ANNA UNIVERSITY TIRUCHIRAPPALLI
Tiruchirappalli – 620 024
Regulations 2007
Curriculum

M.E. STRUCTURAL ENGINEERING

SEMESTER I

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**MA5111**	Applied Mathematics	3	1	0	100
2	**ST5101**	Experimental Methods and Model Analysis	3	0	0	100
3	**ST5102**	Structural Dynamics	3	1	0	100
4	**ST5103**	Constitutive Models and Modes of Failure	3	1	0	100
5	**EI******	Elective I	3	0	0	100
6	**E2******	Elective II	3	0	0	100

SEMESTER II

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**ST5151**	Concrete Structures	3	0	0	100
2	**ST5152**	Design of Substructures	3	0	0	100
3	**ST5153**	Steel Structures	3	0	0	100
4	**ST5154**	Computational Methods	3	1	0	100
5	**E3******	Elective III	3	0	0	100
6	**E4******	Elective IV	3	0	0	100
Practical						
7	**ST5155**	Structural Engineering Laboratory	0	0	3	100

SEMESTER III

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**E5******	Elective V	3	0	0	100
2	**E6******	Elective VI	3	0	0	100
3	**E7******	Elective VII	3	0	0	100
Practical						
4	**ST5215**	Practical Training (4 weeks in previous summer)	0	0	0	100
5	**ST5220**	Seminar	0	0	2	100
6	**ST5251**	Project Work Phase I	0	0	12	*

SEMESTER IV

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Practical						
1	**ST5251**	Project Work Phase II	0	0	24	*

LIST OF ELECTIVES

S.No.	Subject Code	Subject	L	T	P	Max. Marks
Theory						
1	**ST5001**	Soil Structure Interaction	3	0	0	100
2	**ST5002**	Aseismic Design of Structures	3	0	0	100
3	**ST5003**	CAAD for Structures	3	1	0	100
4	**ST5004**	Design of Bridges	3	0	0	100
5	**ST5005**	Design of Plates, Shells and Spatial Structures	3	0	0	100
6	**ST5006**	Design of Steel Concrete Composite Structures	3	0	0	100
7	**ST5007**	Design of Structures for Dynamic Loads	3	0	0	100
8	**ST5008**	Design of Tall Buildings	3	0	0	100
9	**ST5009**	Industrial Structures	3	0	0	100
10	**ST5010**	Maintenance and Rehabilitation of Structures	3	0	0	100
11	**ST5011**	Optimization in Structural Design	3	0	0	100
12	**ST5012**	Prestressed Concrete	3	0	0	100
13	**ST5013**	Stability of Structures	3	0	0	100
14	**ST5014**	Wind and Cyclone effects on Structures	3	0	0	100
15	**ST5015**	Advanced Structural Analysis	3	0	0	100

ANNA UNIVERSITY TIRUCHIRAPPALLI

Tiruchirappalli - 620 024

Regulations 2007

Syllabus

M.E. STRUCTURAL ENGINEERING

SEMESTER I

MA5111 – APPLIED MATHEMATICS

L	T	P
3	1	0

UNIT I TRANSFORM METHODS 12

Laplace and inverse transforms – integral transforms – transform methods for boundary value problems – initial value problems – applications in one and two dimensions.

UNIT II CALCULUS OF VARIATIONS 12

Variations –one and multi-dimensional – Euler equation – functionals – differential and integral variations – Ritz and Kantarovich methods – weighted residuals – Discrete approximations – finite difference, finite element and boundary elements.

UNIT III PROBABILITY AND RANDOM THEORY 12

Probability and random variables and functions – moments in one and two dimensions – first order and second order methods – correlation and regression Multi dimensions-applications

UNIT IV ESTIMATION THEORY 12

Principles of least squares – multiple and partial correlations – parameter estimation – likelihood estimates – method of moments

UNIT V SOFT COMPUTING METHODS 12

Deterministic and fuzzy variables- likelihood functions – fuzzy relations – neural nets – algorithms in neural nets – evolutionary approaches – genetic algorithms

L: 45 T: 15 Total: 60

REFERENCES

1. Jain, R.K., Iyengar, SRK., Advanced Engineering Mathematics, Narosa Publications, 2003.
2. Andrews, L.C. and Srivamoggi, B.K., Integral Transform for Engineers, Prentice Hall of India Pvt. Ltd., New Delhi, 2003
3. A.S. Gupta – Calculus of Variations with Applications, Prentice Hall of India Pvt. Ltd., 1997
4. J.N. Kapan & H.C. Sexana – Mathematical Statistics, S. Chand & Co., 2003
5. R. Beale, C.T. Jacson, Neural Computing – An Introduction, Adam Hilger, 1990
6. Melanie Mitchell, An Introduction to Genetic Algorithms, PHI, 1990
7. Simon Haykin, Neural Networks: A Comprehensive Foundation, 2nd Edition, Prentice Hall / Pearson Education, 1999.
8. Valluru Rao, Hayagriva Rao, C++ Neural Networks and Fuzzy Logic, MIS Press, 1994.

ST5101 – EXPERIMENTAL METHODS AND MODEL ANALYSIS

L	T	P
3	1	0

UNIT I STRAIN MEASUREMENTS - GAUGES 9

Basic Concept in Measurements, Measurement of displacement, strain pressure, force, torque etc, Type of strain gauges (Mechanical, Electrical resistance, Acoustical etc).

UNIT II ELECTRICAL STRAIN GAUGES 9

Strain gauge circuits – The potentiometer and Wheatstone bridge – use of lead wires switches etc. Use of electrical resistance strain gauges in transducer applications.

UNIT III STRAIN ROSETTE- DYNAMIC TESTING 9

Indicating and recording devices - Static and dynamic data recording –Data (Digital and Analogue) acquisition and processing systems. Strain analysis methods – Rosette analysis. Static and dynamic testing techniques. Equipment for loading- Moire's techniques.

UNIT IV NON DESTRUCTIVE TESTING 9

Non destructive testing techniques. Photoelasticity – optics of photoelasticity Polariscope – Isoclinics and Isochromatics - methods of stress separation.

UNIT V MODELS - TESTING 9

Laws of similitude - model materials – model testing – testing large scale structures – holographic techniques.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Dally J W and Riley W.F, Experimental stress Analysis, McGraw-Hill, Inc. New York, 1991.
2. Srinath L S et al, Experimental Stress Analysis, Tata McGraw-Hill Publishing Co., Ltd., New Delhi, 1984.

REFERENCES

1. Rangan C S et al., Instrumentation – Devices and Systems, Tata McGraw-Hill Publishing Co., Ltd., New Delhi, 1983.
2. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 1996.

ST5102 – STRUCTURAL DYNAMICS

L	T	P
3	1	0

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS 9+3

Formulation of equation of motion, Free and forced vibrations, Response to dynamic loading, Effect of damping.

UNIT II MODAL ANALYSIS 9+3

Free and forced vibration of undamped and damped MDOF systems. Equation of motions, Evaluation of natural frequencies and mode shapes, Approximate methods, Mode superposition method, Numerical integration procedures

UNIT III CONTINUOUS SYSTEMS 9+3

Dynamics of distributed parameter systems, Free and forced vibration of flexural beams, shear beams and columns.

UNIT IV TRANSIENT AND DYNAMIC RESPONSE OF STRUCTURES 9+3

Idealisation of structures to mathematical models, Mode superposition method, Numerical integration procedures

UNIT V RANDOM AND STOCHASTIC VIBRATION 9+3

Random Variables and random processes, Models of random dynamic loads, Stochastic response of SDOF systems.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Clough R.W, and Penzien J, Dynamics of Structures, Second Edition, McGraw-Hill International Edition, 1993
2. Mario Paz, Structural Dynamics – Theory and Computations, Third Edition, CBS publishers, 1990.

REFERENCES

1. Roy R Craig, Structural Dynamics – An Introduction to Computer Methods, John Wiley and Sons, 1981.
2. Anderson R.A, Fundamentals of Vibration, Amerind Publishing Co., 1972.
3. Humar J L Dynamics of Structures, Prentice Hall, 1990.
4. Smith J W, Vibration of Structures – Application in Civil Engineering. Design Chapmat Hill 1988.

ST5103 – CONSTITUTIVE MODELS AND MODES OF FAILURE

L	T	P
3	1	0

UNIT I ELASTICITY 9+3

Stress strain analysis – 2D problems – Cartesian and polar coordinates – generalized Hooke's law – 3D problems–energy relations

UNIT II PLASTICITY 9+3

Yielding and yield surface – strain rates and failure theories – flow rule – elastic plastic and strain hardening models – beam and soil applications

UNIT III MECHANICAL MODELS 9+3

Kelvin and Maxwell models – viscoelasticity – friction and Coloumb models – series, parallel and hybrid models – applications

UNIT IV ENERGY RELATIONS 9+3

Work and energy types – energy theorems and material models – formulations Applications in beams and simple structures

UNIT V APPLICATIONS 9+3

Engineering material models – steel and concrete – reinforced concrete - composites-one, two and three dimensional models – practical examples

L: 45 T: 15 Total: 60

REFERENCES

1. Dowling, N.E., Mechanical Behaviour of Materials: Engineering Methods of Deformation, Fracture and Fatigue, 2nd Edition, Prentice – Hall, 1999.
2. Bedford, A.M. and Liechti, K.M., Mechanics of Materials, Prentice Hall, 2001.
3. Popov, E "Mechanics of Materials", Prentice Hall Reprinted Pearson Education, 2003.

SEMESTER II

ST5151 – CONCRETE STRUCTURES

L	T	P
3	1	0

UNIT I DESIGN OF BEAMS 9

Behaviour of RCC beams under combined Shear Torsion and Bending-Modes of Failures-Inter action effects-Analysis and design of beams circular in plan and Spandrel beams-Design for Serviceability Limit states-Design calculation of deflections and crack width according to IS 456-2000

UNIT II DESIGN OF SLENDER COLUMNS 6

Behaviour of slender RCC Columns- Failure modes and Interaction curves-Additional Moment method-Comparison of codal provisions- calculation of design moments for braced and unbraced columns-Principles of Moment magnification method-design of slender columns.

UNIT III DESIGN OF SPECIAL RC ELEMENTS 12

Design and detailing of Concrete braced and unbraced walls according to BIS code— Classification of shear walls, design principles, design of rectangular and flanged shear walls-Analysis of forces, Design and detailing of Corbels-Design and detailing of Deep beams- and Approximate analysis and design of Grid floors.

UNIT IV DESIGN OF FLAT SLABS AND FLAT PLATES 9

Yield line theory of slabs - Hillerberg method of design of slabs- Design of Flat slabs and flat plates according to BIS method-Shear in Flat Slabs and Flat Plates

UNIT V INELASTIC BEHAVIOUR OF CONCRETE BEAMS AND FRAMES 9

Inelastic behaviour of concrete beams-moment-rotation curves-moment redistribution-Bakers method of analysis and design-Design of cast-in-situ joints in frames. Detailing requirements for ductility, durability and fire resistance

L: 45 T: 15 Total: 60

TEXT BOOKS

1. Varghese, P.C. “Advanced Reinforced Concrete Design”, Prentice Hall of India, (2002).
2. Shah V.L., & Karve S.R. “Limit state theory and Design of Reinforced Concrete”, Structures Publications, Pune (2003)
3. Krishna Raju, N., “Advanced Reinforced Concrete Design”, CBS Publishers and Distributers, (1986)
4. Sinha.S.N., “Reinforced Concrete Design”, Tata-McGraw-Hill (1996).

REFERENCES

1. Purushothaman, P, Reinforced Concrete Structure Structural Elements: Behaviour Analysis and Design, Tata McGraw-Hill, (1986).
2. Varghese, P.C. “Limit State Design of Reinforced Concrete”, Prentice Hall of India, (2002).
3. Jack C. MCCormac., “Design of Reinforced Concrete”, John Wiley &Sons(200)
4. Ramchandra & Virendra Gehlot., “Elements of Limit State Design of Concrete Structures” Scientific Publishers (India), (2004)
5. Arthur H.Nilson “Design of Concrete Structures”, Tata McGraw-Hill,(2003)
6. Park. R, & Paulay .T, “Reinforced Concrete Structures”, John Wiley & Sons (1975)

ST5152 – DESIGN OF SUBSTRUCTURES

L	T	P
3	0	0

UNIT I SUB SURFACE EXPLORATION 5

Purpose - Programme and Procedures – Interpretation of bore logs, soil data and exploration reports.

UNIT II SHALLOW FOUNDATIONS 10

Types of foundations and their specific applications – depth of foundation – bearing capacity and settlement estimates – structural design of isolated footings, strip, rectangular and trapezoidal combined footings – strap – balanced footings – raft foundation – Approximate flexible method of raft design - Compensated foundations.

UNIT III DEEP FOUNDATIONS 6

Types of Piles and their applications - Load capacity - Settlements - Group action - Design of piles and pile caps – Lateral load capacity of piles.

UNIT IV FOUNDATIONS FOR BRIDGES AND OTHER MISCELLANEOUS STRUCTURES 12

Drilled shaft foundations and caissons for bridges - Foundations for towers – Chimneys – Silos – Structural Design of supports for foundation excavations – Design of Anchors.

UNIT V MACHINE FOUNDATIONS 12

Types - General requirements and design criteria - General analysis of machine-foundations-soil system - Stiffness and damping parameters - Tests for design parameters - Guide lines for design of reciprocating engines, impact type machines, rotary type machines, framed foundations.

L: 45 T: 0 Total: 45

REFERENCES

1. Thomlinson, M.J. and Boorman. R. “Foundation Design and Construction”, ELBS Longman VI edition, 1995.
2. Nayak, N.V., “Foundation Design manual for Practicing Engineers”, Dhanpat Rai and Sons, 1982.
3. Winterkorn H.F., and Fang H.Y., “Foundation Engineering Hand Book - Van Nostrard - Reinhold - 1976.
4. Brain J Bell and M.J. Smith “Reinforced Concrete Foundations” George Godwin Ltd.
5. Braja M. Das “Principles of Foundations Engineering” Thomson Asia (P) Ltd.

ST5153 – STEEL STUCTURES

L	T	P
3	1	0

UNIT I ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS 9

Review of loads on structures-Dead, Live, wind and Seismic loads as per National standard-Analysis and Design of Industrial buildings and bents-Sway and non-sway frames- Design of Purlins, lovuver rails, gable column and Gable wind girder-Analysis and design of Gable frames.

UNIT II BEHAVIOUR AND DESIGN OF CONNECTIONS 9

Connection behaviour -Design requirements of Bolted and welded connections-unsiffened and stiffened seat connections –framed connections- Connections for force and moment transmission-tee stub and end plate connections- Column stiffeners and other reinforcement-principles of semi rigid connections

UNIT III ANALYSIS AND DESIGN OF COLD-FORMED STEEL STRUCTURES 9

Types of cross sections-concepts of local buckling, and Effective width-Design of compression and tension members,- concepts of lateral buckling –Design of Beams, deflections of beams and design of beam webs.- Combined stresses and connections-Empirical design of Z-purlins with lips and wall studs.

UNIT IV ANALYSIS AND DESIGN OF SPECIAL STRUCTURES 9

Analysis and design of Steel Water Tanks- Cylindrical and pressed steel tanks -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

UNIT V ADVANCED DESIGN PHILOSOPHIES 9

Concepts of Plastic design – Probabilistic basis of Load and Resistance Factors-LRFD – Limit State Design –Ultimate and serviceability limit states-Limit State Design of Axially loaded members – Design of beams.

L: 45 T: 15 Total: 60

TEXT BOOKS

1. P.Dayaratnam, “Design of Steel Structures”, Wheeler Publishing, (1990)
2. Teaching Resource for Structural Steel Design, INSDAG. Kolkotta (2001)
3. J.Rhodes, “Design of Cold-Formed Steel Members”, Elsevier Science Publishers (1991)
4. S.Ramchandra, Design of Steel Structures, Vol.-II, Standard Publication, New Delhi.

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 Structures-Design and Behaviour, Harper and Row, 1980.
3. Robert Englekirk, “Steel Structures – Controlling Behaviour Through Design”, John Wiley & Sons
4. Kuzamanovic, B.O.and Williems, 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.
7. Arthur R. Thamboli, “Steel Design Hand Book-LFRD Method” McGraw-Hill (1997)
8. William T. Segui “LFRD Steel Design” PWS Publishing (1)

ST 5154 – COMPUTATIONAL METHODS

L	T	P
3	1	0

UNIT I MODELLING 9 + 3

Engineering design cycle – modeling types – dimensional and analytical models – numerical and design models – computer-based modeling- examples

UNIT II MATRIX METHODS 9 + 3

Force and displacement methods – relation with energy – stiffness and flexibility solution of equations – beam, truss and frame applications

UNIT III LINEAR ANALYSIS 9 + 3

Performance of structural systems – load-deflection – moment-rotation – linearity Discretisation by finite elements – assembly and solution – applications using Software- pre and post processor interpretations

UNIT IV NON-LINEAR ANALYSIS 9 + 3

Definition – geometric and material nonlinearity – strain displacement – stress- strain – finite element format – software usage for large deflection – software for inelastic behaviour.

UNIT V DYNAMIC ANALYSIS 9 + 3

Mass and damping in time dependent structural response – basic equations – eigenvalues and eigenvectors **–** modal methods – integration methods –software usage

L: 45 T: 15 Total: 60

REFERENCES

1. Rao, S.S., Applied Numerical Methods for Scientists and Engineers, Pearson Higher Education, 2001.
2. Rao, S.S., The Finite Element Method in Engineering, Pergamon Press, 1999.
3. Bathe, K.J., Finite Element Procedures in Engineering Analysis, Prentice Hall, 1995.
4. Moaveni, S., Finite Element Analysis – Theory and Application, Prentice Hall, 1999.
5. P.Seshu, Finite Element Analysis, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.

ST5155 – STRUCTURAL ENGINEERING LABORATORY

L	T	P
0	0	3

1. Concrete mix design - Properties of fresh and hardened concrete
2. Strain gauges – Principles and applications, mechanical, optical and electrical strain gauges, Strain recording instruments.
3. Study the constitutive behaviour of structural materials (concrete and steel)
4. Study the response of structural members (RC columns, beams) using accelerometers, load cells etc.
5. Use of static and dynamic data recording and processing systems.

REFERENCES

1. Dally J W, and Riley W F, “Experimental Stress Analysis”, McGraw-Hill, Inc. New York, 1991.

ELECTIVES

ST5001 – SOIL STRUCTURE INTERACTION

L	T	P
3	0	0

UNIT I SOIL-FOUNDATION INTERACTION 6

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

UNIT II 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.

UNIT III 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.

UNIT IV 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.

UNIT V LATERALLY LOADED PILE 9

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

Total: 45

REFERENCES

1. Selvadurai, 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

ST5002 – ASEISMIC DESIGN OF STRUCTURES

L	T	P
3	0	0

UNIT I SEISMOLOGY - EARTHQUAKE CHARECTERISTICS 9

Elements of Engineering Seismology - Characteristics of Earthquakes - History – Seismic Susceptibilty of Indian Subcontinent - Performance of structures under past earthquakes, Lessons learnt from past earthquakes.

UNIT II STRUCTURALELEMENTSUNDERCYCLICLOADING 9

Building Systems – Rigid Frames, Braced Frames, Shear Walls - Behaviour of RC, steel and prestressed concrete elements under cyclic loading - Soil performance.

UNIT III EARTHQUAKE RESISTANT DESIGN 12

Concept of Earthquake Resistant Design - Provisions of Seismic Code IS 1893 (Part I) – 2002 - Response Spectrum - Design Spectrum - Structural Configuration - 3 D computer analysis of building (Theory) - Design and Detailing of Frames, Shear Walls and Framed Walls – Provisions of IS-13920.

UNIT IV STRENTHENING OF STRUCTURES 8

Design of Non Engineered construction - strengthening of buildings - Design Provisions for Bridges and Dams.

UNIT V MODERN DESIGN ASPECTS 7

Modern Concepts – Base Isolation – Adoptive systems – Case studies.

Total: 45

TEXT BOOKS

1. Course Notes “Design of Reinforced Concrete Buildings”, IIT Kanpur, June, 1999 (NPEEE publication).
2. Minoru Wakabayashi, “Design of Earthquake Resistant Buildings”, McGraw – Hill Book Company, New York, 1986

REFERENCES

1. Anil K Chopra, “Dynamics of structures – Theory and applications to Earthquake Engineering”, Prentice Hall Inc., 2001.
2. Norman B Green, “Earthquake Resistant Building Design and Construction”, Elsevier Science Publishing Co. Inc., New York, 1987

ST5003 – CAAD FOR STRUCTURES

L	T	P
3	0	0

UNIT I 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.

UNIT II STRUCTURAL ANALYSIS 9

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

UNIT III STRUCTURAL DESIGN 9

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

UNIT IV OPTIMIZATION 9

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

UNIT V ARTIFICIAL INTELLIGENCE 9

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

Total: 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.

ST5004 – DESIGN OF BRIDGES

L	T	P
3	0	0

UNIT I 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.

UNIT II SHORT SPAN BRIDGES 9

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

UNIT III LONG SPAN GIRDER BRIDGES 12

Design principles of continuous bridges, bow string girder bridges, balanced cantilever bridges.

UNIT IV DESIGN OF PRESTRESSED CONCRETE BRIDGES 9

Flexural and torsional parameters – Courbon's theory – Distribution co-efficient by exact analysis – Design of girder section – maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable Zone in girder – check for stresses at various sections – check for diagonal tension – Diaphragms – End block – short term and long term deflections

UNIT V DESIGN OF PLATE GIRDER BRIDGES 9

Design of riveted and welded plate girder bridges for highway and railway loading – wind effects – main section, splicing curtailment, stiffeners – Different types of bearings – Design of bearings – Design of masonry and concrete piers and abutments – Types of bridge foundations – Design of foundations

Total: 45

REFERENCES

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

ST5005 – DESIGN OF PLATES, SHELLS AND SPATIAL STRUCTURES

L	T	P
3	0	0

UNIT I PLATES - DEFORMATION 10

Equation of equilibrium and deformation of plates – Bending of rectangular plates and circular plates.

UNIT II ENERGY APPROACH – FINITE ELEMENT 10

Energy method, finite difference and finite element methods for solution of plate bending problems. Principles of design of folded plates

UNIT III SHELLS – ANALYSIS AND DESIGN 10

Geometry of shells – Classification of Shells – membrance theory of circular and cylindrical shells – Details Analysis and design of cylindrical shells – Detailing of Reinforcement in shells, edge beams and transfer beam

UNIT IV SPACE STRUCTURES 5

Space frames – configuration – types of nodes – general principles of design Philosophy– Behaviour

UNIT V COMPUTER ANALYSIS – SPACE FRAMES 10

Analysis of space frames – Formex Algebra, FOR MAIN – detailed design of space frames.

Total: 45

REFERENCES

1. Wilhelm Flugge, 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. Szllard, R. Theory of Analysis of Plates, Prentice Hall Inc.

ST5006 – DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

L	T	P
3	0	0

UNIT I INTRODUCTION **9**

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

UNIT II DESIGN OF COMPOSITE MEMBERS **9**

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

UNIT III DESIGN OF CONNECTIONS **9**

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

UNIT IV COMPOSITE BOX GRIDER BRIDGERS **9**

Introduction - Behaviour of box girder bridges - Design concepts.

UNIT V GENERAL **9**

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

Total: 45

REFERENCES

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

ST5007 – DESIGN OF STRUCTURES FOR DYNAMIC LOADS

L	T	P
3	0	0

UNIT I 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.

UNIT II DESIGN AGAINST EARTHQUAKES 10

Earthquake characterisation - Response spectra - seismic coeffcient 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.

UNIT III 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 bulidings for blast and impact as per BIS codes of practice.

UNIT IV DESIGN AGAINST WIND 10

Characteristics of wind - Basic and Design wind speeds - Effect of premeability 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.

UNIT V 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: 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.

ST5008 – DESIGN OF TALL BUILDINGS

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UNIT I DESIGN CRITERIA 6

Design Philosophy, Materials – Modern concepts – High Performance Concrete, Fibre Reinforced Concrete, Light weight concrete, Self Compacting Concrete.

UNIT II LOADING 8

Gravity Loading – Dead load, Live load, Impact load, Construction load, Sequential loading. Wind Loading – Static and Dynamic Approach, Analytical method, Wind Tunnel Experimental methods. Earthquake Loading – Equivalent lateral Load analysis, Response Spectrum Method, Combination of Loads,

UNIT III BEHAVIOUR OF STRUCTURAL SYSTEMS 9

Factors affecting the growth, height and structural form, Behaviour of Braced frames, Rigid Frames, In filled frames, Shear walls, Coupled Shear walls, Wall – Frames, Tubular, Outrigger braced, Hybrid systems.

UNIT IV ANALYSIS AND DESIGN 13

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of structures as an integral unit, Analysis for member forces, drift and twist. Computerized 3D analysis. Design for differential movement, Creep and Shrinkage effects, Temperature Effects and Fire Resistance.

UNIT V STABILITY ANALYSIS 9

Overall buckling analysis of frames, wall – frames, Approximate methods, Second order effect of gravity loading, P – Delta Effects, Simultaneous first order and P-Delta analysis, Translational instability, Torsional Instability, Out of plumb effects, Effect of stiffness of members and foundation rotation in stability of structures.

Total: 45

TEXT BOOKS

1. Bryan Stafford Smith and Alex Coull, “Tall Building Structures”, Analysis and Design, John Wiley and Sons, Inc., 1991.
2. Taranath B.S, “Structural Analysis and Design of Tall Buildings”, McGraw-Hill, 1988

REFERENCES

1. COULL, A. and SMITH, STAFFORD, B. “Tall Buildings”, Pergamon Press, 1997.
2. LinT.Y. and Burry D.Stotes, “Structural Concepts and Systems for Architects and Engineers”, John Wiley, 1994.
3. Lynn S.Beedle, Advances in Tall Buildings, CBS Publishers and Distributors, 1996.

ST5009 – INDUSTRIAL STRUCTURES

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UNIT I 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.

UNIT II INDUSTRIAL BUILDINGS 9

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

UNIT III POWER PLANT STRUCTURES 9

Bunkers and Silos – Chimney and Cooling Towers – Design of Steel storage tanks – Nuclear containment structures.

UNIT IV POWER TRANSMISSION STRUCTURES 9

Cables – Transmission Line Towers – Substation structures – Tower foundations – Testing towers.

UNIT V INDUSTRIAL RCC ROOFS 9

Shells – various types – Design of cylindrical and north light shell roofs. Folded plate roofs – design of north light folded plate roofs

Total: 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, Transmision Line Structures, Tata McGraw-Hill 1992.
5. Dr. K. Rajagopalan – Storage Structures – Oxford IBH Publishing Company Ltd.1989.

ST5010 – MAINTENANCE AND REHABILITATION OF STRUCTURES

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UNIT I INFLUENCE ON SERVICEBILITY AND DURABILITY 9

Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties and cracking. 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.

UNIT II MAINTENANCE AND REPAIR STRATEGIES 9

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.

UNIT III MATERIALS FOR REPAIR 9

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete.

UNIT IV TECHNIQUES FOR REPAIR 9

Rust eliminators and polymers coating for rebars during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete Epoxy injection, Mortar repair for cracks, shoring and underpinning.

UNIT V EXAMPLES OF REPAIR TO STRUCTURES 9

Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure.Engineered demolition techniques for Dilapilated structures - case studies

Total: 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. Lakshmipathy, Metal Lecture notes of Workshop on “Repairs and Rehabilitation of Structures”, 29 - 30th October 1999.

ST5011 – OPTIMIZATION IN STRUCTURAL DESIGN

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UNIT I INTRODUCTION 9

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

UNIT II OPTIMIZATION TECHNIQUES AND ALGORITHMS 9

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

UNIT III COMPUTER SEARCH METHODS 9

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

UNIT IV OPTIMIZATION THEOREMS 9

Optimization by structural theorems, Maxwell, Mitchell and Heyman's Theorems for trusses and frames,

UNIT V DESIGN - DEFORMATION CONSTRAINTS 9

Stresses design with deflection constraints, optimality criterion methods.

Total: 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.

ST5012 – PRESTRESSED CONCRETE

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UNIT I PRINCIPLES AND ANALYSIS FOR FLEXURE 9

Principles of Prestressing – Types of prestressing systems – Materials – Systems and devices – Analysis and design for flexure- Behaviour of prestressed concrete elements – General concept of prestress – Force transmitted by pretensioned and post tensioned systems - losses in prestress – analysis for Ultimate strength – Comparison of codal provisions - at service load and Magnel's approach .

UNIT II DESIGN FOR FLEXURE 9

Concept of Limit State design – Limit state of Collapse and serviceability – Design using allowable stresses – Stress range approach - Lin's approach – Magnel's approach.

UNIT III DESIGN FOR SHEAR, TORSION AND ANCHORAGE ZONE 9

Shear resistance in beams – Design for shear in rectangular and flanged beams – Behaviour under torsion –Modes of failure - Design for torsion, shear and bending Anchorage Zone – analysis and design of pretensioned and post tensioned end blocks - IS code provisions – Comparison of other codes.

UNIT IV STATICALLY INDETERMINATE STRUCTURES 9

Analysis of indeterminate structures – Continuous beams – Concept of concordance and linear transformations – Single storied rigid frames – Choice of cable profiles.

UNIT V PSC SPECIAL STRUCTURES 9

Concept of circular prestressing – Design of prestressed concrete pipes and cylindrical water tanks - Composite construction- types, behaviour, flexural stresses, longitudinal shear transfer, transverse shear – Compression members – Design of poles and piles - Partial pre stressing – Principles, analysis and design concepts

Total: 45

TEXT BOOKS

1. Prestressed Concrete by N.Rajagobalan, Norosa Publishing House (2002)
2. Prestressed Concrete by N.Krishnaraju, Tata McGraw-Hill Publishing Company 3rd Ed (1985)

REFERENCES

1. Design of Prestressed Concrete Structures by T.Y.Lin & Nedbhurns 3rd edition (1982), John Wiley & Sons
2. Fundamentals of Prestressed Concrete by N.C.Sinha & S.K.Roy, S.Chand & Co, New Delhi (1985)

ST5013 – STABILITY OF STRUCTURES

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UNIT I STABILITY OF COLUMNS 9

Concepts of Elastic Structural stability- Analytical approaches to stability - characteristics of stability analysis- Elastic Buckling of columns- Equilibrium; Energy and Imperfection approaches – Non-prismatic columns- Built up colyumns- orthogonality of buckling modes- Effect of shear on buckling load - Large deflection theory.

UNIT II METHODS OF ANALYSIS AND IN ELASTIC BUCKLING 9

Approximate methods – Rayleigh and Galerkin methods – numerical methods – Finite difference and finite Element - analysis of columns – Experimental study of column behaviour – South well plot - Column curves - Derivation of Column design formula - Effective length of Columns - Inelastic behaviour- Tangent modulus and Double modulus Theory

UNIT III BEAM COLUMNS AND FRAMES 9

Beam column behaviour- standard cases- Continuous columns and beam columns – Column on elastic foundation – Buckling of frames – Single storey portal frames with and without side sway – Classical and stiffness methods – Approximate evaluation of critical loads in multistoried frames – Use of Wood's charts.

UNIT IV BUCKLING OF BEAMS 9

Lateral buckling of beams – Energy method- Application to Symmetric and simply symmetric I beams – simply supported and Cantilever beams - Narrow rectangular cross sections- – Numerical solutions – Torsional buckling – Uniform and non uniform Torsion on open cross section - Flexural torsional buckling – Equilibrium and energy approach.

UNIT V BUCKLING OF THIN PLATES 9

Isotropic rectangular plates - Governing Differential equations - Simply Supported on all edges – Use of Energy methods – Plates with stiffeners – Numerical Techniques.

Total: 45

TEXT BOOKS

1. Ashwini kumar, "Stability of Structures", Allied Publishers Ltd, (1998)
2. NGR Iyengar, "Structural Stability of Columns and Plates" Affiliated East- West Press Pvt. Ltd (1986)
3. Stephen P. Timoshenko and Gere "Theory of Elastic stability", McGraw-Hill Company (1963)

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. Brush and Almorth, Buckling of Bars, plates and shells, McGraw-Hill Book Company, 1975.
4. Chajes, A. Principles of Structures Stability Theory, Prentice Hall 1974.

ST5014 – WIND AND CYCLONE EFFECTS ON STRUCTURES

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UNIT I INTRODUCTION 10

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

UNIT II WIND TUNNEL STUDIES 5

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

UNIT III WIND EFFECT 12

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

UNIT IV DESIGN PRINCIPLES 12

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

UNIT V CYCLONE AND DESIGN 6

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

Total: 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, 1972.
2. Lawson T.V., Wind Effects on Building Vol. I and II, Applied Science Publishers, 1980.

ST5015 – ADVNACED STRUCTURAL ANALYSIS

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UNIT I STATISTICALLY INDETERMINATE RIGID JOINTED STRUCTURES 15

Degree of statical indeterminacy – Grid structures – Plate analogy – moment distribution – Viaduct frame – Vierendeal girders – Naylor's distribution – Slab less treated riser – Analysis – Winkler – Bach formula – Hooks – chain links

UNIT II STATICALLY REDUNDANT FRAMES 12

Degree of redundancy – plane frames – space frames – simple transmission tower – simple geodesic dome – with pin jointed members – introduction to Lamella grids

UNIT III INFLUENCE LINES FOR DETERMINATE AND INDETERMINATE STRUCTURES 12

3 & 4 span continuous beams – beams with intermediate hinges – Muler Brslau principl– double integration – I.L for shear, moment and reaction – application – Betti

Maxwell law

UNIT IV MATRIX ANALYSIS RIGID JOINTED STRUCTURES 12

Storeyed frames – Multi bayed frames – Grid frames – space frames – viaduct frames – gable frames – Vierndeel girders

UNIT V MATRIX ANALYSIS OF PIN JOINTED FRAMES 9

Pin jointed – Plane frames – space frames – Hybrid frames – cable stayed bridges

Total: 45

TEXT BOOK

1. G.S. Pandit & Gupta "Structural Analysis" (Matrix Approach) Tata McGraw Hill Book company, 1986.

REFERENCE BOOK

1. Gere, Moment Distribution – McGraw Hill Book Company,1942.
2. Wang C.K Matrix Analysis of Structures – McGraw Hill Book Company,1970
3. Schodek D.L :Structural – 4th edition – Prentice Hall India 2004,