency

Unit IV

Forced Vibrations of MDF systems and Free Vibrations of Continuous systems

Forced Vibration analysis using mode superposition and mode acceleration method for harmonic loadings and simple pulse loadings including base excitations, Free flexural vibrations and Axial vibrations of continuous systems and application to single span systems

Unit V

Soil-Foundation Interaction

Introduction to soil - Foundation interaction problems, Soil behaviour, Foundation behaviour, Interface, behaviour, Scope of soil-foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.

Text Books:

1. Mario Paz, Structural Dynamics, CBS Publishers, New Delhi
2. Anil K Chopra, Dynamics of Structures, Pearson Publications, New Delhi

References:

1. Madhujit Mukhopadyay, Vibrations, Dynamics and Structural Systems, Oxford Publishers, New Delhi
2. Clough and Penzein, Dynamics of Structures, Mcgraw Hill Publishers, New York
3. Rao S.S, Mechanical Vibrations, Pearson Publications, New Delhi
4. Leonard Meirovitch, Elements of Vibration Analysis, Tata Mcgraw Hill, New Delhi
5. Roy Craig, Structural Dynamics, John Wiley Publications, New York
6. Structure Soil Interaction - State of Art Report, Institution of structural Engineers, 1978.

Course Outcomes (COs):

The students will be able to

- Evaluate the damping present in structural systems and apply the knowledge of energy absorption mechanisms to minimize the vibration of structural systems.
- Identify, formulate and solve problems of transmissibility of forces to foundations of structural systems.
- Analyze the shear buildings and their performance to dynamic loadings.
- Assess the impact of arbitrary loadings on performance of structures and behavior of continuous systems subjected to flexural vibrations.
- Formulate the lumped and Consistent mass and stiffness matrices for bar and beam element using finite element approach

FINITE ELEMENT METHOD OF STRUCTURAL ANALYSIS

Course Code: MSTR23
Credit: 3:1:0 **Contact Hours: 42+14**

Course Content

UNIT - I

Introduction: Basic concepts of elasticity – Kinematic and Static variables for various types of structural problems – approximate method of structural analysis – Rayleigh – Ritz method – Finite difference method – Finite element method. Principles of finite element method - advantages & disadvantages - Finite element procedure. Finite elements used for one, two & three dimensional problems – Element aspect ratio – mesh refinement vs. higher order elements – Numbering of nodes to minimize band width.

UNIT - II

Displacement Model: Nodal displacement parameters – Convergence criterion – Compatibility requirements – Geometric invariance – Shape function – Polynomial form of displacement function
– Generalized and Natural coordinates – Lagrangian interpolation function – shape functions for one, two & three dimensional elements.

UNIT – III

Concept of Isoparametric Elements: Internal nodes and higher order elements – Serendipity and Lagrangian family of Finite Elements – Sub parametric and Super parametric elements – Condensation of internal nodes – Jacobian transformation Matrix –Variation method and minimization of Energy approach of element formulation (Development of strain – displacement matrix and stiffness matrix) – consistent load vector – numerical integration.

UNIT - IV

Application of Finite Element Method for the analysis of one dimensional problems: Analysis of simple beams and plane trusses and rigid plane frames.

UNIT – V

Application of Finite Element Method for the analysis of Two dimensional problems: Application to plane stress/ strain/ Ax symmetric problems using CST, LST & Quadrilateral elements. Choice of displacement function (C_0, C_1 and C_2 Type) for plate and shell elements.

Text Books:

1. Krishnamoorthy C S, “Finite Element Analysis”, Tata McGraw Hill
2. Desai C and Abel J F, “Introduction to the Finite Element Method”, East West Press Pvt.Ltd., 1972

References

1. Bathe K J, “Finite Element Procedures in Engineering Analysis”, Prentice Hall
2. Rajasekaran. S, “Finite Element Analysis in Engineering Design”, Wheeler Publishing
3. Cook R D, Malkan D S & Plesta M.E, “Concepts and Application of Finite Element Analysis”, 3rd Edition, John Wiley and Sons Inc., 1989
4. Shames I H and Dym C J, “Energy and Finite Element Methods in Structural Mechanics”, McGraw Hill, New York, 1985

Course Outcomes (COs):

The students will be able to

- Describe finite element analysis applied to structural systems
- Identify, formulate and solve engineering problems related to one, two and three Dimensional elements.
- Identify, formulate and solve engineering problems related to one, two and three Dimensional iso parametric elements.
- Apply FEM analysis to one dimensional problem such as beams, trusses & rigid frames.
- Apply FEM analysis to two dimensional problems such as plates, shells and axi- symmetric problems.

REHABILITATION OF STRUCTURES

Course Code: MSTRE241
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT– I

Durability and Deterioration: Physical causes: Durability of concrete causes of distress in concrete, sulphate attack, shrinkage, freeze and thawing, weathering, abrasion, temperature, fire, formwork movement, settlement, foundation settlement, construction errors, overloads, accidental loadings and design errors. Chemical causes: Chemical attack on concrete, sulphate attack, acid attack, alkali reaction, aggregate reaction, silica reaction, crystallization of salts in pores, sea water attack, biological attack, other chemical attacks. Corrosion : Principle of corrosion, mechanism , process, damage due to corrosion, codal provisions, symptoms of distress due to corrosion, corrosion protection techniques.

UNIT– II

Structural Damage Assessment: Inspection, Structural Appraisal, Economic appraisal, components of quality assurance, conceptual basis for quality assurance schemes. Destructive testing systems - direct load tests, load test on structural elements, semi destructive testing systems - penetration techniques, Pull out test, core sampling, permeability test, and non destructive testing systems – NDT methods, ultrasonic pulse velocity test, pulse echo method, electromagnetic methods, acoustic emissions, radiographic methods. Assessment of damage due to fire.

UNIT– III

Functional Materials for Repair and Rehabilitation : Criteria for selecting repair materials, classification of materials, physical and chemical strength tests, adhesive strengths and test for surface quality. Patching materials, cementitious materials, polymer mortar and concrete, quick setting compounds, bituminous materials, protective coatings, sealing materials, water stops, water proofing materials, coatings, membranes, bonding materials. Special repair materials, chemicals and mineral admixtures, SP, accelerators, fly ash, GGBS,CSF, polymeric materials and coatings, SFRC, application of SFRC to repair, FRF composites, ferro cement, glass fibers, carbon fibers SIFCON, SIMCON, Slurry Infiltrated Fibrous Concrete, nano materials for rehabilitation.

UNIT–IV

Rehabilitation and Strengthening Techniques: Repair of cracks, methods of repair, stages of repair, resin injection, routing and sealing, stitching, external stressing, bonding, blanketing, overlays, flexible sealings, drilling, plugging, surface coatings, **grinding, sand blasting**, acid etching. Rust eliminators and polymers coating for re-bars, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Examples of repairs to structures, Repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering, wear, fire, leakage, marine exposure. Structure concrete strengthening, jacketing, external bonding, section enlargement, externally bonded steel plates, external reinforcement, NSM techniques. Cathodic production

UNIT–V

Maintenance: Definition, necessity of maintenance, classification of maintenance, environmental agencies, normal wear and tear , failure of structures, inspection of structures, inspection periods, preventive maintenance, predictive maintenance, reliability centered maintenance, reactive maintenance, organization for maintenance, computerized maintenance management system. Condition of flooring, roof leakage, Condition of service fittings, drainage from terrace roof, growth of vegetation, steps to reduce repairs and replacement, normal breakup, management tools for effective maintenance.

Text Books:

1. "Rehabilitation of Concrete Structures ", Dr. B. Vadivelli, Standard Publishers Distributors, Delhi .
2. "Concrete Technology – Theory and practice", MS. Shetty, S.Chand and company, New Delhi.

Reference Books:

1. Dension Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical, U.K, 1991.
2. .RT. Allen and S.C. Edwards, "Repair of concrete Structures", Blakie and sons,UK, 1987.
3. "Training course notes on damage assessment and Repair in low cost housing Santhakumar", S.R. RHDC-NBO Anna University, Madras, July, 1992.
4. " CPWD hand book for Rehabilitation of structures"

Course Outcomes (COs):

The students will be able

- Reproduce the basic knowledge of mathematics, science and engineering in the maintenance and rehabilitation of structures.
- Demonstrate the procedural knowledge to maintain and rehabilitate structures.
- Practice the culture of professional and ethical responsibilities by following codal provisions in the rehabilitation of structures.
- Evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures, maintenance and rehabilitation of structures.
- Provide factual knowledge on analysis and design of rehabilitation of structures and train students to participate and succeed in competitive examinations.

VALUATION ENGINEERING

Course Code: MSTRE242

Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Introduction: Terms used in valuation, cost price and value_ purpose of valuation Different forms of values - Accommodation value, Annual Value, Book value, Market value, Potential value, replacement value, salvage value, speculative and sentimental value.

UNIT - II

Outgoings: Municipal and Government taxes - Annual repairs and maintenance, Insurance - sinking fund. Capitalized value, Deferred land value, Depreciation, life of structure, Class of Structure, Rating, Year‟s purchase - Lease-hold property.

UNIT - III

Methods of valuation: Open land valuation - Comparative methods, Abstractive method, Belting method, Valuation of land with building. Cost of structure, I S I rules measurement of plinth area and cubical contents.

UNIT - IV

Rent Analysis: Definition of rent, determination of rental value, standard rent - Valuation based on reconstruction cost, land and building method - Rental method of valuation - Valuation on profit basis - Residual or development method. Easements - self imposed - legally created - effect on valuation due to easement. Fair market value and open market value - parameters which affect the fair market value.

UNIT - V

Valuation of Different Properties: Valuation of different types of properties - Leasehold properties Agricultural land - farm house - case studies. Investments - Bonds, gilt- edged securities. Debentures, preferences and equity shares, Capital gains, wealth tax and income tax - Valuation by break up method - average profit basis.

Text Books:

1. Mitra “Theory and Practice of valuation” Eastern Law House, Calcutta, 1986.
2. Roshan Namavati, “Theory and Practice of Valuation, Universal book Corporation., 1986.

Reference Books:

1. Gopinatha Rao, “Valuation practices of immovable properties” 1985.
2. Shah N A “Quantity surveying and Valuation”, Khanna Publishers, First Edition, 1976.

Course Outcomes (COs):

The students will be able to

- Reproduce the basic knowledge of mathematics, science and engineering in the valuation of properties.
- solve engineering problems in valuation of properties subjected to cost index.
- Evaluate the procedural knowledge to value moveable and immoveable properties
- Evaluate the rental analysis for various building.
- Valuate of different types of properties

STEEL - CONCRETE COMPOSITE STRUCTURES

Course Code: MSTRE243
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Introduction: Introduction to Steel - Concrete composite construction, Advantages, Theory of Composite structures, Introduction to steel - Concrete - Steel sandwich construction

UNIT - II

Design of Composite Beams, Columns and Trusses: Behaviour of composite beams, Design of Composite beams, Behaviour of composite columns, Steel - Concrete composite columns, Design of composite trusses

UNIT - III

Design of Connections: Types of connections, Design of connections in composite structures, shear connections, Design of connections in composite trusses

UNIT - IV

Composite Box Girder Bridges: Introduction, Behavior of Box girder bridges, Design concepts

UNIT - V

Miscellaneous: Seismic behaviour of composite structures, Case studies on steel - Concrete composite construction in buildings

Text Books:

1. Johnson R.P., "Composite structures of steel and concrete", Blackwell Scientific Publications, Second Edition, UK, 1994.
2. Owens G.W. and Knowels. P., "Steel Designers Manual", Fifth edition, Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 1992.

References:

1. Proceedings of a workshop on "Steel Concrete Composite Structures", conducted at Anna University, 2000.
2. Steel Concrete Composite Construction, INSDAG Publication, Kolkata.

Course Outcomes (COs):

The students will be able to

- Acquire the knowledge of steel-concrete composites
- solve engineering problems with respect to design of composite beams, columns and trusses.
- Analyze structural system with the design concepts of composite structures.
- Design of box girder bridges.
- Seismic behavior of composite structures

COMPOSITE AND SMART MATERIALS

Course Code: MSTRE244
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Introduction to the Composite materials: classifications and applications. Anisotropic elasticity- unidirectional and anisotropic laminate, thermo-mechanical properties, micro-mechanical analysis, characterization tests. Classical composite lamination theory, cross and angle-play laminates, symmetric, antisymmetric and general symmetric laminates, mechanical coupling. Analysis of simple laminated structural elements ply-stress and strain, lamina failure theories- first fly failure, vibration and buckling analysis. Sandwich structure face and core materials, secondary failure modes environmental effects, manufacturing of composites.

UNIT - II

Introduction to smart materials and structures-piezoelectric materials-coupled elctromechnaical constitutive relations- depoling and coercive field-field-strain relation-hysterics-creep-strain rate effects-manufacturing.

UNIT - III

Actuators and sensors-single and dual actuators-pure extension, pure bending-bending extension relations-uniform strain beam model-symmetric induced strain actuators-bond shearing force- Bernoulli‟s-Euler (BE) beam models- embedded actuators-Asymmetric induced strain actuators in uniform strain and Euler-Bernoulli models. Uniform strain model –energy principle formulation-BE model- single and dual surface bonded actuators-Extension-bending and torsion model.

UNIT - IV

Introductions to control systems-open loop and close loop transfer functions-stability criteria- deflection control of beams like structures-using piezoelectric sensors and actuators-shape memory alloy.

UNIT - V

Introduction to Nanostructured materials, chemical and structural characterization, material behavior and technological implications to these materials.

Text Books:

1. Robert M Jones, “Mechanic of Composite Materials”, McGraw Hill Publishing Co.
2. Bhagwan D Agaravalam & Lawrence J Brutman, “Analysis and Performance of Fiber Composites”, John Wiley and Sons.

Reference Books:

1. Lecture notes on, “Smart Structures”, by Inderjith Chopra, Department of Aero space Engg. University of Maryland
2. Crawley E & Anderson E, “Detailed Models of Piezocermic actuation of Beams”, proceedings of the 30th AIAA/ASME/ASME/ ASCE/AHS/ASC-Structural dynamics and Material conference, AIAA Washington DC, April 1989.
3. Crawley E & De Luis J, “Use of Piezoelectric actuators as elements of Intelligent Structures”, AIAA Journal, Vol. 25, No 10, Oct 1987, pp 1373-1385.

Course Outcomes (COs):

The students will be able to

- Classify Composite materials and its applications.
- Application of smart materials in structural elements.
- Behaviour of Actuators and sensors.
- Apply the knowledge of control systems in structural elements.\
- Structural characterization of nano material

ADVANCE DESIGN OF STEEL STRUCTURES

Course Code: MSTRE251
Credit: 4:0:0 **Contact Hours: 56**

Course Content

Unit I

Introduction: General methods of plastic design, trial and error method, method of combining mechanism method, Plastic moment distribution method, Estimation of deflection.

Unit II

Plastic Analysis: Factors affecting the fully plastic moment, Plastic design of continuous beams, rectangular and gable frame, minimum weight design, Composite Beams

Unit III

Industrial Building: Design of Industrial Buildings, Trussed bents, Rigid frames (including fixed column bases) Gantry Girders.

Unit IV

Light Gauge Sections: Analysis and Design of light gauge sections, Plate Girders

Unit V

Chimney: Design of chimney, bins and silos

Text Books:

1. Plastic analysis by B.G Neal
2. Design of steel structures by Arya and Ajmani

References:

1. Plastic analysis of steel structures by L.S.Beedle.
2. Design of Steel structures by Ramchadra Vol-II
3. Introduction to plastic analysis of steel structures by J.F Bakar and Heyman. Publication /Publishers.
4. Design of steel structures by Edwin A. Gaylord, Jr. Charles N.Gaylord, James E Stallmeyer.
5. Design of Steel structure by N. Subramanyam

Course Outcomes (COs):

The students will be able to

- Reproduce the basic knowledge of plastic design, Plastic moment distribution method
- Apply the knowledge of plastic analysis to various component of structural system.
- Design of Industrial Buildings
- Analysis and Design of light gauge sections
- Design of chimney, bins and silos

DESIGN OF CONCRETE BRIDGES

Course Code: MSTRE252
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Introduction & Design of Slab Culvert: Historical Developments, Selection for Bridges, Classification of Bridges, Forces on Bridges, Dead load BM & SF, BM & SF For IRC Class AA Tracked Vehicle, BM & SF For IRC Class AA Wheeled Vehicle, BM & SF For IRC Class A Loading, Structural Design of Slab Culvert, Reinforcement Detail

UNIT - II

Box Culvert: Loading Cases, IRC Class AA Tracked Vehicle, IRC Class AA Wheeled Vehicle, IRC Class A Loading, Moment Distribution, Structural Design of Box Culvert, Reinforcement Detail

UNIT - III

T Beam Bridge: Slab Design: Proportioning of Components, Analysis of Slab using IRC Class AA Tracked Vehicle, Analysis of Slab Using IRC Class AA Wheeled Vehicle, Analysis of Slab using IRC Class A Loading, Structural Design of Slab. **Cross Girder:** Analysis of Cross Girder for Dead Load & IRC Class AA Tracked Vehicle, Analysis of Cross Girder for IRC Class AA Wheeled Vehicle & Class A Loads, Structural Design of Cross Girder. **Main Girder:** Analysis of Main Girder Using COURBON‟S Method for IRC Class AA Tracked vehicle for B M, Analysis of Main Girder Using COURBON‟S Method for IRC Class AA Wheeled vehicle for B M, Calculation of Live load SF, Calculation of Dead load BM and SF, Structural Design of Main Girder, Reinforcement Details of Main Girder

UNIT - IV

PSC Bridge: Introduction to Pre & Post Tensioning, Proportioning of Components, Analysis & Structural Design of Slab, Analysis of Main Girder Using COURBON‟S Method for IRC Class AA Tracked vehicle, Calculations of Prestressing Force, Calculations of Stresses, Cable profile, Design of End Block, Detailing of Main Girder.

UNIT - V

Balanced Cantilever Bridge: Introduction & Proportioning of Components, Design of Simply Supported Portion, Design of Simply Supported Portion, Design of Simply Supported Portion, Design of Cantilever Portion, Design of Cantilever Portion, Design of Articulation, Design of Articulation, Reinforcement Details of Main Girder

Text Books:

1. Essentials of Bridge Engineering by Dr D Johnson Victor, Oxford & IBH Publishing Co New Delhi
2. Design of Bridges by Dr N Krishna Raju, Oxford & IBH Publishing Co New Delhi

References:

1. Principles and Practice of Bridge Engineering by S P Bindra, DhanpatRai& Sons New Delhi
2. IRC 6 -1966 Standard Specifications And Course Code Of Practice For Road Bridges Section II Loads and Stresses, The Indian Road Congress New Delhi
3. IRC 21 - 1966 Standard Specifications And Course Code Of Practice For Road Bridges Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
4. IS 456 - 2000 Indian Standard Plain and Reinforced Concrete Course Code of Practice (Fourth Revision) BIS New Delhi
5. IS 1343 - Indian Standard Prestressed Concrete Course Code of Practice BIS New Delhi

Course Outcomes (COs):

The students will be able to

- Analyze and solve engineering problems in design of slab culvert subjected to flexure, shear and torsion.
- Analyze and solve engineering problems in design of box culvert subjected to flexure, shear and torsion.
- Demonstrate the procedural knowledge to design a system component as per needs and specifications of T- beam bridges subjected to various load combinations.
- Analyze and Design of Pre-tensioned as well as Post-tensioned slabs, girders subjected to various load combinations.
- Analyze and design the components of balanced cantilever bridge

DESIGN OF FORM WORKS

Course Code: MSTRE253
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Form Materials and Pressures on Formwork: Lumber – Types – Finish – Sheathing boards - Working stresses – Repetitive member stress – Plywood – Types and grades – Textured surfaces and strength – Reconstituted wood – Steel – Aluminum Form lining materials – Hardware and fasteners – Nails in Plywood – Bolts lag screw and connectors – Bolt loads. Pressures on Formwork - Concrete density – Height of discharge – Temperature – Rates of Placing – Consistency of concrete – Live loads and wind pressure – Vibration Hydrostatic Adjustment for non standard condition.

UNIT - II

Shores and Form Design: Simple wood stresses – Slenderness ratio – Allowable loads – Tubular steel shores - Patented shores – Site Preparation - Size and spacing – Steel Tower Frames – Safety practices – Horizontal shoring for multi-levels – More concentrated shore loads - T-heads – Two tier wood shores – Ellis shores – Dayton sure grip and Baker Roos shores – Safway Symons shores – Beaver Advance shores - Dead shores – Raking and Flying shores Basic simplification – Beam formulas – Allowable stresses

UNIT - III

Planning, Site Equipment and Plant for Form Work: Overall Planning – Detailed Planning – Standard units – Corner units – Schedule for column formwork – Formwork elements – Planning at Tender stage – Development of basic system – Planning for maximum reuse – Economical form construction – Planning examples – Crane size, effective scheduling estimate – Recheck plan details – Detailing the forms. Crane arrangement – Site layout plan – Transporting plant – Formwork beams – Formwork ties – Wales – Scaffold frames - Form accessories – Vertical transport tableform work.

UNIT - IV

Deflection bending lateral stability – Shear, Bearing – Examples in wall forms – Slab forms – Beam form – Ties, Anchors and Hangers – Column forms – Examples in each.

UNIT – V

Dome Forms, Tunnel Forms, Slipforms and Safety Practices for Scaffolds: Shells of translation and revolution - Hemispherical – Parabolic - Barrel vaults – Hypar Shells – Conoidal Shells - Folded plates – Shell form design – Building the form – Placing concrete – Strength requirements – Tunnel forming components – Curb and Invert forms

Text Books:

1. Robert L. Peurifoy and Garold D. Oberlender, "Formwork for Concrete Structures", Third Edition McGraw-Hill, 1996.
2. Hurd, M.K., "Formwork for Concrete", Special Publication No. 4 Sixth Edition, American Concrete Institute, Detroit, 1995.

Reference Books:

1. Michael P. Hurst, "Formwork", Construction Press, London and New York, 1997.
2. Austin, C.K., "Formwork for Concrete", Cleaver – Hume Press Ltd., London 1996.
3. Tudor Dinescu and Constantin Radulescu, "Slipform Techniques", Abacus Press, Turn Bridge Wells, Kent, 1992.
4. "Guide for Concrete Formwork", American Concrete Institute Detroit, Michigan, 1996.
5. "Safety Requirements for Scaffolding", American National Standards Institute, New York, 1994.

Course Outcomes (COs):

The students will be able to

- Behavior of form work material and pressures acting on formwork.
- Design of formwork and Shores
- Design a system, component or process as per needs and specifications of formwork
- Analysis, design and detailing of formwork and scaffolding elements for strength and durability.
- Acquire the Knowledge in Dome Forms, Tunnel Forms, Slip forms and Safety Practices for Scaffolds.

ROCK MECHANICS AND TUNNELING

Course Code: MSTRE254
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Engineering classification of Rocks: Classification and index properties of rocks, Rock strength and failure criteria, Initial stress in rocks, Influence of joints and their orientation on distribution of stresses - deformability of rocks.

UNIT - II

Laboratory and in-situ testing of rocks: Laboratory and in situ tests for various physical and mechanical properties. Field shear test, Deformability tests on rock mass, State of stress in the ground. In-situ stress, various methods of stress measurement, Hydro-fracturing technique, Flat jack technique.

UNIT - III

Behaviour of rock structures: Underground opening in infinite medium, Elastic and elasto-plastic approach. Stress concentration for different shapes of opening, Zone of influence. Failure criteria for rock and rock masses, Strength and deformability of jointed rock mass. Fracture strength of jointed rock mass.

UNIT - IV

Rock slope Engineering and improving of rock mass stability: Stability of rock slopes, Modes of failure. Foundations on rocks, Estimation of bearing capacity, Pile foundation in rocks. Methods to improve rock mass responses, Rock reinforcement, Grouting in rocks, Rock bolting, Rock anchors.

UNIT - V

Tunnel Engineering: Necessity, Planning of tunnels, Site investigation for tunnels, Types, Alignment and grade, Size and shape of a tunnel, Methods of construction, Tunneling in hard rocks- full face method-heading and bench method-drift method, Different methods of tunneling in soft soils. Shafts in tunnels-ventilation in tunnels, Lining of tunnels-drainage and lighting in tunnels. Problems in tunnel construction.

Text Books:

1. Godman, P.E."Introduction to Rock Mechanics", John Wiley, New York, 1989.
2. Jager, G. "Rock Mechanics and Engineering", Cambridge University Press, 1972.

References:

1. Verma, B.P. "Rock Mechanics for Engineers", Khanna publishers, New Delhi.
2. "Rock Mass Classification Systems", A Practical Approach in Civil Engineering Elsevier Publishers, New York.
3. Ramamurthy, T. "Engineering in Rocks for Slopes, Foundation and Tunnels", Prentice Hall India Pvt. Ltd.
4. Obert, L. and Wilbur. I. Duvall. “Rock Mechanics and the Design of Structures in Rock", John Wiley & Sons, Inc., New York.

Course outcomes (COs):

The students will be able to

- Classify the rocks and find the deformability of rocks.
- Understand the different laboratory tests to estimate the physical and mechanical properties.
- Understand the behavior of rock structures under the application of loads.
- Assess the stability of rock slopes and foundations on rocks.
- Select suitable method of tunneling for a given ground condition and its design

ADVANCED COMPUTATION LABORATORY

Course Code: MSTRL26
Credit: 0:0:1 **Total session: 14 (Each of 3hrs)**

Course Content

1. Analysis of steel trusses using FEM Software
2. Static analysis of Building structure using FEM Software
3. Dynamic analysis of Building structure using FEM Software
4. Design and detailing of RCC structure using FEM Software
5. Analysis and design of Elevated Water Tank using SAP 2000
6. Analysis and design of bridge deck using SAP 2000
7. Pushover analysis of RC structure using FEM Software
8. Stress analysis of cantilever beam, simply supported beam and fixed beam using Ansys.
9. Modal, Harmonic and Transient Analysis of a Cantilever Beam using Ansys
10. Eigen buckling and post buckling analysis of columns and steel plates subjected to different boundary condition using Ansys

Reference Books:

1. Rajaraman, V. Computer Oriented Numerical Methods, Prentice – Hall of India, 2004
2. Finite Element Analysis: Theory and Application with ANSYS - (2008 3rd ed.) - Saeed Moaveni, Minnesota
3. State University, Mankato CSI Analysis Reference Manual - Etabs 2013
4. Analysis and Design of Structures – A Practical Guide to Modeling Book D. Trevor Jones

Course outcomes (COs):

Students will be able to

- Analyze the static and Dynamic behavior of RC Building
- Design and develop analytical skills on Elevated Water Tank and Bridge deck
- Optimize a structural system by evaluating to non-linear static analysis.
- Explore the dynamic analysis capabilities of ANSYS. Modal, Harmonic, and Transient Analyses
- Analyze Eigen value and Nonlinear methods to solve a simple buckling problem

DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

Course Code: MSTR31
Credit: 3:1:0 **Contact Hours: 42+14**

Course Content

UNIT I

Engineering Seismology:
Elastic rebound theory and Theory of plate tectonics, Seismic waves, Seismic zoning, Seismic risk and hazards, Magnitude and intensity, Seismic pickups, Strong ground motion, Local site effects, Response of structures, Return period

UNIT II

Response Spectra: Elastic and inelastic design spectra, Tripartite plot, Use of response spectrum in earthquake resistant design, Selection of design EQs, Peak ground acceleration, Comparison of design and response spectra, Effects of yielding and ductility, Response control concepts using external devices and energy dissipating devices.

UNIT III

Conceptual Design: Structural configuration for earthquake resistant design, Simplicity and symmetry, frames, Shear walls and dual systems, Effect of infill masonry on frames, soft and weak storeys, Ductility and energy absorption in buildings, Strong column - weak beam design, Base isolation, Construction materials

UNIT IV

Linear Earthquake Analysis: Seismic design requirements, Design Earthquake loads, Load combinations, Mathematical modelling, Methods of analysis - Seismic coefficient method, Response spectrum method and Time history method, Symmetrical and unsymmetrical structures, Torsion in structures, Structural requirements, Earthquake resistant design methods.

UNIT V

Reinforced Concrete, Steel and Masonary Structures: Damages during past earthquakes, Ductility and Course Code guidelines, Capacity based designs, Design of shear walls, Precast constructions, Retrofitting, Behaviour of steel, Ductility requirements, Flexural members, Members subjected to axial load and bending moment,

Design of connections, Stiffeners and bracings, Retrofitting. Basic earthquake resistant design features and considerations for masonry structures.

Text Books:

1. 1.Pankaj Agarwal and Manish Shrikande, Earthquake Resistant Design of Structures, PrenticeHall of India Private Ltd, New Delhi
2. Duggal S K, Earthquake Resistant Design of Structures, Oxford University Press, New Delhi

Reference Books:

1. James L Stratta, Manual of Seismic Design, Pearson Education, Asia, New Delhi
2. Anil K Chopra, Dynamics of Structures, Pearson Education, Asia, New Delhi
3. Steven L Kramer, Geotechnical Earthquake Engineering, Pearson Education, Asia, New Delhi
4. Mark Fintel, Handbook of Concrete Engg, CBS Publishers, New Delhi

IS Codes: IS 1893: 2016, IS 13920: 2016, IS 4326: 2013, IS456(2000), SP16

Course Outcomes (COs):

Students will be able to

- Identify the theories responsible for occurrence of earthquakes, consequences and necessity of seismic zoning.
- Construct the site specific response spectra for a particular earthquake and response control using energy dissipating devices.
- Recognize the necessity of conceptual design, ductility and base isolation of structural systems to minimize the damage to structures.
- Evaluate the forces in the structures subjected to static and dynamic loadings using codal provisions.
- Design the shear walls, connections and ductility design of beams and columns, basic earthquake resistant features and considerations for masonry structures

DESIGN OF SUBSTRUCTURES

Course Code: MSTRE321
Credit: 4:0:0 **Contact Hours: 56**

Course Content

Unit I

Classification of foundation systems: General requirement of foundations, Selection of foundations, Computations of Loads, Design concepts. Shallow Foundations: Bearing capacity failures, Bearing capacity formulae & factors, Factor of safety, Selection of soil shear strength parameters, Settlement analysis of footings, Shallow foundations in clay, Shallow foundation in sand & c – ø soils, Footings on layered soils and sloping ground, foundations on rocks, Design for Eccentric or Moment Loads.

Unit II

Combined footings (rectangular & trapezoidal), strap footings, Soil-structure interaction effects & general concepts of structural design, Types of rafts, bearing capacity & settlements of raft foundation, Rigid methods, Elastic theory in raft foundations.

Unit III

Deep foundations - Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different types of piles in different soil conditions, laterally loaded piles, tension piles & batter piles, Load testing of piles.

Unit IV

Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles, Proportioning and design concepts of pile cap.

Unit V

Foundations for tower structures: Introduction, Forces on tower foundations, Selection of foundation type, Stability and design considerations, Retaining walls - analysis and design. Foundations on problematic soils – collapsible soils, expansive soils and sanitary landfills.

Text Books:

1. Swami Saran – "Analysis & Design of Substructures", Oxford & IBH Pub. Co. Pvt. Ltd., 1998.

2. Nainan P Kurian – "Design of Foundation Systems", Narosa Publishing House, 1992

References:

1. R.B. Peck, W.E. Hanson & T.H. Thornburn – "Foundation Engineering", Wiley Eastern Ltd., Second Edition, 1984.
2. Joseph E. Bowles – "Foundation Analysis and Design", McGraw-Hill Int. Editions, Fifth Ed., 1996.
3. W.C. Teng – "Foundation Design", Prentice Hall of India Pvt. Ltd., 1983.
4. Bureau of Indian Standards Course Codes: IS-1498, IS-1892, IS-1904, IS-6403, IS-8009,

IS-2950, IS-11089, IS-11233, IS-2911, IS - 802 and all other relevant Course Codes.

Course Outcomes (COs):

Students will be able to

- Analyze the Geotechnical data for the estimation of bearing capacity and settlement of soil under different field conditions.
- Design different types of shallow foundations and perform settlement analysis.
- Design deep foundations in different soil conditions.
- Design pile groups through bearing capacity and settlement analysis of soil.
- Analyze and / or design special foundations like tower structures, retaining walls and foundations on problematic soils

SOFT COMPUTING TOOLS

Course Code: MSTRE322
Credit: 4:0:0 **Contact Hours: 56**

Course Content

Unit I

Introduction

Optimization, Definition, Constrained Optimization, Unconstrained Optimization, Minimization and Maximization problems, Local Optimum, Global Optimum, Continuous Optimization, Combinatorial Optimization, Traditional Optimization Techniques, Travelling sales man problem.

Unit II

Biological Inspiration, Genetic Algorithm, Generic Operators (Crossover and Mutation), Selection Method, Population Size, Premature Convergence, Epitasis, Applications to Structural Optimization

Unit III

Simulated Annealing

Natural Motivation, Simulated Annealing, Algorithm, Initial Solution, Assess Solution, Randomly Tweak Solution, Acceptance Criteria, Temperature (Initial Temperature, Final Temperature, Temperature function, iterations at Temperature, Applications to Structural optimization.

Unit IV

Ant Colony Optimization

Natural Motivation, Ant Algorithm, Network - The Ant, Difference between Real and Virtual Ants, Initial population/colony size, Ant movement, Ant Tour, Pheromone and Pheromone Evaporation, Restart, Influence of Number of Ants, Multiple Ant Colony Optimization, Applications to Structural Optimization.

Unit V

Applications of Structural Optimization

Weight Minimization and Topology, Optimization of Truss Structures, Cost Minimization of RCC Structures and Pre-stressed Concrete Members

Text Books:

1. Rajasekaran S, Pai and Vijayalakshmi GA, " Neural Networks, Fuzzy Logic and Genetic Algorithm", PHI, Publishers, India
2. Tim Jones M, "AI Applications Programming", Charles River Media Inc, USA

Reference Books:

1. Rao SS, "Engineering Optimization:Theory and Practice", John Wiley, New York.
2. http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol4//tcw2/report.html
3. http:/iridia.ulb.ac.be/~mdorigo/ACO/ACO.html
4. Dorigo M, "Ant Colony Optimization", Prentice Hall India Limited, India
5. Journal: Engineering Optimization, Taylor & Francis and Journal of Heuristics.

Course outcomes (COs):

The students will be able to

- Define and use optimization terminology and concepts, and understand how to classify an optimization problem.
- Identify, formulate and solve engineering problems using Optimization Techniques
- Understand the importance and application of Simulated Annealing in solving the optimization problems.
- Apply the Ant Colony Optimization algorithm to Structural Optimization.
- Perform structural optimization on RCC and pre-stressed structures

STABILITY ANALYSIS OF STRUCTURES

Course Code: MSTRE323
Credit: 4:0:0 **Contact Hours: 56**

Course Content

Unit I

Beam - Column:
Differential equation, Beam column subjected to (i) lateral concentrated load, (ii) several concentrated lateral load, Applications of trigonometric series, Euler‟s formation using fourth order differential equation for pinned - pinned, fixed - fixed, fixed - free and fixed - pinned column.

Unit - II

Buckling of Frames and Continuous Beams:
Elastic energy method, Approximate calculation of critical loads for a cantilever, Exact critical load for hinged - hinged column using energy approach, Buckling of bar on elastic foundation, Buckling of cantilever column under distributed loads, Determination of critical loads by successive approximation, Bars with varying cross section, Effect of shear force on critical load, Column subjected to non- conservative and pulsating forces.

Unit – III

Stability Analysis by Finite Element Approach:
Derivation of shape functions for a two node Bernoulli - Euler beam element (lateral and translation DOF), element stiffness and element geometric stiffness matrices, assembled stiffness and geometric stiffness matrices for a discredited column with different boundary condition, elevation of critical loads for a discredited (two elements) column (both ends built-in), Algorithm to generate geometric stiffness matrix for four node isoparametric elements, Buckling of pin jointed frames (maximum of two active DOF), symmetrical single way portal frame.

Unit – IV

Lateral Buckling of Beams:
Differential equation, pure bending, cantilever beam with point load, simply supported beam of I section subjected to central concentrated load, Pure torsion of thin walled bars of open cross section Non uniform torsion of thin walled bars of open cross section.

Unit – V

Buckling of Plates:

Expression for strain energy in plate bending (linear and non- linear), Buckling of simply supported rectangular plate, uniaxial load and biaxial load, Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides.

Text Books:

1. Stephen. P. Timoshenko, James M. Gere, "Theory of elastic stability", 2nd edition, Mcgraw- Hill, New York
2. Bleich F, "Buckling Strength of Metal Structures", Mcgraw- Hill, New York

References:

1. Robert D Cook et-al, "Concepts and applications of finite element anlysis",4th edition, John Wiley and Sons, New York
2. S. Rajshekaran, "Computational structural mechanics", Prentice Hall, New Delhi

Course outcomes (COs):

The students will be able to

- Apply the knowledge of trigonometric series and Euler"s formula for various loading and end conditions.
- Apply the elastic energy method in buckling of frames and continuous beams.
- Forecast safety against failure, through analytical modeling using software.
- Demonstrate structural stability of individual elements and also at junctions bending elements.
- Buckling behavior of plates for various end conditions

RELIABILTY ANALYSIS AND DESIGN OF STRUCTURES

Course Code: MSTRE324
Credit: 4:0:0 **Contact Hours: 56**

Course Content

Unit I

Concepts of Structural safety and Basic statistics:

Permissible and limit state design methods, Data reduction, Histograms, Sample correlation

Unit II

Probability Theory:

Introduction to Set theory, random events and variables, moments and expectations, common probability distributions

Unit III

Resistance Distribution and Parameters:

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.

Unit IV

Probabilistic Analysis of loads:

Gravity load, Introduction, load as a stochastic process. Wind load- Introduction, wind speed, return period, estimation of life time design wind speed, and probability model of wind load.

UNIT V

Basic Structural Reliability:

Introduction, Computation of structural reliability, Monte Carlo study of structural safety and applications. Level - 2 Reliability methods: 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

Text Books:

1. Ang, A. H. S., and Tang, W. H. "Probability Concepts in Engineering Planning and Design, "Volume I, John Wiley and Sons, Inc, New York. (1984).
2. Ranganathan, R. Structural Reliability Analysis and Design, Jaico Publishing House, Mumbai, India. (1999)

References:

1. Milton, E. Harr, "Reliability Based Design in Civil Engineering, McGraw Hill Book Co. (1987).
2. Nathabdndu, T., Kottegoda, and Renzo Rosso Statistics, Probability and Reliability for Civil and Environmental Engineers, McGraw Hill International Edition, Singapore. (1998).
3. Achintya Haldar, and Sankaran Mahadevan, "Probability, Reliability and Statistical Methods in Engineering Design, John Wiley and Sons. Inc. (2000).
4. Thoft Christensen, P., and Baker, M J, "Structural Reliability Theory and its Applications, Springer Verlag, Berlin, New York. (1982),

Course Outcomes (COs):

Students will be able to

- Solve engineering problems of structural safety and statistics
- Solve engineering problems of random variables and probability distributions
- Solve problems with respect to statistical properties of materials and characteristic strength
- Solve engineering problems with respect to loads treated as stochastic process
- Solve engineering problems with respect to reliability based design of structures

MASONRY STRUCTURES

Course Code: MSTRE331
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT I

Introduction, Masonry Units, Materials & Types

History of masonry, characteristics of Brick, stone, clay block, concrete block, stabilized mud block masonry units, strength, modulus of elasticity & water absorption, Masonry materials - Classification & properties of mortars, selection of mortars

UNIT II

Strength of Masonry in Compression

Behavior of Masonry under compression, strength & elastic properties , influence of masonry unit & mortar characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength of masonry in Indian context, failure theories of masonry under compression. Effect of slenderness & eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength

UNIT III

Flexural & Shear Bond, Flexural Strength & Shear Strength

Bond between masonry unit & mortar , tests for determining flexural & shear bond strengths, factors affecting bond strength , effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure , shear strength of masonry, test procedures for evaluating flexural& shear strength, Permissible compressive stress, stress reduction & shape reduction factors, increase in Permissible stresses for eccentric vertical & lateral loads, permissible tensile & shear stresses. 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 IV

Design of Load Bearing Masonry Buildings

Permissible compressive stress, stress reduction & shape reduction factors, increase in Permissible stresses for eccentric vertical & lateral loads, permissible tensile & shear stresses , Effective height of wall & columns, openings in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action , lintels, Wall carrying axial loads, eccentric load with different eccentricity ratios, wall with openings, freestanding wall. Concept of Limit State Design of load bearing

masonry for building up to 3 to 8 storey using Reinforced Masonry with Proposed BIS Course Code provisions

UNIT V

Design of Reinforced Masonry Buildings

Reinforced Masonry: Introduction, Flexural strength, Shear strength of reinforced masonry, Deflection of reinforced masonry beams, Reinforced masonry columns, using BS 5628 : Part2

Behavior of masonry and Reinforced Masonry during earthquakes, concepts & design procedure for earthquake resistant masonry, Seismic design requirements and design of masonry structures, BIS Course Code provisions, Masonry arches, domes & vaults Components & classification of masonry arches, domes & vaults.

Text Books:

1. Hendry A.W , "Structural masonry" , Macmillan Education Ltd. ,2nd edition
2. Sinha B.P & Davis S.R. "Design of Masonry structures" , E&FN Spon.

References:

1. Dayaratnam P, "Brick & Reinforced Brick structures" , Oxford & IHB
2. Curtin, "Design of Reinforced & Pre stressed Masonry" , Thomas Telford
3. Sven Sahlin, "Structural Masonry" , Prentice Hall
4. Jagadish K.S Venkatarama Reddy B.V & Nanjunda Rao K.S, "Alternative building materials & technologies" , New age International , New Delhi & Bangalore
5. IS 1905 BIS New Delhi
6. SP 20 (S & T) New Delhi.

Course Outcomes (COs):

Students will be able to

- Classify and describe the characteristics of Brick, stone, clay block, concrete block,
- Describe the behavior of masonry under compression, strength & elastic properties.
- Calculate masonry flexural, shear bond strength of and permissible compressive stress.
- Analyze and design the load bearing masonry building.
- Understand behavior of reinforced masonry building and design earthquake resistant masonry building

ADVANCED PRESTRESSED CONCRETE

Course Code: MSTRE332
Credit: 4:0:0 **Contact Hours: 56**

Course Content

Unit I

Pre-stressing systems and end anchorages, losses of pre-stress, deflections, analysis of beams of different cross sections for flexure, shear, bond and bearings, Cable layouts.

UNIT II

Design of circular systems, domes and slabs

Unit III

Design of Pre-stressed Bridges, (Super-structure only)

Unit IV

Design of continuous beams, folded plates and shells

UNIT V

Design of tension, compression members and pipes

Text Books:

1. Krishna Raju N, „Pre - stressed Concrete", Tata Mcgraw Hill, New Delhi
2. Rajagopalan N, „Pre - stressed Concrete „, Narosa Publishing House, New Delhi

Reference books:

1. Lin T Y and Burns N H, „Design of Pre - stressed Concrete Structures" , John Wiley and Sons, New York
2. Pundit G S and GuptaS P, „Pre - stressed Concrete „, C B S Publishers, New Delhi

Course Outcomes (COs):

The Students will be able to

- Understand the basic principles of Prestressing.
- Analyze and design circular systems, domes and slabs
- Design Pre-stressed Bridges.
- Design continuous beams, folded plates and shells.
- Design tension and compression members

PRE-FABRICATED STRUCTURES

Course Code: MSTRE333
Credit: 4:0:0 **Contact Hours: 56**

Course Content

Unit I

Introduction: Need for prefabrication, principles, materials, modular coordination, standardization, systems production, transportation and erection.

Unit II

Prefabricated Components: Behaviour of structural components, Large panel constructions, Construction of roof and floor slab, Wall panels, Columns, Shear walls.

Unit III

Design Principles: Disuniting of structures, Design of cross section based on efficiency of material used, Problems in design because of joint flexibility, Allowance for joint deformation.

Unit IV

Joint in Structural Members: Joints for different structural connections, Dimensions and detailing, Design of expansion joints.

Unit V

Design for Abnormal Loads: Progressive collapse, Code provisions, Equivalent design loads for considering abnormal effects such as earthquakes, cyclones, etc., Importance of avoidance of progressive collapse.

Text Books

1. CBRI, Building materials and components, India, 1990
2. Gerostiza C.Z., Hendrikson C. and Rehat D.R., Knowledge based process planning for construction and manufacturing, Academic Press Inc., 1994

References

1. Koncz T., Manual of precast concrete construction, Vols. I, II and III, Bauverlag, GMBH, 1971.
2. Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 1978.

Course Outcomes (COs):

The students will be able to

- Understand the principles, need and the erection methods of prefabricated structures.
- Analyze the Prefabricated components for different types of loads.
- Design various cross sections of prefabricated structures.
- Analyze and detail the joints for different structural connections and expansion joints.
- Apply the codal provisions for designing the structures to abnormal loads

FRACTURE MECHANICS

Course Code: MSTRE334
Credit: 4:0:0 **Contact Hours: 56**

Course Content

UNIT - I

Elastic Crack Model: Fundamentals of the Theory of Elasticity and Indicial Notations. Elastic Stress Field at Crack Tip, William‟s Problem, Stress Intensity Factors, Fracture Toughness, Different Modes of fracture, Direction of Crack Propagation.

UNIT II

Griffith Energy Balance & Plasticity Effects::Basic Energy Balance, Fixed Grip and Fixed Force Conditions, Strain Energy Release Rate, Experimental Calibration. Elementary estimates of Size and Shape of Plastic Zones, Plasticity Correction Factor, Plane Strain vs. Plane Stress Conditions, Dugdale Model, Crack Tip Opening, J-integral and its Applications.

UNIT - III

Applied FractureMechanics:3-D Effects at the Crack Front, Fatigue Crack Growth, Penny and Elliptical Shaped Flaws, Part-Through Surface Cracks, Summary and Relevant Crack Tip Stress Intensity Factors.

UNIT – IV

Analytical Stress Analysis:Westergaard Stress Function.Advanced Topics: Fracture Toughness of Fiber Reinforced Brittle Matrix Composites, Stress Intensity Factors at Crack Corners, Interface Cracks.

UNIT - V

Numerical Stress Analysis: Boundary Collocation, Conventional Finite Elements, Special Crack

Tip Elements, Quarter Point Eight Node Isoparametric Elements.

Text Books

1. K. Hellan, Introduction to Fracture Mechanics, McGraw-Hill, 1984.
2. D. Broek, Elementary Engineering Fracture Mechanics, 4th Revised Edition, Kluwer Academic Pub., 1991.

References

1. G. Sih, Handbook of Stress Intensity Factors, CBS Publications, New Delhi
2. T. Anderson, Fracture Mechanics, CRC Publications, New York

Course outcomes (COs):

Students will be able to

- Understand basic knowledge of fracture mechanics and elastic crack model.
- Apply the knowledge of Griffith Energy Balance & Plasticity Effects in the analysis of structures.
- Analyze the Fatigue crack growth and relevant crack tip stress intensity factors.
- Evaluate the Toughness of fiber reinforced brittle mix composites.
- Analyze the Iso parametric elements for different stresses.

DYNAMICS & EARTH QUAKE ENGINEERING LABORATORY

Course Code: MSTRL34
Credit: 0:0:1 **Total session: 14 (Each of 3hrs)**

Course Content

List of Experiments

1. Determination of Natural frequency of Equivalent Spring Mass System
   a) To study the free longitudinal vibrations of a spring mass system
   b) To verify the Dunkerley's formula for transverse vibration.
2. Determination of Natural frequency of three storied building frame subjected to harmonic base motion.
3. Determination of Natural frequency of one-storied building frame with planar asymmetry subjected to harmonic base motions
4. Dynamics of a three storied building frame subjected to periodic (non-harmonic) base motions 5. Vibration isolation of a secondary system
7. Dynamics of a vibration absorber
8. Dynamics of a four storied building frame with and without an open ground floor
9. Dynamics of one-span and two-span beams
10. Earthquake induced waves in rectangular water tanks
11. Seismic wave amplification, liquefaction and soil-structure interactions.

Text Books:

1. Mario Paz, Structural Dynamics, CBS Publishers, New Delhi
2. Anil K Chopra, Dynamics of structures, Pearson Publications, New Delhi.
3. Steven L Kramer, Geotechnical Earthquake Engineering, Pearson Education.
4. James L Stratta, Manual for Seismic Design, Pearson Education, Asia, New Delhi.

Reference Books:

1. Clough and Penzein, Dynamic of structures, Mcgraw Hill Publishers, New York Manuals of Dynamics of structures

Course outcomes (COs):

The students will be able to

- Evaluate the natural frequency of SDOF systems subjected to free longitudinal vibrations

- Analyze the three storied building subjected to harmonic and non harmonic base excitations.
- Assess the impact of vibration isolation on the seismic performance of structure.
- Understand the concept of soft storey and weak storey and their performance during earthquakes.
- Recognize the necessity of soil structure interaction and effect of liquefaction during earthquakes

REMEDIAL ENGINEERING LABORATORY

Course Code: MSTRL35
Credit: 0:0:1 **Total session: 14 (Each of 3hrs)**

Course Content

List of Experiments

1. Rebound hammer test on concrete with various methods of holding the instrument.
2. Ultra-Sonic Pulse Velocity test on concrete members.
3. Carbonation and corrosion test on concrete.
4. Measurement of shrinkage and creep in concrete.
5. Shear Test on cylinder
6. Tests on concrete at elevated temperature under controlled condition
7. Permeability test on concrete
8. Core sampling test on concrete.
9. Fresh and hardened properties of cementious Grout
10. Condition survey

Text Books

1. Sidney, M. Johnson "Deterioration, Maintenance and Repair of Structures".
2. Denison Campbell, Allen & Harold Roper, "Concrete Structures – Materials, Maintenance and Repair"- Longman Scientific and Technical

Reference Books:

1. R.T.Allen and S.C. Edwards, "Repair of Concrete Structures"-Blakie and Sons
2. Raiker R.N., "Learning for failure from Deficiencies in Design, Construction and Service"- R&D Center (SDCPL)
3. CPWD Hand book on rehabilitation of structures

Course Outcomes (COs):

The students will be able to

- Carry out the inspection of distressed structures to observe and record comprehensive information about the distress and prepare structural evaluation report.
- Use Rebound Hammer, ultra-sonic pulse velocity to evaluate strength and quality of concrete

- Measure shrinkage, creep and permeability in concrete
- Detect reinforcement , its diameter and measure corrosion and carbonation of rebars in RC members
- Retrofit the structural elements

INTERNSHIP / INDUSTRIAL TRAINING

Course Code: MSTR36
Credit: 0:0:2

Course Content

Course outcomes (COs):

The students will be able to

- Analyse a given engineering problem, identify an appropriate problem-solving methodology, implement the methodology and propose a meaningful solution.
- Apply prior acquired knowledge in problem solving.
- To work in a team and take initiatives.
- To manage a project within a given time frame.
- To adopt a factual approach to decision making.

DISSERTATION WORK I & II

Course Code: MSTR37	**Course Code: MSTR41**
Credit: 0:0:6	**Credit: 0:0:22**

Course Content

Course outcomes (COs):

The students will be able to

- Identify the Project work topic by literature review.
- To conduct the necessary investigation in relation to the identified gap.
- Carry out the analysis for the obtained data through experimentation /Analytical investigations/Computational studies.
- Interpret the results of the research and assess the usefulness of the work.
- To lead into a career as structural engineer/ faculty/ researcher