COURSE CURRICULUM

DEPARTMENT OF CIVIL ENGINEERING

(w.e.f. Session 2018-19)

INSTITUTE OF ENGINEERING & TECHNOLOGY

Table of Contents

COURSE STRUCTURE

M.TECH.

(STRUCTURAL ENGINEERING)

First Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HR/WK
			L	T	P		
1	MCE-C0-001	Advanced Mechanics of Solids	4	0	0	4	4
2	MCE-C0-002	Advanced Structural Analysis	4	0	0	4	4
3	MCE-C0-003	Advanced Design of Metal Structures	4	0	0	4	4
4	MCE-C0-004	Numerical Analysis & Computer Programming	4	0	0	4	4
5	MCE-C0-005	Structural Dynamics	4	0	0	4	4
		TOTAL	**20**	**0**	**0**	**20**	**20**

Second Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	CONTACTS HRS/WK
			L	T	P		
1	MCE-C0-006	Finite Element Method	4	0	0	4	4
2	MCE-C0-007	Advanced Concrete Design	4	0	0	4	4
3	MCE-C0-008	Earthquake Resistant Design	4	0	0	4	4
4	MCE-C0-009	Concrete Technology Laboratory	0	0	4	2	4
5		Elective I	4	0	0	4	4
6		Elective II	4	0	0	4	4
		TOTAL	**20**	**0**	**4**	**22**	**24**

Third Semester

S. No.	SUBJECT CODE	SUBJECT	PERIODS			CREDITS	CONTACT HRS/WK
			L	T	P		
1		Elective III	4	0	0	4	4
2		Elective IV	4	0	0	8	4
3		Dissertation-I	-	-	-	4	-
4		Seminar	0	0	4	2	4
		TOTAL	**8**	**2**	**4**	**14**	**12**

Fourth Semester

S. No.	SUBJECT CODE	SUBJECT	PERIODS			CREDITS	CONTACT HRS/WK
			L	T	P		
1		Dissertation –II	-	-	-	14	
		TOTAL				**14**	
		TOTAL CRADIT OF ALL THE SEMESTERS				**70**	

PROGRAM ELECTIVE						
S. no	**Type**	**Courses**	**L**	**T**	**P**	**Code**
1	PE	Advanced Design of Bridges	4	0	0	MCE-E0-001
2	PE	Advanced Concrete Technology	4	0	0	MCE-E0-002
3	PE	Non Conventional Construction Materials &Elements	4	0	0	MCE-E0-003
4	PE	High Rise Structures	4	0	0	MCE-E0-004
5	PE	Durability Assessment and Structural Strengthening of Reinforced Concrete	4	0	0	MCE-E0-005
6	PE	Experimental Stress Analysis	4	0	0	MCE-E0-006
7	PE	Soft Computing Methods for Civil Engineering	4	0	0	MCE-E0-007
8	PE	Optimization Methods in Civil Engineering	4	0	0	MCE-E0-008
9	PE	Soil Structure Interaction	4	0	0	MCE-E0-009
10	PE	Theory of Plates and Shells	4	0	0	MCE-E0-010
11	PE	Construction Management And Equipment	4	0	0	MCE-E0-011
12	PE	Retrofitting of Structures	4	0	0	MCE-E0-012

SYLLABUS
M.TECH.

(STRUCTURAL ENGINEERING)

MCE-C0-001: ADVANCED MECHANICS OF SOLIDS

Objective:

The objective of this course is to impart of the basic principles of the continuum mechanics namely theory of elasticy, plasticity and visco elasticity enabling to analyses and design structures obeying complicated constitutive relationship etc.

Credits: 04 **Semester I** **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	**Analysis of Stress:**Concept of Stress, Stress Components, Equilibrium Equations, Stress on a General Plane (Direction Cosines, Axis Transformation, Stress on Oblique Plane through a point, Stress Transformation), Principal Stresses, Stress invariants, Deviatoric Stresses, Octahedral Stresses, Plane Stress, Stress Boundary, Condition Problem. **Analysis of Strain:**Deformations (Lagrangian Description, Eulerian Description),Concept of Strain, Strain Components (Geometrical Interpretation),Compatibility Equations, strain transformation, Principal Strains, Strain Invariants, Deviatoric Strains, Octahedral Strains, Plane Strain, Strain Rates. **Stress-Strain Relations:** Introduction,One-Dimensional Stress-Strain Relations (Idealized Time-independent and time-dependent stress-strain laws), Linear Elasticity (generalized Hooke's Law), Stress-Strain Relationship for Isotropic and Anisotropic Materials (Plane Stress and Plane Strain).	12
II	**Basic Equations of Elasticity for Solids:**Introduction, Stresses in Terms of displacements, Equilibrium Equations in terms of displacements, Compatibility equations in Terms of Stresses, Special cases of Elasticity equations (Plane Stress, Plane Strain, Polar Co-ordinates), Principle of Superposition, Uniqueness of Solution, Principle of virtual work, Potential and Complementary energy, Variational Principals, St. Venant's Principle, Methods of analysis for Elastic Solutions, Elastic solutions by Displacement and stress Functions, Airy's Stress function (Plane stress, Plane strain, Polar Co-ordinates). **Torsion:**introduction, Circular, shaft, Torsion of non-circular cross-section, St. Venant's theory, Warping function, Prandtl's stress function, Shafts of other cross-sections, Torsion of bars with thin walled section.	16
III	**Plasticity:**Introduction, Basic Concepts, Yield Criteria (Tresca, Von-Mises, Mohr Coloumb, Drucker-Prager), Yield Surface, equivalent stress and equivalent strain, Plastic work, Flow Rule-Plastic Potential, Elastic-Plastic and plastic stress-strain relations, Plastic Flow of anisotropic materials **Viscoelasticity and Viscoplasticity:**Introduction, Viscoelastic models (Maxwell, Kelvin-Voigt, Generalized Maxwell and Kelvin models), Viscoelastic stress-strain relationships, Viscoplasticity.	12

Reference Books/ Text Book / Cases:

1. "Mathematical Theory of Elasticity" by I. S. Sokolnikoff(1941).
2. "Advanced Machanics of Materials" by Boresi(2011).
3. "Theoretical Elasticity" by A. E. Green and W. Zerna(1968).
4. "Theory of Elasticity" by Timoshienko(1934).
5. "Advanced Strength and Applied Elasticity" by A. C. Ugural and S. K. Fenster(2003)
6. "Applied Elasticity" by R.T. Fenner(1988).
7. "Advanced Strength of Materials" by L. S. Srinath(2000)

Outcomes:

After completing this course the students' will learn the basics teachings for the analysis of continuum based on theory of elasticity plasticity and visco elasticity and apply those to specific problems. This will also help them in taking up challenges in their engineering profession and research in handling complicated structures.

MCE-C0-002:ADVANCED STRUCTURAL ANALYSIS

Objective:

The objective of this course is to develop a computer program for structural analysis based on the matrix stiffness, analyse the general stiffness and flexibility method and apply it to solve indeterminate structures, etc.

Credits: 04 **Semester I** **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	**Matrix Analysis of Structures:**Introduction; Coordinate systems; Displacement and force transformation matrices, Element and structure stiffness matrices, Element and structure flexibility matrices, Equivalent joint loads; Stiffness and flexibility approaches. **Matrix Analysis of Structures with Axial Elements:**Axial stiffness and flexibility; Stiffness matrices for an axial element (two dof), plane truss element (four dof) and space truss element (six dof). Analysis by stiffness method (two/one dof per element), Analysis by flexibility method, Plane Trusses: Analysis by stiffness and flexibility methods. Space Trusses: Analysis by stiffness method.	14
II	**Matrix Analysis of Beams and Grids:**Beam element stiffness (four dof); Generation of stiffness matrix for continuous beam; Dealing with internal hinges, hinged and guided-fixed end supports. Accounting for shear deformations.Beam element stiffness (two dof); Dealing with moment releases, hinged and guided-fixed end supports. **Flexibility Method for Fixed and Continuous Beams:** Force transformation matrix; Element flexibility matrix; Solution procedure (including support movements). **Stiffness Method for Grids:**Introduction; Torsional stiffness of grid element and advantage of torsion release; Analysis by stiffness method using grid element with six/three dof.	16
III	**Matrix Analysis of Plane and Space Frames:** **Stiffness Method for Plane Frames:**Element stiffness (six dof); Generation of structure stiffness matrix and solutionprocedure; Dealing with internal hinges and various end conditions. **Flexibility Method for Plane Frames:**Force transformation matrix; Element flexibility matrix; Solution procedure (including support movements); Ignoring axial deformations. **Introduction to nonlinear analysis**	10

Reference Books/ Text Book / Cases:

1. Matrix analysis of framed structures – W.Weaver& J.M. Gere(1990)
2. Matrix structural analysis – J.L.Meek(1971).
3. Matrix structural analysis –R.H.Galaghar Jr(2014).
4. Introduction to linear system analysis – R.G.Brown&J.W.Nilson(1962)

Outcomes:

After completing this course the students are able to solve the structural problems by using both conventional and direct methods of matrix analysis (both flexibility and stiffness methods), they will also able to write the programs for analysis and design of the structures.

MCE-C0-003:ADVANCED DESIGN OF METAL STRUCTURES

Objective:

The objective of this course is to develop the ability to analyse and design steel structures of advanced level like transmission Towers, Industrial Sheds, etc.

Credits: 04 **SemesterI** **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	Introduction to the use of light gauge steel sections with application to flat slab, grid and orthotropic plates. Design of Aluminum structures.	12
II	Design of transmission line towers, concept of TV and guyed towers. Buckling of steel columns, Beam column and their designs. Rigid, Semi-Rigid and Flexible connections.	16
III	Plastic methods of Structural Analysis of frames. Design of Industrial trussed bents. Pressed steel construction	12

Reference Books/ Text Book / Cases:

1. Design of steel structures- Bresler Lin &Scalzi(2000).
2. Steel building analysis and design- Crawley &Dhillon(1993).
3. Design of steel structures- S. K. Duggal(2010).
4. Design of steel structures- Arya&Ajmani(1972).

Outcomes:

On completion of this course the students will be able to design advanced steel structures which are not covered in under graduate level but important as per industrial consideration. This subject also helps in developing the fundamentals of design using Light Gauge Steel which is not yet popular in India but has huge future scope.

MCE-C0-004:NUMERICAL ANALYSIS AND COMPUTER PROGRAMMING

Objective:

The objective of this course is to impart numerical techniques in analysis of complex real problem dealing with Transcendental, polynomial linear nonlinear equation, ODE, PDE, Numerical Integration with the help of computer.

Credits: 04 **Semester I** **L-T-P: 4-0-0**

Module No.	Content	Teaching Hours
I	Introduction, roots of a non-linear equation and roots of a polynomial of nth degree [incremental search method, method of successive approximations, Newton's method, bisection method, secant method, Müller's method, synthetic division, Bairstow's method] and convergence study Solution of (non-homogeneous) linear algebraic equations, review of matrix algebra, Gauss elimination method, Cholesky's decomposition method, householder method, Gauss-Siedal iterative method	12
II	Solution of non-linear algebraic equations, method of successive approximation, Newton's method, modified Newton – Raphson method, secant method Eigen values and Eigen vectors, reduction of generalized Eigen value problem to the standard Eigen value problem, methods for obtaining Eigen values and Eigen vectors [polynomial method, vector iteration method, Mises power method, Jacobi method]	14
III	Time marching schemes for solution of problems in time domain, numerical integration (2 – D) [Newton – Cotes method, Gauss – Legendre method] Solution of ordinary and partial differential equations, Euler's method, Runge – Kutta method, finite difference method, applications to problems of beam and plates on elastic foundation, Laplacian equation, consolidation equation, laterally loaded piles etc Computer programming using MATLAB and its application in solving civil engineering problems	14

Reference Books:

1. Chapra, S. C. and Canale R. P., "Numerical Methods for Engineers", Tata McGraw hill(2012).
2. Carnahan, B., Luther, H. A. and Wilkes, J. O., "Applied Numerical Methods", John Wiley(1972).
3. Heath, M. T. ,"Scientific Computing : An Introductory Survey", McGraw hill(1946).
4. Douglas Faires, J. and Richard Burden, "Numerical Methods", Thomson(2012).
5. Rajasekaran, S., "Numerical Methods in Science and Engineering", S. Chand(2003).

Outcomes:

Students will be able to solve complicated engineering problems involving Simultaneous linear and nonlinear equation, roots of transcendental and polynomial equation, ODE & PDE, numerical integration, MATLAB programming aspect of different numerical method and its application in solving civil engineering problems.

MCE-C0-005:STRUCTURAL DYNAMICS

Objective:

The objective of this course is to develop fundamentals about various dynamic problems of complex nature and response of structures to these conditions.

Credits: 04 **Semester I** **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	**Introduction:**Types of dynamic loads, Basic background of methods available and motivation for structural dynamics **Dynamics of Single Degree-of-Freedom Structures**: Dynamic equation of equilibrium, Free vibration of single degree of freedom systems, Forced vibration: harmonic and periodic loadings, Dynamic response functions, force transmission and vibration isolation, SDOF response to arbitrary functions **Numerical Evaluation of Dynamic Response of SDOF Systems:**Time domain analysis: finite difference methods, Frequency domain analysis: basic methodology	12
II	**Earthquake Response of SDOF Systems**: Earthquake excitation, response history and construction of response spectra, Response spectrum characteristics, tripartite plot, and design spectrum. **Multi Degree of Freedom Systems - Basics:**Dynamic equations of equilibrium, static condensation, Symmetricplan and plan-asymmetric systems. **Free Vibration Response of MDOF Systems:**Undamped systems: natural modes and their properties, Numerical solution for the eigenvalue problem, Solution of free vibration response for undamped systems, Free vibration analysis of systems with damping.	16
III	**Dynamic Analysis of Linear MDOF Systems**: Introduction, modal analysis, Response-history for earthquake excitations using modal analysis, Response spectrum analysis for peak responses, Concept of Caughey damping as a general type of proportional damping. **Generalized Single Degree of Freedom Systems**: Basic concepts, mass-spring system, Lumped mass systems, Systems with distributed mass and elasticity, Rayleigh's method, shape function selection.	12

Reference Books/ Text Book / Cases:

1. Introduction to Structural Dynamics – J. M. Biggs(2010).
2. Elements of Earthquake Engineering – Jai Krishna and A. R. Chandrasekharan(1976).
3. Soil Dynamics – ShamsherPrakash(1981).
4. Dynamics of Structures – R.W.Clough&J.Penzien(2003).
5. Earthquake Resistant Design of Structure – PankajAgarwal& Manish Srikhande(2006)
6. Structural Dynamics – Mario Piaz(2013)
7. Dynamics of Structure – Anil K Chopra (2011)

Outcomes:

After completing thiscourse the students will be able to develop fundamental knowledge of dynamics and its application in the field of structures. They will also be able to develop the background required for design of structures subjected to various forms of dynamic loadings including Earthquake and Blast.

MCE-C0-006:FINITE ELEMENT METHOD

Objective:

The objective of this course is to develop understanding of types of elements and their use in solving complex problems using computation techniques.

Credits: 04 **Semester II** **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	**Introduction to Finite Element Analysis:** Introduction Basic Concepts of Finite Element Analysis Introduction to Elasticity Steps in Finite Element Analysis **Finite Element Formulation Techniques**:Virtual Work and Variational Principle, Galerkin Method, Finite Element Method: Displacement Approach, Stiffness Matrix and Boundary Conditions	12
II	**Element Properties:**Natural Coordinates, Triangular Elements, Rectangular Elements, Lagrange and Serendipity Elements, Solid Elements, Isoparametric Formulation, Stiffness Matrix of Isoparametric Elements, Numerical Integration: One Dimensional. Numerical Integration: Two and Three Dimensional **Analysis of Frame Structures:**Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beam, Plane Frame Analysis, Analysis of Grid and Space Frame	16
III	**FEM for Two and Three Dimensional Solids:** Constant Strain Triangle,Linear Strain Triangle,RectangularElements,Numerical Evaluation of Element Stiffness,Computation of Stresses, Geometric Nonlinearity and Static Condensation,AxisymmetricElement,Finite Element Formulation of Axisymmetric Element,Finite Element Formulation for 3 Dimensional Elements Introduction to Plates and Shells	12

Reference Books/ Text Book / Cases:

1. Finite Element Method for Engineers and scientists – O.C.Zienkiewicz(2013).
2. Numerical Methods in Finite Element Analysis – K.J.Bathe&E.L.Wilson(2014).
3. Matrix Computations for Engineers & scientists – Alan Jennings(1977).
4. Introduction to Finite Element Method – C.S.Desai&J.F.Abel(2001).
5. Finite Element Method in Engineering – S.S. Rao(2011)

Outcomes:

On completion of this course the student will develop the ability to solve complex problems using finite no of elements by any standard FEM software or even by self developed programmes. This course also enables them to model problems of complex nature.

MCE-C0-007:ADVANCED CONCRETE DESIGN

Objective:

The objective of this course is to design the water retaining structures, flat slab, plate and shells, bunkers, silos and bunkers.

Credits: 04 **Semester II** **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	Design of water tanks including the effect of continuity. Design of roofing elements - flat slabs,	16
II	Design of folded plate and shell roof	12
III	Design of Reinforced Concrete Chimney, silos and bunkers.	12

Reference Books/ Text Book / Cases:

1. Plain & Reinforced Concrete, Vol. I & II- O.P.Jain&Jaikrishna(1998).
2. Reinforced Concrete (Limit State Design)- A.K.Jain(1983).
3. Reinforced Concrete Design- Mosley W.H. &Bungey J.H(1999).
4. Reinforced Concrete Fundamentals- Ferguson Phil M (1988).
5. Theory & Design of Concrete Shells- B.K.Chatterjee(1990).
6. Fundamentals of Reinforced Concrete - N.C. Sinha& Roy(2007).
7. BIS Codes

Outcomes:

After the completion of respective course the students will be able the design and carry out of the reinforcement detain of building frames as roofing elements. They will get the knowledge about the design and detail of folded plate and shell roof, analysis and design of slabs using yield line theory. Design special RC elements including, chimney, silos and bunkers

MCE-C0-008:EARTHQUAKE RESISTANT DESIGN

Objective:

This course integrates information from various engineering and scientific disciplines in order to provide a rational framework for the design of earthquake-resistant structures.

Credits: 04 **Semester II** **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	**Engineering Seismology** : Earthquake phenomenon, Causes and effects of earthquakes, Faults ,Structure of earth, Plate Tectonics ,Elastic Rebound Theory, Earthquake Terminology, Earthquake size – Magnitude and intensity of earthquakes, Classification of earthquakes, Seismic waves ,Seismic zones, Seismic Zoning Map of India , Seismograms and Accelerograms **Earthquake Resistant Design:** Code based seismic design methods, Equivalent lateral force method, Response spectrum method, Time history method, Soil dynamics and seismic, Spectral analysis,Nonlinear and push over analysis, Effect of plan configurations on the response of the structure.	16
II	**Codal Design Provisions**: Review of the latest Indian seismic code IS:1893: 2002 (Part-I) provisions for buildings, Earthquake design philosophy, Assumptions, Analysis by seismic coefficient and response spectrum methods, Displacements and drift requirements,Time history method. Provisions for torsion, Analysis of a multistoriedbuilding using Seismic Coefficient method and response spectrum method. **Codal Detailing Provisions**: Review of the latest Indian codes IS: 4326 and IS: 13920 Provisions for ductile detailing of R.C buildings, Beam, column and joints.	12
III	**SeismicDesignofSpecialstructures:**Elevatedliquidstoragetanks'hydrodynamic pressure in tanks, stack like structures; **IS-1893 Codalprovisionsforbridges:** Super structure, sub structure, submersiblebridges. **Rectrofitting and base isolation technique:** Retrofitting and strengthening of structures, Base isolation concept, isolation systems and their modeling;linear theory of base isolation, stability of elastomeric bearings;Codal provisions for seismic isolation, introduction todifferent types of seismic dampers	12

Reference Books/ Text Book / Cases:

1. Agarwal, P. and Shrikhande, M. (2007), Earthquake Resistant of Design of Structures, PHI Publications.
2. Biggs, J.M. (2004), Introduction to Structural Dynamics, McGraw Hill Publications, New York, USA.
3. Chopra, A.K. (2004), Dynamics of Structures, Pearson Education, New Delhi.
4. Duggal, S.K. (2008), Earthquake Resistant of Design of Structures, Oxford University Press, New Delhi.
5. IS: 1983. (1984), Criterion for Earthquake Resistant Design, Bureau of Indian Standards, New Delhi.
6. Paz, M. (1997), Structural Dynamics - Theory and Computation, Springer, New York, USA.

Reference Books/ Text Book / Cases:

After the completion of respective course the students will be able to evaluate seismic forces for various structures as per relevant Indian standards. Design and ductile detailing of structures for seismic resistance as per Indian Standards, Apply concepts of repair and rehabilitation of earthquake affected structures.

MCE-C0-800: Concrete Technology Laboratory

Objective:

The objective of this laboratory is gain practical idea about the behavior structural element made of construction material especially concrete and steel and design these material as per given strength criteria.

Credits: 02 **Semester II** **L-T-P: 0-0-4**

Module No.	Contents	Teaching Hours
I	1. Design of Concrete mix by IS Code Method 2. Tests on Concrete – in compression, tension and bending – modulus of elasticity 3. Demonstration of a typical under – reinforced beam 4. Demonstration of a typical over – reinforced beam 5. Durability studies on concrete. 6. Effect of super plasticizer on properties of concrete in fresh and hardened stages. 7. Tensile and Flexural strength of concrete of different grades. 8. Tensile strength of different types of steel rebars, rolled steel sections. 9. Testing of simply supported RCC beams for flexural failure. 10. Study of crack pattern developed in a simply supported beam under single and two point load. 11. Non-destructive tests on concrete – Rebound hammer and ultrasonic concrete test and penetration test 12. Experiment on photo elasticity 13. Experiment based on shake table and Data Acquisition System	30

Reference Books/ Text Book / Cases:

1. Gambhir.M.L., Concrete Technology, McGraw Hill Education, 2006.
2. Gupta.B.L., Amit Gupta, "Concrete Technology, Jain Book Agency, 2010.
3. Neville, A.M., Properties of Concrete, Prentice Hall, 1995, London.
4. Santhakumar.A.R. ;"Concrete Technology",Oxford University Press,2007.
5. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi, 2003

Outcomes:

In this lab student will be able to learn behavior of concrete in practical condition, effect of different ingredients of concrete, durability studies on concrete. Also student will be able to comment on the strength of different type of steel bars used in RCC construction.

MCE-E0-002:ADVANCED CONCRETE TECHNOLOGY

Objective:

This course provides a comprehensive treatment of the materials and civil engineering principles which results in production and construction of high quality concrete for buildings and infrastructure

Credits: 04 **Semester II** **L-T-P: 4-0-0**

Module No.	Content	Teaching Hours
I	**Introduction**: different types of cementitious materials, different types of cements and pozzolanas, energy efficient cement burning technologies. **Admixtures and Construction Chemicals**: Benefits of admixtures, type of admixtures, plasticizers, action of plasticizers, super- plasticizers, classification of super plasticizers, effect of super-plasticizers, doses of super plasticizers, super plasticizers-cement compatibility, waterproofing admixture, antibacterial and similar admixtures.	12
II	**Strength of Concrete**: Factors affecting the strength, curing of concrete, autogenious healing, strength in tension, failure in compression, failure under multiaxial stress, micro cracking, aggregate cement paste interface, effect of age on strength of concrete, relationship between compressive and tensile strength, bond between concrete and reinforcement, failure strength of concrete, impact strength, electrical and accoustic properties of concrete, temperature effects in concrete. **Durability of Concrete**: Causes of inadequate durability, transportation mechanism in concrete, diffusion, absorption, water permeability of concrete, air and vapour permeability, carbonation, acid attack on concrete, sulphate attack on concrete, efflorencence, effect of sea water on concrete, alkali-silica reaction, type of cracking, action of frost, air entrainment, effect of de-icing agent, chloride attack, threshold content of chloride ions, influence of blended cement on corrosion, other factors affecting corrosion of reinforcement, test for penetrability of concrete to chlorides, stopping corrosion	14
III	**Special Concrete and Concreting Techniques** : Introduction, light weight concrete, ultra light weight concrete, vacuum concrete, mass concrete, roller compacted concrete, concrete with different cementitious materials like flyash, ggbs, silica fume, rice husk ash, shotcrete or guniting, ferrocement, fiber reinforced concrete, polymer concrete composites, sulphur concrete, jet cement concrete, gap graded concrete, high performance concrete, self compacting concrete, foamed concrete	14

Reference Books:

1. A. M. Neville, Properties of Concrete, Pearson education(2012).
2. Performance Criteria for Concrete Durability, E & F N Spon, London.- J. Kroop and H.K.Hilsdorf(2004).
3. Concrete for High Temperature, Maclaren and sons, London- A.Petzold&M.Rohrs(1970).
4. Concrete Construction Enginering Hand Book, CRC Press, New York.- Edward G Nawy(2008).
5. Concrete Technology, theory and Practice, S.Chand- M. S. Shetty(2000)
6. Concrete Technology, Theory and Practice, McGraw Hill.- M. L. Gambhir(2013)
7. Concrete, Tata Mc Graw Hill.,- P.K.Mehta & Paulo J.M.Monterio(2005)
8. Advances in Cement Technology, Tech Book International, New Delhi.-S.N.Ghosh(2006).

Outcomes:

Students will be able to successfully design and assess the performance of various cement-based materials including normal and high strength concrete as well as special cement composites

MCE-E0-001:ADVANCED DESIGN OF BRIDGES

Objective:

To develop an understanding of and appreciation for basic concepts in proportioning and design of bridges in terms of aesthetics, geographical location and functionality.

Credits: 04 **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	Introduction and selection of type. Evolution of existing bridges. Design of super structures: RCC, Prestressed concrete and composite Bridges	16
II	Design of Sub Structures: Abutments, Piers and their foundations	12
III	Bearings, Expansion joints, Construction methods, Maintenance of bridges Concept of Different types of Long Span Bridges: Suspension Bridge, Cable Stayed Bridge	12

Reference Books/ Text Book / Cases:

1. Design of Concrete Bridges – Aswini, Vazrani&Ratwani(2014).
2. Design of Bridges- N. Krishna Raju(2015).
3. Design of Bridges- D.J.Victor(2014).
4. Concrete Bridges Design – V.K. Raina(2006)
5. Bridge Superstructure – N. Rajagopalan(2013)
6. IRC & IRS Codes

Outcomes:

After completing thiscourse the students understand the concept of planning and investigation of bridges. The get the information about the analysis and design of super structures for various type of RCC bridges, they are able to perform dynamic analysis of bridges , analysis and design of various type of substructures and foundation.

MCE-E0-006:EXPERIMENTAL STRESS ANALYSIS

Objective:

To study the working principles of different types of strain gauges, understand the model analysis, know the fundamentals of photo elastic coatings, study the effects of 2-D photo elasticity, study the working principle of load, pressure and displacement transducers.

Credits: 04 **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	**Strain Gauges** - Mechanical and optical strain gauges – Description and operation –Electrical resistance- Inductance and capacitance gauges-Detailed treatment on resistant gauges – Measurement of static and dynamic strains – Strain rosettes – Effect of transverse strains – Use of strain recorders and load cells.	12
II	**Photo Elasticity**: Stress Analysis by photo elasticity **Two dimensional photo elasticity** - Stress optic law – Introduction to polariscope – Plane and circular polariscope – Compensators and model materials – Material and model fringe value – Calibration of photo elastic materials – Isochromatic and isoclinic fringes –Time edge effects. **Three dimensional photo elasticity**- Introduction – Stress freezing techniques – Stress separation techniques – Scattered light photo elasticity – Reflection polariscope.	14
III	**Model Analysis** - Structural similitude, Use of models, Structural and dimensional analysis, Buckingham Pi Theorem, Muller Breslau's principle for indirect model analysis, Use of Begg's and Eney'sdeformeters – Moment indicators – Design of models for direct and indirect analysis. **Miscellaneous Methods**: Brittle coating method ,Byrefringent coating method, Moire fringe method, Non-destructive testing ,Ultrasonic pulse velocity technique, Rebound hammer method , X-ray method, Gamma-ray method.	14

Reference Books/ Text Book / Cases:

1. Rally-Dally: Experimental Stress Analysis McGraw Hill Book Company,New York(1991).
2. P. H. Adam, R. C. Dove: Experimental Stress Analysis and Motion Measurements, Prentice Hall(1964).
3. M. Heteny: Hand book of Experimental Stress Analysis John Wiley and Sons, New York.(1972).
4. Srinath, L.S., (2004), Experimental Stress Analysis, Tata McGraw Hill PublishingCo., New Delhi(1980)..
5. H. I. Langhar: Dimensional Analysis and Theory of Models(1978)
6. Frocht M.M.; Photoelasticity Vol. I &II., John Wiley and Sons, New York.(1998).

Outcomes:

On completion of the course, the students will be able to: identify the different types of strain gauges carry out model analysis apply the concepts of photo elastic coatings analyze the behavior of 2-D photo elasticity apply the working principles of transducers

MCE-E0-007:SOFT COMPUTING METHODS FORCIVIL ENGINEERING

Objective:
The objective of this course is to impart various techniques like fuzzy logic, ANN, expert system in generating computer model to solve the complex civil problem dealing with large statistical/experimental data.

Credits: 04 **L-T-P: 4-0-0**

Module No.	Content	Teaching Hours
I	Expert System: Theory of representation; Working principles of ANN; Two computational paradigms: Multi-layer networks; Auto associative and hetero associative nets; Learning in neural nets: Supervised and unsupervised learning; Application of neural nets; Neural network simulators.	13
II	Genetic algorithm and Traditional optimization methods; Simple genetic algorithms- reproduction, crossover and mutation; Analysis of GA-operators; Deception; Working principles of genetic algorithms; Multi-model and multi-objective optimization; Engineering applications; Introduction with applications for Evolution strategy. Combined use of ANN-GA.	13
III	Fuzzy sets, fuzzy numbers, fuzzy relations, fuzzy measures, fuzzy logic and the theory of uncertainty and information; applications of the theory to inference and control, clustering, image processing and data handling. Neuro-fuzzy systems, application of Neuro-fuzzy systems; Term Paper: Based on applications and/or algorithms development.	14

Reference Books:

1. Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence - Bart, K.(1997)
2. Evolutionary Multiobjective Optimization Algorithms- Deb, K(2011).
3. Genetic Algorithms in Search, Optimization and Machine learning- Goldberg, D. E(1986).
4. Neural Networks: A Comprehensive Foundations- Haykin, S(1998).
5. Fuzzy Logic with Engineering Applications- Ross, T. J(2004).
6. Introduction to Artificial Neural Systems- Zurada, J.M(2002).

Outcomes:
After learning this course student will be able to appreciate the principles of ANN and their application in civil engineering problem involving large experimental data. Genetic algorithm, concept of fuzzy logic in simulating such problems under uncertain condition.

MCE-E0-004:HIGH RISE STRUCTURES

Objective:

The objective of this course is to develop fundamentals of high rise buildings and their difference with ordinary buildings and also to develop ability in students to design High Rise Structures.

Credits: 04 **L-T-P: 4-0-0**

Module No.	Content	Teaching Hours
I	Gravity, Wind, Blast & Earthquake Loads. Analysis of Tall Buildings for gravity and lateral loads – Approximate and Exact methods. Sequential and Simultaneous analysis.	14
II	Load combinations. Design of beams, columns and foundations. Detailing of Joints. Plane and coupled shear walls in Tall Buildings. Shear Wall – Frame Interaction,	12
III	Foundations for Tall Buildings and their design. Analysis and Design of Transmission Towers.	14

Reference Books:

1. Response of Multistory Concrete Structures to Lateral Forces, SP–36,ACI Publication(1974)..
2. Response of Buildings to Lateral Forces, ACI Task Committee Report 442(1971)..
3. Elastic Analysis of Tall Concrete Building, Report of Technical Committee No.21,ACI.
4. Tall Building, Programme Press – A.Coull and B.S.Smith(1966),
5. Manual on Transmission line Towers, Tech. Report No.9,Central Board of Irrigation and Power(2011)

Outcomes:

This course enables students to understand basis methods of analysing high rise structures. This also includes design of shear walls which are very common in high rise buildings. On completion of this course the students will be able to design high rise structures.

MCE-E0-005:DURABILITY ASSESSMENT AND STRUCTURAL STRENGTHENING OFREINFORCED CONCRETE

Objective:

The objective of this course is to develop knowledge about the resistance capacity(durability) of concrete and its reinforcement, its estimate and also how to improve durability.

Credits: 04 **L-T-P: 4-0-0**

Module No.	Content	Teaching Hours
I	Characterization of concrete making material, Interfacial transition zone and its critical evolution, Pozzolonic material and associated effect on concrete , Transport mechanism such as diffusion permeation, Capillary suction, Adsorption and desorption and migration, Various form of material deterioration in concrete, Effect of sulphates, chlorides and acids on concrete	14
II	Carbonation and corrosion of reinforcement in concrete. Methods of improving durability of concrete. Service life determination and integrated life cycle design of structure. Modeling for durability of concrete.	14
III	Damage of different type of structure. Assement of damage and repair methodology. Rehabilitation of damaged structure, Method of sealing. Providing additional steel. External Prestressing. Stitching. Jacketing. FRP'S, Rehabilitation techniques , retrofitting method's for concrete structures, Bridge retrofitting with live examples	12

Reference Books:

1. Guide to durable Concrete, ACI 201 2R-77. Detroit Michigan: ACI Commity 201(2000).
2. Fly ash in concrete. Amsterdam: Gordon and Breach Science publication.- Joshi R.C. &Lahotia R.P(1997).
3. Concrete Micro Structure, Properties and Material New Delh: Tata Mcgraw Hill- Publishing company limited.- Mehta P.K., &monteiro P.J(2013).
4. Durability of Reinforced Concrete in Aggressive Media, Oxford & IBH Publishing Company Pvt. Limited.- Alekseev et al(2003).
5. RILEM Report 12 Performance Criteria for Concrete Durability, E & FN SPON , London- Kroop j and H.K.Hilsdorf(2004)
6. Property of Concrete, Pearson Education Ltd. New Delhi.- Neville A.M(2014).
7. Integrated Life Cycle Design of Structure.-AskoSarja(2003)

Outcomes:

Students will be able to assess durability of concrete, structure life span etc. They will also learn the methods as well as material used to improve the durability of concrete. Several rehabilitation and retrofitting technique and their application.

MCE-E0-009:SOIL STRUCTURE INTERACTION

Objective:

The objective of this course is to provide the students with the basic principles and tools to models soil-foundation structures interaction problems for predicting there response under external loads etc.

Credits: 04 **L-T-P: 4-0-0**

Module No.	Content	Teaching Hours
I	Introduction to soil-foundation interaction problems, idealized soil behavior, foundation behavior, interface behavior, analytical techniques, scope of soil-foundation interaction analysis. Idealized soil response models for the analysis of soil-foundation interaction: Elastic models of soil behavior, Winkler model, elastic continuum model, homogeneous and non-homogeneous elastic continuum, isotropic and anisotropic elastic continuum, orthotropic elastic continuum, layered and structured elastic medium. Two parameter elastic models: Filonenko-Borodich model, Paternak model, Hetenyi model, Vlazovmodel,andReissner model.	13
II	Elastic –plastic and time dependent behavior. Plane-strain analysis of an infinitely long beam and an infinite plate; analysis of beam of finite length under different loading conditions.	14
III	Analysis of circular and rectangular plates on elastic foundations. Settlement analysis of single pile: Load transfer method, analysis based on elastic theory, settlement of pile groups, load deflection prediction for laterally loaded piles, Pile raft system, dynamic loads on piles. Flexural behavior of axially and laterally loaded piles.	12

Reference Books:

1. Analytical and Computer Methods in Foundation, McGraw Hill.- Bowels J.E(2014).
2. Elastic Analysis of Soil-Foundation Interaction, Elsevier. -Selvadurai, A. P. S(1979)
3. Pile Foundation Analysis and Design, John Wiley- Poulos H. G. and Davis E. H.(1999)
4. Foundation analysis and design, McGraw Hill.- Bowles J.E(2014).
5. Foundation Analysis, Prentice Hall.- Scott R. F(1996).
6. Numerical Methods in Geotechnical Engineering, McGraw Hill.-Desai C.S.& Christian J.T.(1977)

Outcomes:

Simulation of soil –foundations –structures interaction studies is essential for predicting integrated responses of structures to extend the loads, the course prepares to the students in simulating such problems using both continuum mechanics and lumped parameter modeling, thus the students will be able to model such interaction phenomenon without resorting to costly in-situ or either prototype or large structures reducing the overall cost of the structures and provide confidence in design as well

MCE-E0-008:OPTIMIZATION METHODS IN CIVIL ENGINEERING

Objectives: Introduce methods of optimization to engineering students, including linear programming, network flow algorithms, integer programming, interior point methods, quadratic programming, nonlinear programming, and heuristic methods. Numerous applications are presented in civil, environmental, electrical (control) engineering, and industrial engineering. The goal is to maintain a balance between theory, numerical computation, problem setup for solution by optimization software, and applications to engineering systems.

Credits: 04 **L-T-P: 4-0-0**

Module No.	Content	Teaching Hours
I	**Introduction**: Engineering application of Optimization, Formulation of design problems as mathematical programming problems, classification of optimization problems. **Optimization Techniques:** Classical optimization, multivariable with no constraints, unconstrained minimization techniques, penalty function techniques, Lagrange multipliers and feasibility techniques. **Linear Programming**: Graphical method, Simplex method, Duality in linear programming (LP),Sensitivity analysis Applications in civil engineering.	14
II	**Non Linear Programming techniques/method**: Unconstrained optimization, one dimensional minimization, golden section, elimination, quadratic and cubic, Fibonacci, interpolation, Direct search, Descent, Constrained optimization, Direct and indirect, Optimization with calculus, Khun-Tucker conditions.	14
III	**Constrained optimization techniques** - Direct, complex, cutting plane, exterior penalty function methods for structural engineering problems.	12

Reference Books:

1. Optimization Methods for Engineering Design – R.L.Fox(2005).
2. Optimization Techniques, Theory and applications – S.S.Rao(2009).
3. Introduction to Dynamic Programming – L.Cooper&M.W.Cooper(2014).
4. Non-Linear programming: Sequential Unconstrained Minimization Techniques-
A.V.Fiacco&G.P.McCormic(1988).
5. Geometric Programming – Duffin, Peterson &Zenar(1997).
6. Foundation of Optimization – J.D.Wilde&C.L.Beightler(1991).
7. An introduction to OR – H Taha(2007).

Outcomes:

Upon successful completion of this course, the student will be able to understand the basic theoretical principles in optimization, formulation of optimization models, solution methods in optimization, methods of sensitivity analysis and post processing of results, applications to a wide range of engineering problems.

MCE-E0-003: NON CONVENTIONAL CONSTRUCTION MATERIALS & ELEMENTS

Credits: 04 **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	**Ferro cement:** Introduction to Ferro cement design principals, materials used, manufacture of Ferro cement elements, Type of members commonly used, use of Ferro cement in rehabilitation of Structures. **Fiber reinforced concrete:** Various types of fibers like glass, steel, asbestos etc. Physical & Mechanical Properties, Use of Fiber Reinforced Concrete in structural elements.	12
II	**Light weight concrete:** Various types of light weight aggregate, physical and mechanical properties. Introduction to structural plastics and similar elements. Smart materials, Environment friendly materials	14
III	**Polymers and Polymer Concrete:** Physical and mechanical properties and its use in Civil Engineering. Introduction to Bamboo in Civil Construction, Cementitious composite reinforced with vegetable and hybrid fibres, Construction with Earth	14

Reference Books/ Text Book / Cases:\

1. Advances in Building Materials and Construction-Mohan Rai&M.P.Jai Singh
2. Fly Ash in Concrete- R.C.Joshi&R.P.Lohtia
3. High Performance Concretes and Applications- S.P.Shah& S.H. Ahmad
4. Building Materials- S.K.Duggal

MCE-E0-011: CONSTRUCTION MANAGEMENT AND EQUIPMENT

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	**Engineering Economy**: Principle of Engineering Economy, Minimum cost point analysis, Breakeven point analysis, Depreciation and depletion. **Safety In Construction:** Causes, classification, cost and measurement of an accident, safety programme for construction, protective equipment, accident report, safety measure: (a) For storage and handling of building materials. (b) Construction of elements of a building (c) In demolition of buildings Safety lacuna in Indian scenario.	12
II	**Construction Planning:** Need of construction planning, Constructional Resources, construction team, stages in construction, preparation of construction schedule, Job layout, inspection and quality control. **General Management**: Introduction and characteristics of management, Principle and function of management, Scientific management. **Materials Management:** Scope, Objective and functions of material management, Procurement and store management, Materials handling management, Inventory control and management. Disposal of Surplus Materials	12
III	**Earth Moving Equipment**: Crawler and wheel tractors their functions, types an specifications; Gradability Bull dozers and their use; tractor pulled scrapers, their sizes and output; effect of grade an rolling resistance on the output of tractor pulled scrapers Earth loaders; Placing and compacting earth fills. **Hauling Equipment:** Trucks; Bottom dump wagons; capacities of trucks and wagons Balancing the capacities of hauling units with the size excavator; effect of grade, rolling resistance and altitude on the cost/performance of hauling equipment; balancing excavating hauling equipment examples. **Drilling, Blasting and Tunneling Equipment** : Definition of terms, bits, Jackhammers, Drifters, wagon drills, che drills, piston drills, blast hole drills, shot drills, diamond drills, tunneling equipment, selecting the drilling method equipment; selecting drilling pattern; Rates for drilling rock, compressors. **Pile Driving Equipment:** Pile hammers, selecting a pile hammer, loss of energy due to impact, Energy losses due to causes other than impact.	16

Reference Books/ Text Book / Cases:\

5. *1.* Construction equipment and its planning and application Dr. Mahesh Verma.
6. 2. Construction Planning equipment and Methods by RL Peuripo Tata McGraw Hill.
7. 3. Heavy construction planning equipment and methods -Jagman Singh Oxford and IBH.
8. 4. Rock Engineering-Ry John A Franklin and Maurice B Dusseault, Tata McGraw Hill.
9. 5. Management Machines and Methods in Civil Engineering-John,Christan, John Wiley and Sons.
10. 6. Modern Construction Equipment and Methods. Frank harris *John Wiley and Sons.*

MCE-E0-0012: RETROFITTING OF STRUCTURES

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
I	Importance of rehabilitation repairs and retrofitting as a part of construction engineering. Difference between the term. Rehabilitation studies of buildings, underground construction, bridges, streets and highways, sewage treatment plants – masonry work, R.C.C. works, steel structures- types of distress. Numerical condition surveys for foundation, structural and functional deterioration, design criteria, materials and technology.	14
II	Earthquake damages of buildings, their retrofitting, restoration, effects of earthquakes, response of buildings to earthquake motion, factors related to building damages due to earthquake, methods of seismic retrofitting, restoration of buildings.	12
III	New Construction materials, processes and techniques used for repairs, rehabilitation and retrofitting. Construction chemicals based on nanotechnology, construction points based on nanotechnology, various types of fibred wrappings etc.	14

Reference Books/ Text Book / Cases:\

1. Technology of Building Repairs, Raikar R N
2. The Bombay Building Repairs & Reconstruction Board Act 1969, Govt. of Maharashtra
3. Maintenance & Repairs of Buildings, P. K. Guha
4. Concrete Structures Protection Repair and Rehabilitation, R. Dodge Woodson, Elsevier Publication
5. Construction, Maintenance & Restoration and Rehabilitation of Highway Bridges, K. S. Rakshit
6. Retrofitting of Concrete Structures by Externally Bonded FRP's – CEB – FIP, Technical report,