



ANNA UNIVERSITY
Chennai-25.
Syllabus for

M.E.(Full Time) Structural Engineering

MA145 Applied Mathematics

3 1 0 100

1. TRANSFORM METHODS 12

Laplace transform methods for one-dimensional wave equation - Displacements in a long string - longitudinal vibration of an elastic bar - Fourier transforms methods for one-dimensional heat conduction problems in infinite and semi-infinite rod.

2. ELLIPTIC EQUATIONS 12

Laplace equation - Properties of harmonic functions - Fourier transform methods for Laplace equation.

3. CALCULUS OF VARIATIONS 12

Variation and its properties - Euler's equation - Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables - Some applications - Direct methods - Ritz and Kantorovich methods.

4. PROBABILITY AND RANDOM VARIABLES 12

Probability Random variables Moments - Moment Generating Function - Standard distributions - Functions of random variables - Two dimensional random variables - Correlation and regression.

5. ESTIMATION THEORY 12

Principals of least squares - Multiple and partial correlation and regression - Estimation of parameters - Maximum Likelihood Estimates - Method of moments.

Total No of periods: 60

References:

1. Sankar Rao, K., *Introduction to Partial Differential Equations*, Prentice Hall of India, New Delhi, 1995.
2. Sneddon, I.N., *Elements of Partial Differential Equations*, Mc Graw Hill, 1986.
3. Elsgolts, L., *Differential Equations and Calculus of Variations*, Mir Publishers, Moscow, 1966
4. Gupta, S.C., & Kapoor, V.K., *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons, Reprint 1999.

1. PRINCIPLES OF DYNAMICS 15

Formulation of equations of motion by different methods, single degree of freedom systems, free and forced response, effect of damping.

2. MULTIDEGREE OF FREEDOM SYSTEMS 10

Formulation of structure property matrices, Eigen values problems, Modes shapes and orthonormality of modes, Approximate methods of extraction of eigen values.

3. DYNAMIC RESPONSE OF MDOF SYSTEMS 10

Mode superposition techniques, Numerical integration procedures.

4. CONTINUOUS SYSTEMS 5

Modeling - free and forced vibration of bars and beams.

5. APPLICATIONS 5

Idealisation of structures to mathematical models, examples of wind, earthquake and impact.

Total No of periods: 45

Text Books:

1. Roy R.Craig, Jr., *Structural Dynamics - An Introduction to computer methods*, John Wiley & Sons, 1981.

References:

1. Clough R.W and Penzien,J., *Dynamics of Structures*, Mc Graw Hill, 1975.

2. Paz Mario, *Structural Dynamics*, Academic Press, 1985.

3. Anderson R.A., *Fundamentals of vibration*, Amerind Publishing Co., 1972.

ST133 Theory of Elasticity and Plasticity

3 1 0 100

1. ANALYSIS OF STRESS AND STRAIN 12

Analysis of stress and strain, stress strain relationship. Generalized Hooke's law. Plane stress and plane strain.

2. 2D PROBLEMS 12

Two dimensional problems in Cartesian and polar co-ordinates for simple problems.

3. TORSION 12

Torsion of non-circular section - methods of analysis - membrane analogy - torsion of thin rectangular section and hollow thin walled sections.

4. ENERGY METHODS 12

Energy methods - principle of virtual work - energy theorem - Rayleigh Ritz methods - Finite Difference method.

5. INTRODUCTION TO PROBLEMS IN PLASTICITY 12

Physical assumption - criterion of yielding, yield surface, Flow rule (plastic stress strain relationship). Elastic plastic problems of beams in bending - plastic torsion.

Total No of periods: 60

References:

1. Timoshenko, S. and Goodier T.N. "Theory of Elasticity", McGraw Hill Book Co., Newyork, II Edition 1988.
2. Chwo P.C. and Pagano, N.J. "Elasticity Tensor, Dyadic and Engineering applications", D.Van Nestrand Co., In Co., 1967.
3. Chenn, W.P. and Henry D.J. "Plasticity for Structural Engineers", Springer Verlag Newyork 1988.
4. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
5. Verma, PDS, "Theory of Elasticity", Vikas Publishing Pvt. Ltd. New Delhi -1997.
6. Sadhu Singh, "Theory of Plasticity", Khanna Publishers, New Delhi 1988.

References:

1. *Coates, R.C., Coutie. M.G., and Kong, F.K., Structural Analysis , John Wiley and Sons, 1979.*
2. *McGuire, W., and Gallagher, R.H., Matrix Structural Analysis , John Wiley and Sons, 1979.*
3. *John L.Meek., Matrix Structural Analysis , Mc Graw Hill Book Company, 1971.*

1. OVERALL REVIEW 9

Review of limit state design of beams - Slabs and columns according to IS 456-2000 - Calculation of deflection and crack width according to IS 456-2000.

2. DESIGN OF SPECIAL RC ELEMENTS 11

Design of Slender columns - Design of Rc walls - Ordinary and shear walls - Design of Corbels - Deep - beams and grid floors.

3. FLAT SLABS AND FLAT PLATES 10

Design of flat slabs and flat plates according to ACI method - Design of shear load - reinforcement and edge(spandrel) beams - Yield line theory and Hillerberg method of design of slabs.

4. INELASTIC BEHAVIOUR OF CONCRETE BEAMS 9

Inelastic behaviour of concrete beams - moment - rotation curves - moment redistribution - Baker's method of plastic design - Design of cast-in-situ joints in frames.

5. GENERAL 6

Detailing for ductility - fire resistance of buildings - field control of concrete.

Total No of periods: 45

Text Books:

1. *Purushothaman, P, Reinforced Concrete Structure Structural Elements : Behaviour Analysis and Design , Tata Mc Graw Hill, 1986.*
2. *Varghese, P.C., Limit State Design of Reinforced Concrete, Prentice Hall of India , 1995.*
3. *Krishna Raju, N.Advanced Reinforced Concrete Design, CBS Publishers and Distributors, 1986.*

1. GENERAL 9

Design of members subjected to lateral loads and axial loads - Analysis and design of Industrial buildings and bents - Sway and non-sway frames - Design of Purlins, Louver rails, Gable column and Gable wind grider - Analysis of Gable Frames check for deflection.

2. DESIGN OF CONNECTIONS 9

Types of connections - Design framed beam connections - Seated beam connections - Unstiffened, Stiffened seat connections, Conitinous beam-to-beam connections and continuous beam-to-column connection both welded rivetted.

3. ANALYSIS AND DESIGN OF STEEL TOWERS 9

Analysis and design of Transmission Line Towers Types of bracing patterns - Sag and Tension calculations - Design of self supporting chimney(lined and unlined) and guyed steel stacks - Stresses due to wind and earthquake forces - Design of foundations - Along with loads - calculation Gust Factor Method.

4. PLASTIC ANALYSIS OF STRUCTURES 9

Introduction - Shape factor - Moment redistribution - Static, Kinematic and Uniqueness theorems - Combined mechanism - Analysis of single bay and two bay portal frames - Methods of plastic moment distribution - Effect of axial force and shear force on plastic moments - Connections Moment resisting connection - Design of continuous beams.

5. DESIGN OF LIGHT GAUGE STEEL STRUCTURES 9

Types of cross sections - local bucking and lateral bucking - concepts of Effective width - Design of compression and tension members, Beams, Deflection of beams and design of beam webs. Combined stresses and connections, wall studs.

Total No of periods: 45

References:

1. *Horne, M.R., and Morris, L.J., Plastic Design of Low -rise frames, Granada Publishing Ltd., 1981.*
2. *Salmon, C.G., and Johnson, J.E. Steel Structure -Design and Behaviour, Harper and Row, 1980.*
3. *Dayarathnam, P., Design of Steel Structure, A.H.Wheeler, 1990.*
4. *Kuzamanovic,B.O. and Willems,N., Steel Design for Structural Engineers, Prentice Hall, 1977.*
5. *Wie - Wen Yu., Cold-formed Steel Structures, McGraw Hill Book Company, 1973.*
6. *William McGuire, Steel Structures, Prentice Hall, Inc., Englewood Cliffs, N.J.1986.*

1. INTRODUCTION 10

Boundary Value Problem - Approximate Solution - Variational and Weighted Residual Methods - Ritz and Galerkin Formulations - Concepts of Piecewise Approximation and Finite Elements - Displacement and Shape Functions - Weak Formulation - Minimum Potential Energy - Generation of Stiffness Matrix and Load Vector.

2. STRESS ANALYSIS 10

Two Dimensional problems - Plane Stress, Plain Strain and Axisymmetric Problems - Triangular and Quadrilateral Elements - Natural Coordinates - Isoparametric Formulation - Numerical Integration - Plate Bending and Shell Elements - Brick Elements - Elements for Fracture Analysis.

3. MESHING AND SOLUTION PROBLEMS 10

Higher Order Elements - p and h Methods of refinement - IIL conditioned Elements - Discretisation Errors - Auto and Adaptive Mesh Generation Techniques - Error Evaluation.

4. NONLINEAR AND VIBRATION PROBLEMS 10

Material and Geometric Nonlinearity - Methods of Treatment - Consistent System Matrices - Dynamic Condensation - Eigen Value Extraction.

5. THERMAL ANALYSIS 5

Application to Thermal analysis Problems.

6. PRACTICALS 30

Total No of periods: 75

References:

1. Bathe , K.J., *Finite Elements Procedures in Engineering analysis*, Prentice Hall Inc., 1995.
2. Zienkiewicz, O.C, and Taylor, R.L., *The Finite Elements Methods* , Mc Graw Hill , 1987.
3. Chandrupatla, R.T. and Belegundu, A.D ., *Introduction to Finite Elements in Engineering, 2nd Edition* , Prentice Hall of India, 1997.
4. Moaveni,S., *Finite Element Analysis : Theory and Application with ANSYS*, Prentice Hall Inc., 1999.

1. SOIL-FOUNDATION INTERACTION 6

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

2. BEAM ON ELASTIC FOUNDATION- SOIL MODELS 10

Infinite beam,Two parameters,Isotropic elastic half space,Analysis of beams of finite length,Classification of finite beams in relation to their stiffness

3. PLATE ON ELASTIC MEDIUM 10

Infinite plate,Winkler,Two parameters,isotropic elastic medium,Thin and thick plates,Analysis of finite plates,rectangular and circular plates,Numerical analysis of finite plates,simple solutions

4. ELASTIC ANALYSIS OF PILE 10

Elastic analysis of single pile,Theoretical solutions for settlement and load distributions,analysis of pile group,Interaction analysis,Load distribution in groups with rigid cap.

5. LATERALLY LOADED PILE 9

Load deflection prediction for laterally loaded piles,Subgrade reaction and elastic analysis,Interaction analysis,Pile raft system, Solutions through influence charts

Total No of periods: 45

References:

1. Selva durai, A.P.S., *Elastic Analysis of Soil Foundation Interaction*, Elsevier, 1979
2. Poulos, H.G., and Davis, E.H., *Pile Foundation Analysis and Design*, John Wiley, 1980
3. Scott, R.F., *Foundation Analysis*, Prentice Hall, 1981
4. *Structure Soil Interaction - State of Art Report*, Institution of Structural Engineers, 1978.
5. ACI 336, *Suggested Analysis and Design Procedures for combined footings and Mats*, American Concrete Institute, Delhi, 1988

ST031 Aseismic Design of Structures

3 0 0 100

1. INTRODUCTION 5

Elements of Engineering Seismology - Theory of Vibration - Response Spectrum.

2. HISTORICAL 5

Indian Seismicity - Earthquake History - Behaviour of Structures in the past Earthquakes.

3. DESIGN CONCEPTS 5

Seismic Design Concepts - Cyclic load behaviour of RC, Steel and Prestressed Concrete elements - Design spectrum - Principles of capacity design.

4. CODAL PROVISIONS 10

Provisions of Seismic Code (IS 1893) - Building systems frames, shear walls, Braced Frames, Combinations - Torsion.

5. DESIGN AND DETAILING 10

Performance of Regular Buildings 3 D Computer Analysis of Building Systems (Theory Only) - Design and Detailing of frames - Shear walls and Frame walls.

6. SPECIAL PROBLEMS AND CASE STUDIES 10

Structural Configuration - Seismic performance - Irregular Buildings - Soil performance, Modern Concepts - Base Isolation - Adaptive system - Case studies.

Total No of periods: 45

References:

1. *Course Notes "Design of Reinforced Concrete Building", IIT, Kanpur, June 1999.*
2. *Bungale S.Taranath "Structural Analysis and Design of Tall Buildings" McGraw Hill Book Company, New York, 1999.*

1. CONCRETE MAKING MATERIALS 9

Aggregates classification, IS Specifications, Properties, Grading, Methods of combining aggregates, specified gradings, Testing of aggregates, Fibers.

Cement, Grade of cement, Chemical composition, Testing of concrete, Hydration of cement, Structure of hydrated cement, Special cements - Water Chemical admixtures, Mineral admixture.

2. CONCRETE 9

Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage, Variability of concrete strength.

3. MIX DESIGN 6

Principles of concrete mix design, Methods of concrete mix design, Testing of concrete.

4. SPECIAL CONCRETE 9

Light weight concrete, Fly ash concrete, Fibre reinforced concrete, Polymer Concrete, Super plasticised concrete, Epoxy resins and screeds for rehabilitation - Properties and Applications - High performance concrete.

5. CONCRETING METHODS 9

Process of manufacturing of concrete, methods of transportation, placing and curing - Extreme weather concreting, special concreting methods, Vacuum dewatering - underwater concrete, special form work.

Total No of periods: 42

References:

- 1. Neville, A.M., Properties of Concrete , Pitman Publishing Limited, London.*
- 2. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi.*
- 3. Rudhani G., Light Weight Concrete Academic Kiado, Publishing Home of Hungarian Academy of Sciences, 1963.*

ST034 Design of Bridges

3 0 0 100

1. INTRODUCTION 6

Classification, investigations and planning, choice of type, I.R.C. specifications for road bridges, standard live loads, other forces acting on bridges, general design considerations.

2. SHORT SPAN BRIDGES 9

Load distribution theories, analysis and design of slab culverts, tee beam and slab bridges.

3. LONG SPAN GIRDER BRIDGES 12

Design principles of continuous bridges, box girder bridges, balanced cantilever bridges.

4. DESIGN OF PRESTRESSED CONCRETE BRIDGES 6

5. DESIGN OF PLATE GIRDER BRIDGES 6

6. BEARINGS, SUBSTRUCTURES AND FOOTINGS FOR BRIDGES 6

Total No of periods: 45

References:

1. Raina V.K. *"Concrete Bridge Practice"* , Tata McGraw Hill Publishing Company, New Delhi, 1991.
2. Krishnaraju, N., *"Design of Bridges"* Oxford and IBH Publishing Co., Bombay, Calcutta, New Delhi, 1988
3. Bakht, B. and Jaegar, L.G., *"Bridge Analysis simplified"*, McGraw Hill, 1985.
4. Ponnuswamy, S., *"Bridge Engineering"*, Tata McGraw Hill, 1989
5. Derrick Beckett, *"An introduction to Structural Design of Concrete Bridges"*, Surrey University Press, Henley Thames, Oxford Shire, 1973.
6. Taylor, F.W., Thomson, S.E., and Smulski E., *"Reinforced Concrete Bridges"*, John Wiley and Sons, New York, 1955.
7. Edwin H.Gaylord Jr., Charles N.Gaylord, James, E.,Stallmeyer *"Design of Steel Structures"* McGraw Hill International Editions, 1992.

1. INTRODUCTION 8

Design of Soil Investigation report for design of foundation structures. General principles of design of reinforced concrete shallow and deep foundations.

2. DESIGN OF SHALLOW AND DEEP FOUNDATIONS 9

Shallow foundations - Beams on elastic foundations - Design of rafts, buoyancy - rafts and basement design - Deep foundations - Load carrying capacity of different types of piles and detailing of reinforcements according to IS2911 - Design of pile caps.

3. FOUNDATIONS FOR BRIDGES AND MACHINES 15

Foundations for bridges - well and caisson foundations - General principles, planning and design of machine foundations.

4. TOWER FOUNDATIONS 15

Design of foundations for towers - Structural design of supports for foundation excavation design of ground anchors.

Total No of periods: 47

Text Books:

- 1. Thomlinson, M.J. and Boorman.R., "Foundation design and construction", ELBS Longman VI edition, 1995.*
- 2. Nayak, N.V., "Foundation Design manual for practising Engineers", Dhanpat Rai and Sons, 1982.*
- 3. Winterkorn H.F., and Fang H.Y., "Foundation Engineering Hand book - Van Nostrard - Reinhold - 1976.*

1. MEMBRANE THEORY OF STEELS**10**

Classification of shells - Types of shells - Structural action - Membrane theory - Shells of revolution and shells of translation - Examples - Limitations of membrane theory.

2. DESIGN OF FOLDED PLATES**10**

Folded Plate structures - structural behaviour - Types - Design by ACI - ASCE Task Committee method.

3. SPACE FRAME - DESIGN PHILOSOPHY**5**

Space frames - configuration - types of nodes - general principles of design Philosophy - Behaviour.

4. ANALYSIS OF SPACE FRAMES**10**

Analysis of space frames - Formex Algebra, FORMIAN - Detailed design of Space frames

5. OPTIMISATION**10**

Optimization by structural theorems - Maxwell, Mirchell and Heyman's Theorems for trusses and frames - Fully stressed design with deflection constraints - Genetic Algorithm.

Total No of periods: 45

References:

1. *Wilhelm Flügge, Stresses in shells, Springer - Verlag*
2. *Timoshenko, S. Theory of Plates and Shells, McGraw Hill, 1990*
3. *Ramasamy, G.S., Design and Construction of Concrete Shells Roofs, CBS Publishers, 1986*
4. *Principles of Space Structures by Dr.N.Subramanian - 1999, Wheeler Publishing Co.*
5. *Proceedings of International Conference on Space Structures, Anna University, November 1997.*
6. *Uri Krish, Optimum Structural Design, McGraw Hill Book Co. 1981*

ST037 Design of Steel Concrete Composite Structures

3 0 0 100

1. INTRODUCTION 9

Introduction to steel - Concrete composite construction - Theory of composite structures - Introduction to steel - Concrete - Steel sandwich construction.

2. DESIGN OF COMPOSITE MEMBERS 9

Behaviour of composite beams - Columns - Design of composite beams - Steel - Concrete composite columns - Design of composite trusses.

3. DESIGN OF CONNECTIONS 9

Types of connections - Design of connections in the composite structures - Shear connections - Design of connections in composite trusses.

4. COMPOSITE BOX GIRDER BRIDGES 9

Introduction - Behaviour of box girder bridges - Design concepts.

5. GENERAL 9

Case studies on steel - Concrete composite construction in buildings - Seismic behaviour of composite structures.

Total No of periods: 45

References:

- 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.*
- 3. Workshop on Steel Concrete Composite Structures, conducted at Anna University, 2000.*

1. INTRODUCTION 10

Factors affecting design against dynamic loads - Behaviour of concrete, steel, masonry and soil under impact and cyclic loads - Recap of Structural dynamics with reference to SDOF, MDOF and continuum systems - Ductility and its importance.

2. DESIGN AGAINST EARTHQUAKES 10

Earthquake characterisation - Response spectra - seismic coefficient and response spectra methods of estimating loads - Response of framed, braced frames and shear wall buildings - Design as per BIS codes of practice - Ductility based design.

3. DESIGN AGAINST BLAST AND IMPACT 10

Characteristics of internal and external blast - Impact and impulse loads - Pressure distribution on buildings above ground due to external blast - underground explosion - Design of buildings for blast and impact as per BIS codes of practice.

4. DESIGN AGAINST WIND 10

Characteristics of wind - Basic and Design wind speeds - Effect of permeability of the structure - pressure coefficient - Aeroelastic and Aerodynamic effects - Design as per BIS code of practice including Gust Factor approach - tall buildings, stacks and chimneys.

5. SPECIAL CONSIDERATIONS 5

Energy absorption capacity - Ductility of the material and the structure - Detailing for ductility - Passive and active control of vibrations - New and favourable materials.

Total No of periods: 45

References:

1. *Bela Goschy, " Design of Building to withstand abnormal loading ", Butterworths, 1990.*
2. *Paulay, .T. and Priestly, .M.N.J., " A seismic Design of Reinforced Concrete and Masonry building ", John Wiley and Sons, 1991.*
3. *Dowling, .C.H., " Blast vibration - Monitoring and control ", Prentice Hall Inc., Englewood Cliffs, 1985.*
4. *Kolousek, .V. et al., " Wind effects on Civil Engineering Structures ", Elsevier, 1984.*
5. *Concrete Structures under Impact and Impulsive Loading, Synthesis Report CEB, Lousanne, Germany, 1988.*

1. DESIGN CRITERIA 5

Design philosophy, Loading, Sequential loading, materials - high performance Concrete - Fiber reinforced Concrete - Light weight Concrete - Design mixes.

2. LOADING AND MOVEMENT 5

Gravity Loading : Dead and live load, methods of live load reduction, Impact, gravity loading, construction loads.

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.

3. BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS 8

Factors affecting growth, Height and Structural form. High rise behaviour, Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, futrigger - braced and hybrid mega system.

4. ANALYSIS AND DESIGN 20

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of building as total structural system considering overall integrity and major subsystem interaction, Anlysis for member forces, drift and twist, computerised general three ditional analysis.

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

5. STABILITY OF TALL BUILDINGS 7

Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P-Delta analysis, Translational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation.

Total No of periods: 45

Text Books:

1. Taranath B.S., *Structural Analysis and Design of Tall Building*, McGraw Hill, 1988.

References:

1. Dr. Y.P.Gupta, Editor. *Proceedings National Seminar on High Rise Structures - Design and Construction practices for middle level cities Nov. 14 -16, 1995*, New Age International Limited, Publishers, Madras - 20.
2. Wilf gang Schuller, *High Rise Building Structures*, John Wiley and Sons, 1977.
3. Bryan stafford Smith, Alexcoull, *Tall Building Structures , Analysis and Design*, John Wiley and Sons, Inc., 1991.
4. T.Y.Lin, D.Stotes Burry, *Structural Concepts and system for Architects and Engineers*. John Wiley, 1988.
5. Lynn S.Beedle, *Advances in Tall Buildings*, CBS Publishers and Distributors, Delhi, 1986.

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Design philosophy, Loading, Sequential loading, materials - high performance Concrete - Fiber reinforced Concrete - Light weight Concrete - Design mixes.

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Total No of periods: 45

1. BEHAVIOUR OF LIFE-LINE STRUCTURES 9

Philosophy for design to resist earthquake, cyclone and flood - National and International codes of practice - By-Law of urban and semi-urban areas - Traditional and modern structures.

2. COMMUNITY STRUCTURES 9

Response of dams, bridges, buildings - Strengthening measures - Safety analysis and rating - Reliability assessment.

3. REHABILITATION AND RETROFITTING 9

Testing and evaluation - Classification of structures for safety point of view - methods of strengthening for different disasters - qualification test.

4. DETAILING OF STRUCTURES AND COMPONENTS 9

Use of modern materials and their impact on disaster reduction - Use of modern analysis, design and construction techniques optimisation for performance.

5. DAMAGE ASSESSMENT OF STRUCTURES 9

Damage surveys - Maintenance and modifications to improve hazard resistance - Different types of foundation and its impact on safety - Ground improvement techniques.

Total No of periods: 45

Text Books:

1. *V.Moskvin , et.all Concrete and Reinforced Concrete - Deterioration and Protection - Mir Publishers - Moscow 1980.*
2. *R.T.Allen and S.C.Edwards, Repair of Concrete Structures, Blakie and Sons, U.K 1987.*

References:

1. *Proceedings IABSE 14th Congress "Civilisation through Civil Engineering" New Delhi, May 1992.*
2. *Raiker R.N.Learning from failures Deficiencies in Design, Construction and Service , R & D Center (SDCPL) Raiker Bhavan, Bombay , 1987.*

1. DESIGN OF PIPES 4

Structural design of a) Concrete b) Prestressed Concrete c) Steel and d) Castiron piping mains, sewerage tanks design - anchorage for pipes - massive outfalls - structural design and laying - hydrodynamic considerations. Advances in the manufacture of pipes.

2. ANALYSIS AND DESIGN OF WATER TANKS 12

Design of concrete roofing systems a) Cylindrical b) Spherical and c) Conical shapes using membrane theory and design of various types of folded plates for roofing with concrete. IS Codes for the design of water retaining structures.

Design of circular, rectangular, spherical and Intze type of tanks using concrete. Design of prestressed concrete cylindrical tanks - Economic analysis - introduction to computer aided design and packages.

3. DESIGN OF SPECIAL PURPOSE STRUCTURES 12

Underground reservoirs and swimming pools, Intake towers, Structural design including foundation of water retaining structures such as settling tanks, clarifloculators, aeration tanks etc. - effect of earth pressure and uplift considerations - selection of materials of construction.

4. REPAIR AND REHABILITATION OF STRUCTURES 12

Diagonising the cause and damage, identification of different types of structural and non-structural cracks - repair and rehabilitation methods for Masonry, Concrete and Steel Structures.

5. EXPOSURE ON STEEL , LATTICE STRUCTURES USED IN WATER AND SEWERAGE WORKS 5**Total No of periods: 45**

Text Books:

1. *Reinforced Concrete* by P.Dayaratnam.
2. *Prestressed Concrete* by Krishna Raju, Tata McGraw Hill Publishing Co. 2nd Edition 1988.
3. *Reinforced Concrete* by N.C.Sinha & S.K.Roy - S.Chand and Co. 1985.

References:

1. Hulse R., and Mosley, W.H., " *Reinforced Concrete Design by Computer* ", Macmillan Education Ltd., 1986.
2. Ramaswamy, G.S., " *Design and Construction of Concrete shell roofs* ", CBS Publishers, India, 1986.
3. Green, J.K. and Perkins, P.H., " *Concrete liquid retaining structures* ", Applied Science Publishers, 1981.

1. PLANNING AND FUNCTIONAL REQUIREMENTS 9

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

2. INDUSTRIAL BUILDINGS 12

Roofs for Industrial Buildings - Steel and RC - Folded Plates and Shell Roofs - Gantry Girders - Design of Corbels and Nibs - Machine Foundations.

3. POWER PLANT STRUCTURES 12

Bunkers and Silos - Chimneys and Cooling Towers - High Pressure boilers and piping design - Nuclear containment structures.

4. POWER TRANSMISSION STRUCTURES 12

Cables - Transmission Line Towers - Substation Structures - Tower Foundations - Testing Towers.

Total No of periods: 45

References:

- 1. Procs. Of Advanced course on Industrial Structures, Structural Engineering Research Centre, 1982.*
- 2. P.Srinivasulu and C.V.Vaidyanathan, Handbook of Machine Foundations, Tata McGraw Hill 1976.*
- 3. S.N.Manohar, Tall Chimneys - Design and Construction, Tata McGraw Hill, 1985.*
- 4. A.R.Santhakumar and S.S.Murthy, Transmission Line Structures, Tata McGraw Hill, 1992.*

1. GENERAL	5
Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking.	
2. INFLUENCE ON SERVICEABILITY AND DURABILITY	8
Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.	
3. MAINTENANCE AND REPAIR STRATEGIES	8
Definitions : Maintenance, repair and rehabilitation, Facets of Maintenance importance of Maintenance Preventive measures on various aspects Inspection, Assessment procedure for evaluating a damaged structure causes of deterioration - testing techniques.	
4. MATERIALS FOR REPAIR	8
Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete.	
5. TECHNIQUES FOR REPAIR	7
Rust eliminators and polymers coating for rebars during repair foamed concrete, mortar and dry pack, vacuum concrete, Guniting and Shotcrete Epoxy injection, Mortar repair for cracks, shoring and underpinning.	
6. EXAMPLES OF REPAIR TO STRUCTURES	7
Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure.	
7.	2
Engineered demolition techniques for Dilapidated structures - case studies	
Total No of periods:	45

Text Books:

1. *Denison Campbell, Allen and Harold Roper, " Concrete Structures ", Materials, Maintenance and Repair, Longman Scientific and Technical UK, 1991.*
2. *R.T.Allen and S.C.Edwards, " Repair of Concrete Structures ", Blakie and Sons, UK, 1987.*

References:

1. *M.S.Shetty, " Concrete Technology - Theory and Practice ", S.Chand and Company, New Delhi, 1992.*
2. *Santhakumar, A.R., " Training Course notes on Damage Assessment and repair in Low Cost Housing ", " RHDC-NBO " Anna University, July, 1992.*
3. *Raikar, R.N., " Learning from failures - Deficiencies in Design ", Construction and Service - R & D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.*
4. *N.Palaniappan, " Estate Management, Anna Institute of Management ", Chennai, 1992.*
5. *Lakshmiathy, Metal Lecture notes of Workshop on " Repairs and Rehabilitation of Structures ", 29 - 30th October 1999.*

ST044 Offshore Structures

3 0 0 100

1. WAVE THEORIES

8

Wave generation process, small and finite amplitude wave theories.

2. FORCES OF OFFSHORE STRUCTURES

8

Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

3. OFFSHORE SOIL AND STRUCTURE MODELING

9

Different types of offshore structures, foundation modeling, structural modeling.

4. ANALYSIS OF OFFSHORE STRUCTURES

10

Static method of analysis, foundation analysis and dynamics of offshore structures.

5. DESIGN OF OFFSHORE STRUCTURES

10

Design of platforms, helipads, Jacket tower and mooring cables and pipe lines.

Total No of periods: 45

References:

1. Chakrabarti, S.K. *Hydrodynamics of Offshore Structures*, Computational Mechanics Publications, 1987.
2. Thomas H. Dawson, *Offshore Structural Engineering*, Prentice Hall Inc Englewood Cliffs, N.J. 1983
3. API, *Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms*, American Petroleum Institute Publication, RP2A, Dalls, Tex.
4. Wiegel, R.L., *Oceanographical Engineering*, Prentice Hall Inc, Englewood Cliffs, N.J. 1964.
5. Brebia, C.A. Walker, S., *Dynamic Analysis of Offshore Structures*, Newnes Butterworths, U.K. 1979.
6. Reddy, D.V. and Arockiasamy, M., *Offshore Structures, Vol.1*, Krieger Publishing Company, Malabar, Florida, 1991.

1. INTRODUCTION 9

Basic concepts of minimum weight, minimum cost design, Objective function, constraints, classical methods.

2. OPTIMIZATION TECHNIQUES AND ALGORITHMS 12

Linear programming, Integer Programming, Quadratic Programming, Dynamic Programming and Geometric Programming methods for Optimal design of structural elements.

3. COMPUTER SEARCH METHODS 12

Linear Programming methods for plastic design of frames, Computer search methods for univariate and multivariate Minimization.

4. OPTIMIZATION THEOREMS 12

Optimization by structural theorems, Maxwell, Mitchell and Heyman's Theorems for trusses and frames, fully stresses design with deflection constraints, optimality criterion methods.

Total No of periods: 45

References:

- 1. Spunt, Optimum Structural Design, Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey 1971.*
- 2. S.S.Rao, Optimization Theory and Applications, Wiley Eastern Limited, New Delhi, 1977.*
- 3. Uri Krisch, Optimum Structural Design, McGraw Hill Book Co. 1981.*
- 4. Richard Bronson, Operation Research, Schaum's Outline Series, McGraw Hill Book Co, Singapore, 1983.*

- 1. INTRODUCTION 3**
General Civil Engineering requirements, specific requirements for planning and I layout of prefabricates plant. IS Code specifications.
- 2. DESIGN PRINCIPLES 6**
Modular co-ordination, standardization, Disuniting, of Prefabricates, production, transportation, erection, stages of loading and codal provisions, safety factors, material properties, Deflection control, Lateral load resistance, Location and types of shear walls.
- 3. REINFORCED CONCRETE 6**
Prefabricated structures - Long wall and cross-wall large panel buildings, one way and two way prefabricated slabs, Framed buildings with partial and curtain walls, single storey industrial buildings with trusses and shells, Crane-gantry systems.
- 4. FLOORS, STAIRS AND ROOFS 9**
Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab design, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long term loads, Ultimate strength calculations in shear and flexure.
- 5. WALLS 9**
Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, approximate design of shear walls.
- 6. DESIGN OF INDUSTRIAL BUILDINGS 6**
Components of single-storey industrial sheds with crane gantry systems, Design of R.C. Roof Trusses, Roof Panels, Design of R.C.cranes-gantry girders, corbels and columns, wind bracing design.
- 7. DESIGN OF SHELL ROOFS FOR INDUSTRIAL SHEDS 6**
Cylindrical, Folded plate and hyper-prefabricated shells, Erection and jointing, joint design, hand book based design.

Total No of periods: 45

References:

1. B.Lewicki, *Building with Large Prefabricates*, Elsevier Publishing Company, Amsterdam/ London/ New York, 1966.
2. Koncz.T., *Manual of Precast Concrete Construction, Vol.I II and III*, Bauverlag, GMBH, 1971.
3. *Structural Design Manual, Precast Concrete Connection Details*, Society for the Studies in the use of Precase Concrete, Netherland Betor Verlag, 1978.
4. Lasslo Mokka, *Prefabricated Concrete for Industrial and Public Sectors*, Akademiai Kiado, Budapest, 1964.
5. Murashev.V., Sigalov.E., and Bailov.V., *Design of Reinforced Concrete Structures*, Mir Publishers, 1968.
6. CBRI, *Building Materials and Components*, 1990, India.
7. Gerostiza. C.Z., Hendrikson, C., Rehat D.R., *Knowledge Based Process Planning for Construction and Manufacturing*, Academic Press, Inc., 1989.
8. Warszawski, A., *Industrialization and Robotics in Building - A managerial approach*, Harper & Row, 1990.

1. INTRODUCTION AND CODAL PROVISIONS 8

Principles of Prestressing - types and systems of prestressing, need for High Strength materials, Analysis methods losses, deflection (short-long term), camber, cable layouts. Behaviour under flexure - codal provisions (IS, British ACI and DIN), ultimate strength.

2. DESIGN PRINCIPLES FOR FLEXURE SHEAR BOND AND END BLOCKS 8

Design of flexural members, Design for Shear, bond and torsion. Design of End blocks and their importance Design of tension members - application in the design of prestressed pipes and prestressed concrete cylindrical water tanks.

3. DESIGN OF COMPRESSION MEMBERS 8

Design of compression members with and without flexure - its application in the design piles, flagmasts and similar structures.

4. COMPOSITE BEAMS 8

Composite beams - analysis and design, ultimate strength - their applications. Partial prestressing - its advantages and applications.

5. CONTINUOUS BEAMS 5

Application of prestressing in continuous beams, concept of linear transformation, concordant cable profile and cap cables.

6. DESIGN OF SPECIAL STRUCTURES 8

Special structures like prestressed folded plates, prestressed cylindrical shells, prestressed concrete poles.

Total No of periods: 45

Text Books:

1. *Prestressed Concrete by Krishna Raju, Tata McGraw Hill Publishing Co. 2nd Edition, 1988.*
2. *Fundamentals of Prestressed Concrete by N.C.Sinha & S.K.Roy S.Chand & Co., 1985.*

References:

1. *T.Y.Lin, Design of Prestressed Concrete Structures, John Wiley and Sons, Inc 1960.*
2. *Leonhardt.F., Prestressed Concrete, Design and Construction, Wilhelm Ernst and Shon, Berlin, 1964.*
3. *Freyssinet, Prestressed Concrete*
4. *Military Engineers Hand Book*
5. *Evans, R.H. and Bennett, E.W., Prestressed Concrete, Champman and Hall, London, 1958.*

1. INTRODUCTION	3
Concept of stability, approaches to stability analysis, characteristics of stability problems.	
2. COLUMNS	12
Buckling of columns with various end conditions, imperfect columns, Elastically supported columns, non-prismatic columns, Built-up columns, Inelastic buckling, Experimental study of column behaviour, Empirical column formulae. Buckling of bars on elastic foundations, Large deflection of buckled bars.	
3. BEAMS - COLUMNS	3
Beam-column theory, Application to buckling of frames.	
4. TORSIONAL BUCKLING	6
Combined torsional and flexural buckling.	
5. LATERAL BUCKLING	6
Lateral buckling of beams, pure bending of simply supported beam and cantilever, numerical solutions.	
6. PLATES	6
Buckling of thin plates, various edge conditions, Inelastic buckling, post buckling strength.	
7. APPROXIMATE METHODS	9
Energy methods, Iterative procedure and Finite element formulation.	
Total No of periods:	45

References:

1. Allen, H.G., and Bulson, P.S., *Background to Buckling*, McGraw Hill Book Company, 1980.
2. Smitses, *Elastic Stability of Structures*, Prentice Hall, 1973.
3. Timoshenko, S., and Gere., *Theory of Elastic Stability*, McGraw Hill Book Company, 1961.
4. Brush and Almorth., *Buckling of Bars, Plates and Shells*, McGraw Hill Book Company, 1975.
5. Chajes, A. *Principles of Structures Stability Theory*, Prentice Hall, 1974.
6. Ashwini Kumar, *Stability Theory of Structures*, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1985.

ST049 Theory of Plates

3 0 0 100

1. LATERALLY LOADED PLATES

10

Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions.

2. RECTANGULAR PLATES

10

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's methods, Rectangular plates with various edge conditions.

3. CIRCULAR PLATES

10

Symmetrical bending of circular plates, plates on elastic foundation.

4. SPECIAL AND APPROXIMATE METHODS

8

Energy methods, Finite difference and Finite element methods.

5. ANISOTROPIC PLATES AND THICK PLATES

7

Orthotropic plates and grids, moderately thick plates.

Total No of periods: 45

References :

1. Szilard, R., *Theory of Analysis of Plates*, Prentice Hall Inc.
2. Timoshenko, S. and Krieger S.W. *Theory of Plates and Shells* , McGraw Hill Book Company, New york.

ST050 Wind and Cyclone effects on Structures

3 0 0 100

1. INTRODUCTION 10

Introduction, Spectral studies, Gust factor, Wind velocity, Methods of measurements, variation of speed with height, shape factor, aspect ratio, drag effects.

2. WIND TUNNEL STUDIES 5

Wind Tunnel Studies, Types of tunnels, Modeling requirements, Interpretation of results, Aero-elastic models.

3. WIND EFFECT 12

Wind on structures, Rigid structures, Flexible structures, Static and Dynamic effects, Tall buildings, chimneys.

4. DESIGN PRINCIPLES 12

Application to design, IS 875 code method, Buildings, Chimneys, Roofs, Shelters.

5. CYCLONE AND DESIGN 6

Cyclone effect on structures, cladding design, window glass design.

Total No of periods: 45

Text Books:

1. Cook.N.J., *The Designer's Guide to Wind Loading of Building Structures*, Butterworths, 1989.
2. Kolousek., *et.al.*, *Wind Effects on Civil Engineering Structures*, Elsevier Publications, 1984.

References:

1. Peter Sachs, *Wind Forces in Engineering*, Pergamon Press, New York, 1972.
2. Lawson T.V., *Wind Effects on Building Vol. I and II*, Applied Science Publishers, London, 1980.

1. COMPUTER GRAPHICS 9

Graphic primitives - Transformations - Basics of 2-D drafting - Modeling of curves and surfaces - Solid modeling - Graphic standards - Drafting software packages and usage.

2. STRUCTURAL ANALYSIS 9

Computer methods of structural analysis - Finite Element programming - Analysis through application packages.

3. STRUCTURAL DESIGN 9

Computer aided design of steel and RC Structural elements - Detailed drawing - Bill of materials.

4. OPTIMIZATION 9

Linear programming - Simplex algorithm - Post-optimality analysis - Project scheduling - CPM and PERT applications Genetic algorithm and applications.

5. ARTIFICIAL INTELLIGENCE 9

Introduction - Heuristic search - knowledge based expert systems - Architecture and applications of KBES - Expert system shells - Principles of neural network.

Total No of periods: 45

References:

1. C.S.Krishnamoorthy and S.Rajeev, *Computer Aided Design*, Narosa Publishing House, New Delhi, 1991.
2. H.B.Harrison, *Structural Analysis and Design Vol.I & II*, Pergamon Press, 1991 E.Hinton and D.R.J.Owen, *Finite Element Programming*, Academic Press 1977.
3. Billy E.Gillet, *Introduction to Operations Research, A computer oriented algorithmic approach*, Tata McGraw Hill 1982.
4. Richard Forsyth (Ed.), *Expert System Principles and Case studies* - Chapman & Hall.