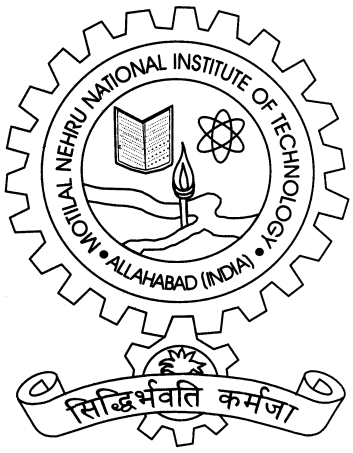
Course Structure & Curriculum

For

M. Tech. in Structural Engineering

From

Academic Session: 2017-18



Department of Civil Engineering
Motilal Nehru National Institute of Technology Allahabad
Prayagraj -211004 (India)

Course Structure for M.Tech. in Structural Engineering

Course Name: M. Tech. in Structural Engineering

Eligibility:

(1) First class B. Tech./ B.E. or Equivalent Graduation Degree in Civil Engineering / Civil Engineering & Planning/Civil Technology/ Construction & Project Management/Construction Engineering/Construction Engineering & Management/ Construction Technology/ Structural Engineering.

(2) Valid GATE score

Scheme of Examination

First Semester

S. No.	Course Code	Subject Name	L	T	P	Credits	Distribution of Marks out of 100		
							TA	Mid Sem. Exam.	End. Sem. Exam.
1.	CE-21101	Advanced Concrete Design	03	01	-	4	20	20	60
2.	CE-21201	Experimental and Computational Methods	-	-	06	4	50	-	50
3.	CE-21XXX	Elective I	03	01	-	4	20	20	60
4.	CE-21XXX	Elective II	03	01	-	4	20	20	60
5.	CE-21XXX	Elective III	03	01	-	4	20	20	60

Total Credits = 20

Second Semester

S. No.	Course Code	Subject Name	L	T	P	Credits	Distribution of Marks out of 100		
							TA	Mid Sem. Exam.	End. Sem. Exam.
1.	CE-22101	Analysis and Design of Plates and Shells	03	01	-	4	20	20	60
2.	CE-22102	Seismic Design of Structures	03	01	-	4	20	20	60
3.	CE-22XXX	Elective IV	03	01	-	4	20	20	60
4.	CE-22XXX	Elective V	03	01	-	4	20	20	60
5.	CE-22XXX	Elective VI	03	01	-	4	20	20	60

Total Credits = 20

Third Semester

S. No	Course Code	Subject Name	Credits	Evaluation (100)
1	CE -23651	Special Study / Industrial Training / Colloquium/Term Paper	4	Marks
2	CE- 23601	Thesis	16	Marks
		Total Credits	**20**	

Fourth Semester

S. No	Course Code	Subject Name	Credits	Evaluation
1	CE -24601	Thesis	20	Marks

Note: The distribution of thesis evaluation marks will be as follows.

1. Supervisor(s) evaluation component : 60%
2. Oral Board evaluation component: 40%

List of Electives:

Odd Semester:

EL-I	1.	CE- 21301	Advanced Steel Design
	2.	CE- 21302	Non Conventional Construction Materials & Elements
	3.	CE- 21303	Advanced Concrete Technology
EL-II	1.	CE- 21304	Structural Health Monitoring
	2.	CE-21305	High Rise Structures
	3.	CE- 21306	Prefabricated Construction Technology
EL-III	1.	AM- 21310	Applied Elasticity
	2.	MA- 21302	Advanced Mathematics
	3.	CE-21357	Soft Computing Methods in Engineering Problem Solving

Even Semester:

EL-IV	1.	CE- 22301	Optimization Methods in Civil Engineering
	2.	CE- 22302	Durability Assessment and Structural Strengthening of Reinforced Concrete
	3.	CE- 22303	CAD in Structural Engineering
EL-V	1.	CE- 22304	Design of Bridges
	2.	CE- 22305	Repair and Retrofitting of Structures
	3.	CE- 22306	Reliability Based Design
	4.	CE- 22307	Plastic Design of Structures
EL-VI	1.	CE- 22308	Finite Element Methods
	2.	CE- 22309	Structural Design of Environmental Engineering Systems
	3.	CE- 22334	Soil - Structure Interaction
	4.	CE- 22358	Environmental Impact Assessment

Syllabus of M. Tech. in Structural Engineering

CE-21101: Advanced Concrete Design

Credit: 4 **3L-1T-0P**

Unit 1. Design of roofing element-flat slabs.
Unit 2. Design of tall building frames and footings.
Unit 3. Design of Reinforced Concrete Chimney.
Unit 4. Design of silos and bunkers.
Unit 5. Design of circular overhead water tanks including the effect of continuity.
Unit 6. Design of intze type overhead water tanks including the effect of continuity.

References:

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

CE-21201: Experimental & Computational Methods

Credit: 4 **0L-0T-6P**

Experimental

1. Determination of physical properties of cement, coarse and fine aggregate.
2. Mix Design of High Performance Concrete.
3. Development of strain distribution diagram at any section of beam using dummy gauges.
4. Development of a co-relation between Destructive and Non-Destructive results of Compressive strength of Concrete.
5. Determination of Filling ability of Self Compacting Concrete using Abrams cone, $T_{50\,cm}$ slump flow and V funnel
6. Determination of Passing ability of Self Compacting Concrete using J-ring, L-box and U- box.
7. Characterization of materials to be used for concrete making.
8. Determination of ultimate capacity of R.C.C. beams.

Computational

1. Development of computer programs for beam, truss and frame members using stiffness method.
2. Mathematical operation of matrix using MATLAB. Plotting of graph, FFT, Solution of linear equation using MATLAB.
3. Analysis and design of a truss, a 2-D building frame, 3-D building frame using STAAD and development of working drawing with CAD.
4. Analysis and design of a truss, a 2-D building frame, 3-D building frame using SAP 2000 and development of working drawing with CAD.
5. Evaluation of stress, strain and other structural parameters of simple, fixed and cantilever beam using ANSYS.
6. Determination of natural frequencies of a building frame using ANSYS.
7. Development of Soil –structure interaction model of a building frame using ANSYS.

References:

1. *Neville A.M., Properties of Concrete, Pitman Publishing Company.*
2. *Shetty M.S. "Concrete Technology, Theory and Practices." S. Chand & Company Ltd., New Delhi.*
3. *Gambhir M.L. "Concrete Technology" - Tata McGraw Hill Publishing Company Ltd., New Delhi.*
4. *Matrix Methods of Structural Analysis, Wang , C. K. , International Text Book Company.*
5. *Matrix analysis of framed structures, W. Weaver & J. M. Gere, Van Nostrand Reinhold Company Inc, Second Edition, 1980.*
6. *Computer aided design: software and analytical tools by C. S. Krishnamoorthy, S. Rajeev and Arunachalam Rajaraman, Narosa Publication, Second Edition, 2009.*

CE-21301: Advanced Steel Design

Credit: 4 **3L-1T-0P**

Unit 1.Introduction to the use of light gauge steel sections with application to flat slab, grid and orthotropic plates.
Unit 2. Design of Tubular structures.
Unit 3.Design of transmission line towers, concept of TV and guyed towers.
Unit 4. Buckling of steel columns, Beam column and their designs. Rigid, Semi-Rigid and Flexible connections. Plastic methods of Structural Analysis of frames.
Unit 5. Design of Industrial trussed bents. Prestressed steel construction. Analysis and Design of Transmission Towers

References:

1. *Design of steel structures- Bresler Lin & Scalzi*
2. *Steel building analysis and design- Crawley & Dhillon*
3. *Design of steel structures- S. K. Duggal*
4. *Design of steel structures- Arya & Ajmani*
5. *Manual on Transmission line Towers, Tech. Report No.9,Central Board of Irrigation and Power, March, 1977.*

CE-21302: Non Conventional Construction Materials & Eléments

Credit: 4 **3L-1T-0P**

Unit 1. 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.
Unit 2. Fiber reinforced concrete: Introduction**,** Various types of fibers like glass, steel, asbestos etc. Physical & Mechanical Properties of Fibre Reinforced Concrete, Use of Fiber Reinforced Concrete in structural elements.
Unit 3. Polymers and Polymer Concrete: Introduction, Physical and Mechanical properties and its use in Civil Engineering
Unit 4. Light weight concrete: Introduction, Various types of light weight aggregate, physical and mechanical properties.
Unit 5. Introduction to structural plastics and similar elements. Smart Materials.

References:

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*

CE-21303: Advanced Concrete Technology

Credit: 4 **3L-1T-0P**

Unit1. Introduction, different types of cementitious materials, 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.

Unit2. Strength of Concrete: Factors affecting the strength, curing of concrete, autogenously 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 acoustic properties of concrete, temperature effects in concrete.

Unit3. Durability of Concrete: Causes of inadequate durability, transportation mechanism in concrete, diffusion, absorption, water permeability of concrete, air and vapor permeability, carbonation, acid attack on concrete, sulphate attack on concrete, efflorescence, 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

Unit4. 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 fly ash, gabs, silica fume, rice husk ash, shotcrete or grunting, ferrocement, fiber reinforced concrete, polymer concrete composites, sulphur concrete, jet cement concrete, gap graded concrete, high performance concrete, self compacting concrete, foamed concrete.

Unit5. Non-destructive testing of hardened concrete: Rebound hammers test, pull-out test, ultrasonic pulse velocity test, resonant frequency method.

References:

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

CE-21304: Structural Health Monitoring

Credit: 4 **3L-1T-0P**

Unit 1. Introduction to structural health monitoring (SHM). Types of Sensor System and its application. Data acquisition system.
Unit 2. Various Techniques for SHM. Global and local techniques. Computational and Experimental aspect of global dynamic technique.
Unit 3. Smart Material and its application for SHM. Piezo-electric material and its application as sensor, actuator and transducer.
Unit 4. Electro-mechanical Impedance (EMI) Technique for SHM, its basic principle, application and limitation.
Unit 5. Low cost adaptations of EMI technique. Fatigue life assessment using EMI Technique.
Unit 6. Integration of global technique and EMI Technique and their validations.

References:

1. *Soh, C.K. Yang Y.W. and Bhalla S. Smart Material in Structural Health Monitoring, Control and Bio-Mechanics Springer, 2011*
2. *Ewins, D.J. Modal Testing: Theory, Practices and Applications, 2nd edition, Research Studies Press Ltd.,Baldock*

CE-21305: High Rise Structures

Credit: 4 **3L-1T-0P**

Unit 1. Gravity, Wind, Blast and Earthquake Loads and their combination, P-Δ effect.
Unit 2. Analysis of Tall Buildings for gravity and lateral loads –Approximate and Exact methods. Sequential and Simultaneous analysis.
Unit 3. Design and detailing of beams and columns. Ductile detailing of Joints.
Unit 4. Plane and coupled shear walls in Tall Buildings. Shear Wall – Frame Interaction.
Unit 5. Different types of Foundations and their design.

References:

1. *Response of Multistory Concrete Structures to Lateral Forces, SP–36, ACI Publication.*
2. *Response of Buildings to Lateral Forces, ACI Task Committee Report 442.*
3. *Elastic Analysis of Tall Concrete Building, Report of Technical Committee No.21,ACI.*
4. *Tall Building – A. Coull and B.S. Smith, Programme Press,1966.*

CE-21306: Prefabricated Construction Technology

Credit: 4 **3L-1T-0P**

Unit 1: Introduction: Introduction, Need for prefabrication, Principles, Materials, Modular coordination, Standardization Systems, Production, Transportation, and Erection.
Unit 2: Prefabricated Components: Behavior of structural components, large panel constructions, Construction of roof and floor slabs, Wall panels, Columns, Shear walls
Unit 3: 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 4: Joint in Structural Members: Joints for different structural connections, Dimensions and detailing, Design of expansion joints
Unit 5: 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.
Unit 6: Computer Added Design: Computer added design of components of prefabricated structure.

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

AM-21310: Applied Elasticity

Credit: 4 **3L-1T-0P**

Unit 1. 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.

Unit 2. 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.

Unit 3. 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 Relationships for Isotropic and Anisotropic Materials (Plane stress and Plane Strain).

Unit 4. 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 Principles, 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).

Unit 5. 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 sections. 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.

Unit 6. *Viscoelasticity and Viscoplasticity:* Introduction, Viscoelastic models (Maxwell, Kelvin-Voigt, Generalized Maxwell and Kelvin models), Viscoelastic stress-strain relationships, Viscoelasticity.

References:

1. *"Mathematical Theory of Elasticity" by I. Sokolnikoff.*
2. *"Advanced Mechanics of Materials" by Boresi.*
3. *"Theoretical Elasticity" by A. E. Green and W. Zerna.*
4. *"Theory of Elasticity" by Timoshienko.*
5. *"Advanced Strength and Applied Elasticity" by A. C. Ugural and S. K. Fenster.*
6. *"Applied Elasticity" by R.T. Fenner.*
7. *"Advanced Strength of Materials" by L. S. Srinath.*

MA-21302: Advanced Mathematics

Credit: 4 **3L-1T-0P**

Unit 1. Matrix Theory: Concept of Eigen values, Eigen vectors, decomposition of matrices, LU-Decomposition, Block LU decomposition, Rank factorization, Cholesky decomposition, LDU, LUP decomposition, QR decomposition, Eigen decomposition.

Unit 2. Partial Diff. Equation: Boundary and Initial Value Problems involving partial differential equations of the second order. Their solutions by the method of seperation of variables.

Unit 3. Numerical Solution of differential equations: Review of Numerical Methods for Solving Polynomial equations and simultaneous linear algebraic equation. Euler's method, modified Eulers method, Runge-Kutta Method, Predictor-Corrector Methods. Numerical Solution of Elliptic and Parabolic Partial differential equation.

Unit 4. Statistics: Probability basics, Special distributions: Bernoulli, Binomial, Geometric, Negative Binomial, Hypergeometric, Poisson, Uniform, Exponential, Gamma, Normal joint distributions, Marginal and conditional distributions, Moments, Independence of random variables, Covariance, Correlation. Regression Problem: Scatter diagram, Simple linear regression, Least squares estimation, multiple regressions**.**

Unit 5. Integral Transforms**:** Laplace Transforms. Transforms of derivatives, inverse transforms. Transforms of Dirac Delta function and Unit Step function, Their applications.

Unit 6. Variation of Calculus: Maxima and Minima of Functions of two three and more variables. Relative Maximum and Minimum value, Basic problems of Calculus of variation, Minimum energy problem, Applications of the Calculus of variation in engineering problems

References:

1. *Engineering Mathematics - Kreyszing, E.*
2. *Mathematics for Engineering, Technology and Computing Science –Martin, H. G.*
3. *Jain, M.K., lyengar, S.R.K and Jain R.K. " Numerical methods for Scientific and Engineering Computations, 3rdEdn. New age International (P) Ltd. Publisher, New Delhi*
4. *Freund, J.E. and Miller, I.R., " Probability and Statistics for Engineers" Prentice- Hall of India, 5th Edition, New Delhi, 1994*

CE-21357: Soft Computing Methods in Engineering Problem Solving

Credit: 4 **3L-1T-0P**

Unit 1. Introduction and Working Principles :Back ground, definitions, classification of soft computing techniques, advantages, limitations; Working principles of soft computing techniques- Fuzzy, ANN, genetic algorithms and other evolutionary techniques', examples in real life.

Unit 2. Fuzzy systems : 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.

Unit 3. Artificial Neural Networks : Theory of representation; Two computational paradigms: Multi-layer networks; Auto associative and heteroassociative nets; Learning in neural nets: Supervised and unsupervised learning; Application of neural nets; Neural network simulators.

Unit 4. Genetic Algorithm : Genetic algorithm and Traditional optimization methods; Simple genetic algorithms- reproduction, crossover and mutation; Analysis of GA-operators; Deception; Working principles of genetic algorithms; Multimode and multi objective optimization; Engineering applications; Introduction with applications for Evolution strategy.

Unit 5. Hybrid Systems: Necessity, combined use of Fuzzy and ANN; Neuro-fuzzy systems, application of Neuro-fuzzy systems; combined use of ANN-GA;

Unit 6. Applications: Case studies and general applications in engineering applications. Implementation of MATLAB.

References:

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

CE-22101 : Analysis and Design of Plates and Shells

Credit: 4 **3L-1T-0P**

Unit 1.Thin Plates: Assumption in the theory of thin plates –Governing differential equations – Simply supported and fixed boundary conditions
Unit 2. Rectangular plates: Differential equations of plates –Boundary conditions – Navier Solution-Levy's method of solution- Approximate methods
Unit 3. Circular Plates: Differential equation of equilibrium –Uniformly loaded circular plates – annular plates.
Unit 4. Thin shells: classification of shells structural actions – Membrane theory
Unit 5. Analysis of shells: analysis of spherical dome – cylindrical shells – folded plates
Unit 6. Design of spherical dome- cylindrical shells – folded plates.

References :

1.S.P.Timoshenko and S.W.Krieger , Theory of Plates and Shells , McGraw Hill, 1989.
2.R. Szilard, Theory and Analysis of Plates-Classical Numerical Method", Prentice Hall inc, 1974.
3. P.L. Gould, Analysis of Shells and Plates, Springer –Verlag, New York ,1988 .

CE-22102: Seismic Design of Structures

Credit: 4 **3L-1T-0P**

Unit1. Introduction to Engineering Seismology & Structural Dynamics : Internal structure of the earth, Theory of plate tectonics, Seismic waves, Size of an earthquake, seismicity, classification of earthquake, strong ground motion characteristics, estimation of ground motion parameters, seismic hazard map, Dynamics of SDOF, Response Spectra, Dynamics of MDOF.

Unit 2. Concepts of Seismic Design **:**Performance of structures in past earthquakes, Type of failure, failure mechanism, Identification of problems in structural configuration, Modelling of structures, Selection of earthquake ground motions, analysis procedures, methods of design, concept of ductility, IS code based procedure, Introduction to performance based design.

Unit 3. Design of RC building**:** Mathematical modeling of RC building, Estimation of Design lateral loads, soil-structure interaction, ductility consideration as per codal provisions, Design examples.

Unit 4. Design of masonry building**:** Modeling, Lateral load analysis procedure, Design considerations as per codal provisions, Design examples.

Unit 5. Design of Bridge**:** Introduction to design philosophy for bridges, Codal provisions.

References:

1. *Dynamics of Structures-Theory and Applicaions to Earhquake Engineering - Anil K. Chopra*
2. *Elements of Earthquake Engineering - Jai Krishna and A.R. Chandrasekaran*
3. *Fundamental of Earthquake Engineering -N.M. Newmarks and E. Rosenblueth*
4. *IS: 1983 –1984 - Criteria for Earthquake Resistant Design of Structures*
5. *IS:1893-2002 (part 1)- Criteria for Earthquake Resistant Design of Structures*
6. *Structural Dynamics - Theory &computation - Mario Paz*
7. *Dynamics of structures - R. W. Clough and JPenjien*
8. *Seismic Design and retrofit of bridges- M.J.N. Priestley, F. Seible and G.M. Calvi*
9. *Earthquake Resistant Design of Masonry Buildings- M. Tomazevic*

CE-22301: Optimization Methods in Civil Engineering

Credit: 4 **3L-1T-0P**

Unit 1. Introduction: Historical development, engineering applications of optimization, statement of an optimization problem, classical optimization techniques.
Unit 2. Linear Programming: Simplex method) and Revised simplex method for linear programming problems. Application of linear programming to civil engineering problems. Post optimality analysis.
Unit 3. Non-Linear Programming: Optimization of one dimensional variable problems by various methods.
Unit 4. Unconstrained and constrained optimization problems of non linear programming methods.
Unit 5. Genetic algorithm & ANN and their application in optimization.

References:

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

CE-22302: Durability Assessment and Structural Strengthening of Reinforced Concrete

Credit: 4 **3L-1T-0P**

Unit 1. Hydration of cement and its structure. Characterization of concrete making materials, Interfacial transition zone and its critical evolution,

Unit 2. Pozzolonic material and associated effect on concrete , Transport mechanism such as diffusion permeation, Capillary suction, Adsorption and desorption and migration,

Unit 3. Various form of material deterioration in concrete, Effect of sulphates, chlorides and acids on concrete. Carbonation and corrosion of reinforcement in concrete.

Unit 4. Methods of improving durability of concrete. Service life determination and integrated life cycle design of structure. Modeling for durability of concrete.

Unit 5. Damage of different type of structure. Assement of damage and repair methodology. Rehabilitation of damaged structure, Method of sealing. Providing additional steel. External prestressing.

References:

1. *ACI Commity 201 (1982). Guide to durable Concrete, ACI 201 2R-77. Detroit Michigan: American Concrete Institute.*
2. *Joshi R.C. & Lahotia R.P.(1997) . Fly ash in concrete. Amsterdam: Gordon and Breach Science publication.*
3. *Mehta P.K., & Monteiro P.J.(2006) Concrete Micro Structure, Properties and Material New Delh: Tata Mcgraw Hill- Publishing company limited.*
4. *Alekseev et al. (1995) Durability of Reinforced Concrete in Aggressive Media, Oxford & IBH Publishing Company Pvt. Limited.*
5. *Kroop j and H.K.Hilsdorf, (1995) RILEM Report 12 Performance Criteria for Concrete Durability, E & FN SPON , London*
6. *Neville A.M. (2005), Property of Concrete, Pearson Education Ltd. New Delhi.*
7. *Asko Sarja (2001) Integrated Life Cycle Design of Structure.*

CE-22303: CAD in Structural Engineering

Credit: 4 **3L-1T-0P**

Unit1. Elements of Computer added Design and its advantage over Conventional Design, type of Hardware required for CAD Works. Principles of Software Design, Concepts of Modular Programming, Debugging and Testing.
Unit 2. Computers Applications in Analysis, Design, Drafting and Detailing of different Structural Components.
Unit3. Development of Programmes for analysis of Skeletal Structures.
Unit 4. Use of Different Commercial software for analysis and design.
Unit 5. Expert System, Neural Networks and their Applications in Structural Engineering,
Unit 6. Introduction to fuzzy logic systems.

References:

1. *W. Weaver & J.M.Gere., Matrix Analysis of Framed Structure*
2. *Hassoush., Fundamental of Artificial Neural Network*
3. *Dan W Patterson., Artificial Inteligence & Expert Sysem*
4. *O.C. Zienkiewicz., Finite Element Method*

CE-22304: Design of Bridges

Credit: 4 **3L-1T-0P**

Unit 1. Introduction/selection/Evolution of Bridge types, Loads and Forces.
Unit 2. Design of Culverts
Unit 3. Design of T-Beam Bridge.
Unit 4. Introduction to Design of different type Superstructures.
Unit 5. Introduction to Design of Abutments, Piers and Foundations.
Unit 6. Introduction to Design of Bearings. Expansion joints.

References:

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

CE-22305: Repair and Retrofitting of Structures

Credit: 4 **3L-1T-0P**

Unit 1: Review of principles of structural analysis; Modelling of structures – Linear modelling, Non-linear modelling, Modelling of soil and foundations
Unit 2: Introduction to dynamic loading; Demand Capacity Ratio Method; Non-linear Pushover Analysis, Non-linear Time-History Analysis, Introduction to Performance Based Engineering
Unit 3: Principles of structural repair, retrofit; Terminology
Unit 4: Nondestructive testing (NDT) methods, Rapid visual screening and simplified evaluation of buildings, Material Properties; In-situ testing methods for RC and masonry structures
Unit 5: Retrofitting Materials, Retrofitting of Structures: Buildings and Bridges, Techniques of repair and retrofitting of masonry buildings
Unit 6: Seismic safety of building equipment and services, Design for durability, Life cycle cost estimation of structures

List of Practicals:

1. In-situ testing of concrete using rebound Hammer and USPV Method
2. In-situ testing of concrete using Pull-out Test
3. In-situ testing of concrete using Pull-off Test
4. Location of reinforcement and measurement of cover using Rebar Locator

References:

1. *FEMA 356, 2000, Prestandard and Commentary for the Seismic Rehabilitation of Buildings, Federal Emergency Management Agency, Building Seismic Safety Council, Washington, D.C.*
2. *FEMA 440 / ATC 55, 2005, Improvement of Nonlinear static Seismic analysis Procedures, Federal Emergency Management Agency, Building Seismic Safety Council, Washington, D.C.*
3. *ATC 40, 1996, Seismic Evaluation and Retrofit of Concrete Buildings, Applied Technology Council, California.*
4. *FEMA 273, 1997, NEHRP Guidelines for the Seismic Rehabilitation of Buildings, Federal Emergency Management Agency, Building Seismic Safety Council, Washington, D.C.*
5. *FEMA 310, 1998, Handbook for the Seismic Evaluation of Buildings – A Prestandard, Federal Emergency Management Agency, Building Seismic Safety Council, Washington, D.C.*
6. *J. H. Bungey, 1989, The Testing of Concrete in Structures, Surrey University Press.*
7. *Penelis, George G., and Kappos, Andreas J., 1997, Earthquake Resistant Concrete Structures, E & FN Spon.*

CE-22306: Reliability Based Design

Credit: 4 **3L-1T-0P**

Unit 1. Introduction: Safety factors, Fallacies in designing by Safety factors, Reliability, Probabilistic Reliability, Reasons for Probabilistic Approach.
Unit 2. Mathematical Considerations: Basic Probability Concepts, Random Variables, Distributions of functions, Moments of functions, Moments of function of random variables.
Unit 3. Algebra of Normal Functions: Independent Binary operations, Moment generating functions, Methods of Partial derivatives, Special Correlated combinations.
Unit 4. Determination of Reliability: Generally distributed allowable and applied stress, Determination of reliability when strength and stress distribution are normal, no normal distribution. Reliability methods: Introduction, Monte Carlo Method, First Order Second Moment method, third order and fourth order. Determination of Partial safety Factor. Applications: Element of force systems, Moment of inertia, Radius of gyration, Estimating Variance.
Unit 5. Reliability based Design: Analysis and Design of tension Member, Short Column, Long column, Beam Column, Simple and cantilever Beams.Reliability Allocation Technique, Limit State and Reliability.

References:

1. *R.E. Melchers., Structural Reliability Analysis and Prediction.*
2. *Alfred M Freudentural Eal., Reliability approach in Structural Engineering.*
3. *Singiresus Rao., Reliability based design.*
4. *Balaguru Samy E., Reliability Engineering.*

CE-22307: Plastic Design of Structures

Credit: 4 **3L-1T-0P**

Unit 1: Introduction to Plasticity, Basic concepts of Limit Analysis, Limit Analysis Theorems.
Unit 2: Analysis and Design of Frames, Plastic moment distribution, Minimum weight design.
Unit 3: Secondary Consideration.
Unit 4: Yield Line theory-its applications and limitations.
Unit 5: Advanced theory of limit design-some practical applications to plates and shells.
Unit 6: Design of Concrete structures with minimum reinforcement.

References:

1. *Bruneau, M., Uang, C.-M. & Whittaker, A., Ductile Design of Steel Structures, McGraw-Hill, New York, 1997.*
2. *Hodge, P.C., Plastic Analysis of Structures, McGraw-Hill, New York, 1959. {624.044 Hod}*
3. *Neal, B.G., The Plastic Methods of Structural Analysis, John Wiley, New York, 1956. {624.044 Nea}*
4. *Gioncu, V. & Mazzolani, M., Ductility of Seismic Resistant Steel Structures, Spon Press, London, 2002.*
5. *Chopra, A.K., Dynamics of Structures, 3rd ed., Pearson Prentice-Hall, 2007.*
6. *Bureau of Indian Standards, IS 800, IS 456, IS 1893 & SP 6(6).*

CE-22308: Finite Element Methods

Credit: 4 **3L-1T-0P**

Unit 1. Brief introduction to numerical methods.
Unit 2. Different Approaches, Direct method, Energy approach, Integral formulations and Variational methods.
Unit 3. Modeling, Interpolation functions, Numerical integration and modeling considerations.
Unit 4. Applications**,** Finite element analysis of 1-D and 2-D problems.
Unit 5. Applications and Error Analysis, Application of the method to the axisymmetric and 3-D bodies, Finite element error analysis.
Unit 6. Dynamic Considerations**,** Eigen value and time-dependent problems.

References:

1. *K. J. Bathe & E. L. Wilson, Numerical Methods in Finite Element Analysis, Prentice-Hall, Englewood Cliffs, N. J., 1976.*
2. *R. D. Cook, Concepts and Applications of Finite Element Analysis, John Wiley, New York, 2001.*
3. *C. Zienkiewicz and R. L. Taylor, Finite Element Method, Butterworth Heinemann publication, 3rd Edition, 2005.*
4. *Thomas J. R. Hughes, The Finite element method, Dover Publications, 2nd Edition, 2000.*
5. *T. R. Chandupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India Pvt. Ltd., New Delhi, 5th Reprint, 1999.*
6. *J. N. Reddy, An Introduction to Linear Finite Element Method, Oxford University Press, Oxford, 2004.*

CE-22309: Structural Design of Environmental Engineering Systems

Credit: 4 **3L-1T-0P**

Unit 1: Hydraulic design of various liquid retaining structures.
Unit 2: Concept of various shapes for liquid retaining structures.
Unit 3: Design of container, Staging and Foundations for tanks.
Unit 4: Design of Ferro cements tanks.
Unit 5: Introduction to pre-stressed Concrete tanks.
Unit 6: Design of pipes for various load conditions.

References:

1. *Plain and Reinforced Concrete vol. II- Jai Krishna and O. P. Jain*
2. *Reinforced Concrete Design-P. Dayaratanam*
3. *IS: 3370 Indian Code of Practice for Water Retaining Structures*
4. *A.K. Jain.- Reinforced concrete (Limit State Design)*

CE-22334 : Soil-Structure Interaction

Credit: 4 **3L-1T-0P**

Unit 1. Scope of soil-foundation interaction analysis, Critical study of conventional methods of foundation design.
Unit 2. Nature and complexities of soil-foundation interaction, Interface behaviour, soil response models, Winkler, Elastic continuum.
Unit 3. Contact pressures and soil-structure interaction for shallow and deep foundations.
Unit 4. Concept of sub grade modulus, effects/parameters influencing subgrade modulus, Analysis of foundations of finite rigidity, Beams on elastic foundation concept, Interaction problems based on the theory of subgrade reaction.
Unit 5. Concept of analysis of piles and pile groups, axially, laterally loaded piles and pile group interaction analysis, Elastic continuum and elasto-plastic analysis of piles and pile groups.
Unit 6. Application of advanced techniques of analysis such as the finite element method, finite differences and interaction for the evaluation of soil-foundation interaction for different types of foundations under various conditions of loading and subsoil characteristics.

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

CE-22358: Environmental Impact Assessment

Credit: 4 **3L-1T-0P**

Unit 1. Overview of EIA; EIA at different levels: Regional; policy; sector levels, EIA process; Screening and scoping criteria.
Unit 2. Rapid and comprehensive EIA; Legal and Regulatory aspect in India; Environmental risk analysis; Economic valuation methods; Cost-benefit analysis; Expert system and GIS applications; Uncertainties.
Unit 3. Legislative and environmental clearance procedures in India and other countries, Siting criteria; CRZ; Public participation; Resettlement and rehabilitation Plans.
Unit 4. Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on physical; biological and socio-economic environment.
Unit 5. Environmental management plan; Post project monitoring, Environmental Audit, EIA report and EIS; Review process.
Unit 6. Case studies on EIA projects and Environmental Management Plan.

References:

1. Canter, L.W., " Environmental Impact Assessment ", McGraw Hill, New York, 1996.
2. Petts, J., " Handbook of Environmental Impact Assessment Vol. I and II ", Blackwell Science, London, 1999.
3. The World Bank Group., " Environmental Assessment Sourcebook Vol. I, II and III ", The World Bank, Washington, 1991.