University of Pune

M.E. (Civil) (Structures)

COURSE STRUCTURE FOR M.E. (For 2008 Course)

(w.e.f. June – 2008)

SEMESTER I

CODE	SUBJECT	TEACHING SCHEME Hrs.\week		EXAMINATION SCHEME Marks					CREDITS
		Lect.	Pr	Paper	TW	Oral	Pr	Total	
501401	Structural Mathematics	3	-	100	-	-	-	100	3
501402	Advanced Solid Mechanics	3	-	100	-	-	-	100	3
501403	Structural Dynamics	3	-	100	-	-	-	100	3
501404	Elective I a. Advanced Design of Concrete Structures b. Structural Design of Concrete Bridges c. Design of Composite Construction d. Design of Foundations	3	-	100	-	-	-	100	3
501405	Elective II a) Advanced Design of Metal Structures b) Structural Design of Steel Bridges c) Plastic Analysis and Design of Steel Structures d) Design of Industrial Steel Structures.	3	-	100	-	-	-	100	3
501406	Lab Practice I	-	6	-	50	-		50	3
501407	Seminar I	-	4	-	50	-	-	50	2
Total of First Term		15	10	500	100	-	**-**	600	20

SEMESTER II

CODE	SUBJECT	TEACHING SCHEME Hrs.\week		EXAMINATION SCHEME Marks					CREDITS
		Lect.	Pr	Paper	TW	Oral	Pr	Total	
501408	Theory of Plates and Shells	3	-	100	-	-	-	100	3
501409	Finite Element Method	3	-	100	-	-	-	100	3
501410	Management in Structural Engineering	3	-	100	-	-	-	100	3
501411	Elective III a. Earthquake Resistant Design of Structures b. Structural Stability c. Structural Reliability d. Non-linear Analysis of Structures.	3	-	100	-	-	-	100	3
501412	Elective IV (**Open**)	3	-	100	-	-	-	100	3
501413	Lab Practice II	-	6	-	50	-		50	3
501414	Seminar II	-	4	-	50	-	-	50	2
Total of Second Term		15	10	500	100	-	**-**	600	20

SEMESTER III

CODE	SUBJECT	TEACHING SCHEME Hrs. \ week		EXAMINATION SCHEME Marks					CREDITS
		Lect.	Pr	Paper	TW	Oral	Pr	Total	
501415	Seminar III	-	4	-	50	-	-	50	2
501416	Project Stage I	-	18	-	50	-		50	6
Total of Third Term		-	22	-	100	-	-	100	08

SEMESTER IV

CODE	SUBJECT	TEACHING SCHEME Hrs. \ week		EXAMINATION SCHEME Marks					CREDITS
		Lect.	Pr	Project	TW	Oral	Pr	Total	
501417	Project Stage II	-	18	150	-	50		200	12
Total of Fourth Term		-	18	150	-	50	-	200	12

Note : The Contact Hours for the calculation of load of teacher Seminar – 1 Hr /week/student &

Project - 2 Hr/week/ student

501401: STRUCTURAL MATHEMATICS

Teaching Scheme:
Lectures : 3 Hrs/Week

Examination Scheme:
Theory Paper : 100 Marks
Duration 4 Hrs.

Section I

Unit 1: Matrices I

Review of Matrix Algebra; Matrix Methods of Structural Analysis. Flexibility & Stiffness matrices. Application of Flexibility method to beams & plane trusses, Application of Stiffness method to beams, plane trusses & space trusses, Assembly process, Applications not involving more than three unknowns.

Unit 2: Matrices II

Stiffness Matrix Method for analysis of Plane portal frames, Space portal frames & Grid structures. Transformation matrix, Assembly process, Applications not involving more than three unknowns. Eigen valve problems, applications for buckling of column & vibration.

Unit 3: Differential Equations

Ordinary & Partial differential equations Taylor series, Euler's, Range Kutta methods. Applications in structural mechanics such as critical loads of struts, beam columns. Solution of transcendental equation, Applications of bucking of simple portal frames

Section II

Unit 4 : Finite Difference Method

Central, forward and backward methods. Ordinary & partial derivatives, Structural applications such as determination of deflection & indeterminate moments in beams. Buckling load of uniform & variable cross sections of columns. Laterally loaded plates, simple application of deflection and moments in plates.

Unit 5 : Regression Analysis

Least square method, Polynominal function curve fitting Interpolation – Polynomial approximation, Lagranges method, spline interpolation.

Unit 6 : Numerical Integration & Fourier Series

Review of trapezoidal, simpson's method. Gauss quadrature rule. Fourier series, periodic functions, Even & odd functions, Fourier integral & transform, Fast Fourier Transform. Application of Fourier series for periodic loading acting on a structure.

Reference Books

1. P.N. Wartikar & J.N. Wartikar – A text book of Applied Mathematics – PVG Prakashan
1. S.C. Chapra & R.P. Canale – Numerical Methods for Engineering – TMH Publications
3. E. Balguru samy - Numerical Methods - TMH Publications
4. Pallab Ghosh - - Numerical Methods with computer programmes in C++ - PHI Pvt Ltd.
5. John F Fleming – Computer Analysis of Structural Systems – McGraw Hill Int. Edn.
6. Martin H.C. – Introduction to Matrix Methods in Structural Analysis – McGraw Hill
7. Aslam Kassimali – Matrix Analysis of Structures – Brooks / Cole Publishing Co.

8. Ghali & Neville – Structural Analysis – A unified classical & Matrix Approach – SPON Press London
9. Pandit and Gupta – Structural Analysis – A Matrix Approach – TMH Publications
10. Timoshenko & Gere – Theory of Elastic Stability - – McGraw Hill
11. S. Rajasekaran & G. Sankara Subramaniam – Computational Structural Mechanics – PHI
12. P. Bhatta – Problems in Structural Analysis by Matrix Methods – Wheelers Publication
13. M. Mukhopadhyaya – Matrix, Finite Element, Computer & Structural Analysis - Oxford & IBH Publishing Co.
14. Gere & Weaver – Matrix Analysis of framed structures – CBS Publications, Delhi.
15. Timoshenko – Strength of Materials - CBS Publications, Delhi.
16. T.N. Ganju – Matrix Structural Analysis using spreadsheets – TMH Publication

501402: ADVANCED SOLID MECHANICS

Teaching Scheme:
Lectures : 3 Hrs/Week

Examination Scheme:
Theory Paper : 100 Marks
Duration 4 Hrs.

Section I

Unit 1: Analysis of Stress and Strains
Concept of stress at a point, stress tensor, stress on inclined plane, stress components on a rectangular parallelepiped in Cartesian coordinate system, derivation of stress equilibrium equations, transformation of stresses, stress invariants. The state of strain at a point, strain displacement relations, strain compatibility condition and stress compatibility conditions.

Unit 2: Stress-Strain Relationship
Generalized Hook's law for Isotropic, Orthotropic, Transversely Isotropic materials, plane stress, plane strain and axisymmetric problems, Problems in 2D Cartesian coordinate system, Airy's stress function, bending of beams.

Unit 3: Polar Coordinate System
Relationship between Cartesian and Polar coordinate system, Equilibrium equations, Strain displacement relations, Stress-strain relationship, Strain-displacement relationship for plane stress and plane strain conditions, Bending of curved bar, Stress concentration problems.

Section II

Unit 4: Axisymmetric Problems
Equilibrium equations, Strain displacement relations, Stress-strain relationship, Stress-compatibility equations, Plane stress and Plane strain conditions. Cylinders subjected to internal and external pressure.

Unit 5: Torsion
Assumptions and Torsion equation for general prismatic solid bars, Warping of Non-circular sections and St. Venant's theory. Prandtle's stress function approach. Torsion of Circular, Elliptical and Triangular cross-section bar. Torsion of thin-walled structures by membrane analogy, Torsion of rolled sections and shear flow.

Unit 6: Beams on Elastic Foundation
Differential equation, Infinite beams with concentrated load, concentrated moment, and finite uniformly distributed load. Semi-Infinite beams with free end subjected to finite uniformly distributed load, hinged end. Finite beams with free end and hinged end.

Reference Books

1. Timoshenko and Goodier - Theory of Elasticity, McGraw-Hill Publications
2. S. Crandall, N. Dahl and T. Lardner - Mechanics of Solids, McGraw Hill Publications
3 Wang - Applied Elasticity, Dover Publications
4. Irving Shames, Mechanics of deformable solids, Prentice Hall

5. Scholer, Elasticity in Engineering, McGraw-Hill Publications
6. Sadhu Singh – Theory of Elasticity, Khanna Publishers
7. L.S.Sreenath – Advanced Mechanics of Solids, Tata McGraw-Hill Publications
8. S M A Kazimi – Solid Mechanics, Tata McGraw-Hill Publications

501403: STRUCTURAL DYNAMICS

Teaching Scheme: **Examination Scheme:**
Lectures : 3 Hrs/Week **Theory Paper : 100 Marks**
Duration 4 Hrs.

Section I

Unit 1:
Nature of exciting forces, degrees of freedom and mathematical modelling of dynamic systems. Single degree freedom system (SDOF): An undamped and damped free vibrations, Viscous and Coulomb's damping.

Unit 2:
SDOF system: Undamped and damped Forced Vibrations to harmonic excitations, Fourier analysis of periodic forces. Response to unit impulse and arbitrary loading by Duhamel's integral.

Unit 3:
SDOF system: Step and Ramp forces, Pulse loadings, Response to ground motion and transmissibility. Non-linear analysis by step-by-step method with linear acceleration.

Section II

Unit 4:
Multiple degrees of freedom (MDOF) system: Free vibrations of a shear building, fundamental frequencies and mode shapes, Orthogonality of mode shapes, Power and Stodola methods. Concept of Tuned Mass Dampers.

Unit 5:
MDOF System: Forced Vibrations of shear building, transformation of coordinates and mode superposition method, Response to ground motion. Non-linear analysis by Wilson-Theta method.

Unit 6:
Continuous system: Free transverse vibrations of beams for various boundary conditions. Free vibration analysis of a cantilever beam by Rayleigh Ritz and Finite Element Method.

Reference Books

1. Mario Paz – Structural Dynamics Theory and Computation, CBS Publications
2. Anil K Chopra – Dynamics of Structures Theory and Applications to Earthquake Engineering, Prentice-Hall Publications
3. R.W Clough and J Penzin – Dynamics of Structures, McGraw Hill Publications
4. R.C. Roy - Structural Dynamics an Introduction to Computer Methods, John Wiley & Sons Publications
5. Madhujit Mukhopadhyay – Structural Dynamics Vibrations and Systems, Ane Books India Publishers

501404: ELECTIVE I

Teaching Scheme:
Lectures : 3 Hrs/Week

Examination Scheme:
Theory Paper : 100 Marks
Duration 4 Hrs.

(a) ADVANCED DESIGN OF CONCERTE STRUCTURES

Section I

I - REINFORCED CONCERTE

Unit 1:
Yield Line Theory for analysis of Slabs: Equilibrium and virtual work methods of analysis, Rectangular slabs and triangular slabs with various edge conditions – yield line patterns, Circular slabs, Design for limit state of strength and serviceability, Orthotropically reinforced slabs.

Unit 2:
Grid or Coffered Floors: General features, Rigorous and approximate methods of analysis, Design of grid floors. Design of aqueduct.

Unit 3:
Elevated Service Reservoirs: Rectangular, Circular and Intze type. Design of staging for wind and earthquake forces, container with flat base and domed bottom. Membrane analysis, Effect of Joint reactions due to continuity.

Section II
II - PRESTRESSED CONCERTE

Unit 4:
Design of Pretension and Posttension Flexural members: Design of partially Prestressed concrete members. Prestressed Concrete Slabs: Introduction, Design of one way, two way and flat slabs.

Unit 5:
Statically Indeterminate Structures: Analysis and Design of continuous beams and Frame. Choice of cable profile-linear transformation-concordancy. Composite Beams: Composite sections of Prestressed concrete beam and cast in-situ RC slab - Analysis of stress, Differential shrinkage, Deflections, Flexural and Shear strength of composite sections, Design of composite sections.

Unit 6:
Prestressed Concrete Pipes and Tanks: Circular prestressing, types of Prestressed concrete pipes. Prestressed Concrete tanks: General features, Analysis and design of circular tanks.

Reference Books

1. T.Y. Lin & Ned H. Burns – Design of Prestressed Concrete Structures, John Wiley Publication

2. N. Krishna Raju – Prestressed Concrete, Tata Mc Graw Hill Publication Co
3. Edward Nawy – Prestressed Concrete – A Fundamental Approach, Prectice Hall International
4. B.C. Punmia, Ashok K. Jain, Arun K. Jain – Reinforced Concrete Structures Vol. II, Laxmi Publications, New Delhi
5. N.C. Sinha, S.K. Roy – Fundamentals of Reinforced Concrete, S. Chand & Co. Ltd, New Delhi
6. P.C. Varghese – Advanced Reinforced Concrete Design, Prentice Hall of India Pvt. Ltd., New Delhi
7. IS: 456: Indian Standard code of practice for plain and reinforced concrete, Bureau of Indian Standards, New Delhi.
8. IS: 1343: Indian Standard code of practice for Prestressed concrete, Bureau of Indian Standards, New Delhi.
9. IS: 1893: Indian Standard cCode of practice for criteria for Earthquake resistant design of structures, Bureau of Indian Standards, New Delhi.
10. IS: 3370-Indian Standard code of practice for concrete structures for storage of liquids, Bureau of Indian Standards, New Delhi.

(b) STRUCTURAL DESIGN OF CONCRETE BRIDGES

Section I

Unit 1:
Introduction to bridge engineering, classification and components of bridges, layout, planning. Structural forms of bridge decks, beam and slab decks, cellular decks. Standard specification for bridges, IRC loadings for road bridges, loading standards for railway bridges.

Unit 2:
Design of slab culvert, box culvert and skew bridge.

Unit 3:
Introduction to Courbon's method, Henry-Jaegar method and Guyon-Massonet method. Design of T-beam PC bridges using Courbon's method.

Section II

Unit 4:
Structural classification of Rigid Frame bridge, analysis and design of Rigid Frame bridge.

Unit 5:
Classification and design of bearings. Expansion joints. Forces acting on abutments and piers, analysis and design, types and design of wing walls.

Unit 6:
Bridge foundations, design of open well, pile and caisson foundation.

Reference Books

1. D. Johnson Victor - Essentials of Bridge Engineering Fifth Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
2. 2. T.R. Jagadeesh, M.A. Jayaram - Design of Bridge Structures, Prentice-Hall of India
3. 3. N. Krishna Raju - Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
4. 4. David Lee – Bridge Bearings and Expansion Joints,E & FN Spon
5. 5. V.K. Raina – Concrete Bridge Practice Analysis, design and Economics, Tata McGraw Hill
6. 6. IRC Codes – IRC: 5, IRC: 6, IRC: 18, IRC: 27, IRC: 45, IRC: 78, IRC: 83
7. 7. Joseph E. Bowles – Foundation Analysis and Design, McGraw-Hill International Edition
8. 8. Nainan P. Kurian – Design of Foundation Systems, Narosa Publishing House

(c) DESIGN OF COMPOSITE CONSTRUCTION

Section I

Unit 1:
Introduction of Composite Constructions. Benefits of Composite Construction, Introduction to IS, BS and Euro codal provisions. Composite beams, elastic behaviour of composite beams, No and Full Interaction cases, Shear Connectors, Ultimate load behaviour, Serviceability limits, Effective breadth of flange, Interaction between shear and moment, Basic design consideration and design of composite beams.

Unit 2:
Composite floors, Structural elements, Profiled sheet decking, Bending resistance, Serviceability criterion, Analysis for internal forces and moments

Unit 3:
Composite Columns, Materials, Concrete filled circular tubular sections, Non-dimensional slenderness, local buckling of steel sections, Effective elastic flexible stiffness, resistance of members to axial compressions, Composite Column design, Fire Resistance.

Section II

Unit 4:
Composite trusses, Design of truss, Configuration, Application range, Analysis and Design aspects and connection details.

Unit 5:
Design of Multi-storeyed commercial and residential composite building, Design basis, load calculations, Design of composite slabs with profile decks, composite beam design, design for compression members, vertical cross bracings, design of foundation.

Unit 6:
Design of Composite Construction in Bridges – IRC specifications and code of practice for loads and composite construction. Composite Deck Slab Design – Design of one way deck slab for Class AA and Class A loading, Design of Cantilever Portion of deck Slab. Design of longitudinal girders.

Reference Books

1. Johnson R. P. – Composite Structures of Steel and Concrete, Vol I, Beams, Columns and Frames in Buildings, Oxford Blackwell Scientific Publications.
2. INSDAG teaching resources for structural steel design Vol – 2, Institute for Steel Development and Growth Publishers, Calcutta
3. INSDAG Handbook on Composite Construction – Multi-Storey Buildings, Institute for Steel Development and Growth Publishers, Calcutta

4. 4. INSDAG Design of Composite Truss for Building, Institute for Steel Development and Growth Publishers, Calcutta
5. 5. INSDAG Handbook on Composite Construction – Bridges and Flyovers, Institute for Steel Development and Growth Publishers, Calcutta
6. 6. INSDAG Design Guide for Composite Highway Bridges (Steel Bridges), Institute for Steel Development and Growth Publishers, Calcutta
7. 7. D. Johnson Victor - Essentials of Bridge Engineering Fifth Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
8. N. Krishna Raju - Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
9. IS:11384, 1985 Code of Practice for Composite Construction in Structural Steel and Concrete, Bureau of Indian Standards, New Delhi.
10. IRC Codes – IRC: 5, IRC: 6, IRC: 18, IRC: 27, IRC: 45, IRC: 78, IRC: 83

(d) DESIGN OF FOUNDATIONS

Section I

Unit 1:
Foundation objectives and their importance, Classification of foundations, Soil classification. Geotechnical design parameters, bearing capacity, settlements and factors affecting settlement. Loads for design, depth of foundation and depth of soil exploration. Parameters for design of foundation on various types of soil, soil structure interaction.

Unit 2:
Types of rafts, Design of Flat slab raft, and beam and slab raft foundation.

Unit 3:
Machine Foundation: Introduction, machine vibrations, design of foundations for rotary machines and impact machine, vibration characteristics, design consideration for foundations.

Section II

Unit 4:
Pile foundations: Function and Classification of piles, Concrete piles, Precast and cast-in-situ piles. Static point and skin resistance capacity of a Pile, Pile settlements, Laterally loaded Piles. Various pile group patterns, Efficiency of Pile in group, Negative skin friction.

Unit 5:
IS code recommendations for structural design for various piles. Design of RC cast-in-situ and precast pile by IS code method. Pile group analysis by rigid and flexible methods, Design of pile cap.

Unit 6:
Shell Foundations: Types and applications, Soil structure interaction, Membrane analysis for Hyper and Conical RC shells with and without edge beams, detailing of critical sections.

References Books

1. Kurain N.P - Modern Foundations: Introduction to Advance Techniques: TataMcGraw Hill,1982 .
2. Kurain N.P - Shell foundations : Geometry, Analysis Design and Construction, Alpha Science International, 2006
3. Kurain N. P. - Design of foundation systems Principles and Practice, Narosa Publishing house, New Delhi, 2005.
4. Dr. H.J.Shah, Reinforced Concrete,Vol II,Charotar Publishing House.
5. Winterkorn H.F. and Fang H.Y. Ed., Foundation Engineering Hand Book, Van-Nostrand Reynold, 1975
6. Bowles J.E., Foundation Analysis and Design (4th Ed.), Mc.Graw –Hill, NY, 1996

7. Poulose H.G. and Davis E.H., Pile foundation Analysis and Design, John-Wiley Sons, NY, 1980.
8. Leonards G. Ed., Foundation Engineering, Mc.Graw-Hill,NY, 1962
9. Shamsher Prakash, Soil Dynamics, McGraw Hill
10. Sreenivasalu & Varadarajan, Handbook of Machine Foundations, Tata McGraw Hill
11. IS 1904: 1986 Code of practice for design and construction of foundations in soils: general requirements (Third Revision)
12. IS 2911: Part 1 : Sec 1 to3 : 1979 Code of practice for design and construction of pile foundations: Part 1 Concrete piles
13. IS 2911: Part 1: Sec 4 : 1984 Code of practice for design and construction of pile foundations: Part 1 Concrete piles
14. IS 2911: Part 3: 1980 Code of practice for design and construction of pile foundations: Part 3 Under-reamed piles
15. IS 2950: Part 1: 1981 Code of Practice for design and construction of raft foundations: Part 1 Design
16. IS 2974: Part 1to 5: 1982 Code of practice for design and construction of machine foundations
17. IS 9456: 1980 Code of practice for design and construction of conical and hyperboloidal types of shell foundations

501405: ELECTIVE II

Teaching Scheme:
Lectures : 3 Hrs/Week

Examination Scheme:
Theory Paper : 100 Marks
Duration 4 Hrs.

(a) ADVANCED DESIGN OF METAL STRUCTURES

Section I

Unit 1 :
Hoarding Structures – Analysis and design of hoarding structures under dead, live and wind load conditions.

Unit 2:
Castellated beams – Fabrication of the castellated beam from rolled beam. Design of castellated beam for bending and shear

Unit 3:
Design of Aluminum Structures: Introduction, Stress-Strain Relationship, Permissible Stresses, Tension and Compression Members, Laced and Battened Columns, Beams, Riveted and Bolted Connections.

Section II

Unit 4:
Microwave Towers – Introduction, structural configuration, function, analysis and design. Transmission Towers – Introduction, structural configuration, bracing systems, analysis and design, codal provision for design of tower and foundation.

Unit 5:
Tubular Structures - Tubular Trusses, joint details, tubular scaffoldings, codal provisions

Unit 6:
Cold Form light gauge section- Type of cross section, Stiffened, multiple stiffened and unstiffened element, flat- width ratio, effective design width, Design of light gauge compression, tension and flexural members.

References Books

1. Ram Chandra - Design of steel Structures Vol II, Standard Book House, Delhi
2. Punmia and Jain- Comprehensive Design of steel structure.
3. Teaching resource materials by INSDAG, Kolkatta
4. IS: 800 – 1984 Code of Practice for General Construction in Steel 22/29
5. IS: 875 – 1964 Code of Practice for Structural Safety of Building: Loading Standards (Revised)
6. IS: 801- 1975 Code of practice for use of cold formed light gauge steel structural members in

general building construction.
7. IS: 802 – 1977 (part I) , 1978 (part II and III) Code of practice for use of structural steel in overhead transmission line towers.
8. IS : 806- 1968 Code of practice for use of steel tubes in general building construction.
9. IS : 4014- 1967(part I and II) Code of practice for steel tubular scaffolding.
10. SP: 6 (2)- 1962 Steel beams and plate girders.
11. SP: 6 (5)- 1980 Structural use of light gauge steel.
12. IS codes for Aluminum Structures, IS:3908, 3909, 3921, 5384, 6445, 6476, 6475, 6449, 8147, Bureau of Indian Standards

(b) STRUCTURAL DESIGN OF STEEL BRIDGES

Section I

Unit 1:
Introduction to steel bridges, classification, selection of bridges, erection methods, historical development of bridges and loading standards for highway and railways.

Unit 2:
Plate Girder Bridges - Types of floor systems, design of deck type plate Girder bridges for broad gauge railway, horizontal truss bracings and end cross frames.

Unit 3:
Truss Girder Bridges - Types, component part, economic proportion, design of through truss girder bridges for highway and broad gauge railway. Various bracing systems for through type truss girder bridges.

Section II

Unit 4:
Plate Girder Bridges - Types of floor systems, design of deck type plate Girder bridges for highway, horizontal truss bracings and end cross frames.

Unit 5:
Truss Girder Bridges - Types, component part, economic proportion, design of through truss girder bridges for highway. Various bracing systems for through type truss girder bridges.

Unit 6:
Bearings – Types, function, selection and design of various types of end bearings

References Books

1. Ram Chandra - Design of steel Structures Vol II, Standard Book House, Delhi
2. D. Johnson Victor - Essentials of Bridge Engineering Fifth Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
3. T.R. Jagadeesh, M.A. Jayaram - Design of Bridge Structures, Prentice-Hall of India
4. N. Krishna Raju - Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
5. IS: 800 – 1984 Code of Practice for General Construction in Steel
6. IS: 875 – 1964 Code of Practice for Structural Safety of Building: Loading Standards (Revised)
7. IS: 1915 – 1961 Code of Practice for Steel Bridges

(c) PLASTIC METHOD FOR ANALYSIS AND DESIGN OF STEEL STRUCTURES

Section I

Unit 1:
Plasticity in ductile materials, actual and idealized stress-strain graph for mild steel, elasto-plastic behavior of beam in flexure, shape factor for different cross sections, yield zones, concept of plastic hinge.

Unit 2:
Plastic collapse loads of determinate and indeterminate structures such as beams and rectangular portal frames, statical and kinematical methods, basic and combined mechanisms. Determination of plastic collapse loads, bending moment diagram at collapse.

Unit 3:
Plastic collapse loads of frames with inclined members such as gable portal frames, various mechanisms.

Section II

Unit 4:
Philosophy of Limit State deign, requirement of steel for design, Limit State of Strength and Serviceability, partial safety factors, design of laterally supported beams, shear resistance

Unit 5:
Secondary design considerations, design of beams with high shear, interaction of bending and shear, interaction of bending and axial force.

Unit 6:
Design of rectangular and gable portal frames, design of corner connection with and without haunches.

References Books

1. Handbook for Structural Engineers SP 6 (8) 1972 (Reaffirmed 1995) – Bureau of Indian Standards.
2. SP: 6 (6) – 1972 Handbook for Structural Engineers: Application of plastic Theory in Design of Steel Structures
3. Draft Code for Revision of IS: 800 Code of Practice for General Construction in Steel
4. A.S. Arya and J.L. Ajmani – Design of Steel Structures, Nemchand & Bros., Roorkee
5. Teaching Resource for Structural Steel Design – INSDAG Kolkatta
6. Ramchandra – Design of Steel Structures Vol – II, Standard Book House, Delhi
7. B.G. Neal – Plastic Method of Structural Analysis, Chapman & Hall
8. L.S. Beedle – Plastic Design of Steel Frames, John Willey & Sons
9. Steel Designers Manual – ELBS

10. Mrazik, M. Skaloud, M. Tochacek – Plastic Design of Steel Structures, Ellis Horward Limited, John Willey & Sons

(d) DESIGN OF INDUSTRIAL STEEL STRUCTURES

Section I

Unit 1:
Analysis and design of knee braced trussed bent with hinged, fixed and partially fixed bases without gantry. Design of knee brace, roof column and its base.

Unit 2:
Various types of column configurations in case of knee braced trussed bent with gantry loads. Design of stepped columns and bases under various load combinations.

Unit 3:
Analysis and design of gable portal frame with and without gantry loads. Design of bracket supporting gantry loads.

Section II

Unit 4:
Open web frames for industrial shed, trussed purlins.

Unit 5:
Mobile gantry structure, machine foundations

Unit 6:
Analysis and design of various bracing systems in industrial shed structure, industrial flooring.

References Books

1. Ramchandra – Design of Steel Structures Vol – II, Standard Book House, Delhi
2. A.S. Arya and J.L. Ajmani – Design of Steel Structures, Nemchand & Bros., Roorkee
3. Teaching Resource for Structural Steel Design – INSDAG Kolkatta
4. IS: 800 – 1984 Code of Practice for General Construction in Steel
5. IS: 875 – 1964 Code of Practice for Structural Safety of Building: Loading Standards (Revised)
6. IS: 4137 – 1967 Code of practice for Heavy Duty electric Overhead Traveling Crane
7. Steel Designers Manual – ELBS
8. John E. Lotheres – Advanced Design in Structural Steel, Prentice Hall

501406: LAB PRACTICE I

Teaching Scheme: Examination Scheme:
Lectures : 6 Hrs/Week Term work: 50 marks

This will be based on syllabi of theory subjects of Semester I. It shall consist of one assignment on each unit of each subject of Semester I. Besides this, following are subject wise additional requirements for term work.

1. Structural Mathematics –
    a. Computer programming for **any four** methods of the following.
        i. Matrix multiplication
        ii. Matrix inversions
        iii. Solution of simultaneous equations
        iv. Runge – Kutta method
        v. Regression analysis
        vi. Gauss Quadrature rule
    b. Software applications for analysis of structures for **any two** of the following
        i. Space truss
        ii. Space frame
        iii. Portal with inclined leg, Gable portal frames
        iv. Vierendeel girder
2. Structural Dynamics – Experimental work to be carried out for Dynamic Analysis of beams and multi storied shear frames under harmonic/non-harmonic excitations.
3. At least one site visit and preparation of study reports of various case studies for actual field/practice oriented problems for each Elective I **and** II.
4. At least one project comprising Analysis, Design and Drawing using professional software for a structure in practice for Elective I **or** II.

501407: SEMINAR I

Teaching Scheme: Examination Scheme:
Practical: 4 Hrs/Week Term Work: 50 Marks

1. Seminar I topic should be based on latest developments in the Structural Engineering.
2. Format of the report should be as per the standards of International Journals in Engineering.
3. Student should submit the report on the Seminar I and present in the presence of panel of examiners appointed by the Principal.

501408 : THEORY OF PLATES AND SHELLS

Teaching Scheme: Examination Scheme:

Lectures: 3Hrs/Week Theory Paper:100 Marks

Duration :4Hrs.

Section I

Unit-1:

Introduction: Thin and thick plates, small and large deflections. Small deflection theory of thin plates: Assumptions, Moment Curvature relations. Stress resultants. Governing differential equation in Cartesian co-ordinates, various boundary conditions.

Unit-2:

Analysis of Rectangular Plates: Navier solution for plates with all edges simply supported. Distributed loads, point loads and rectangular patch load.

Levy's Method: Distributed load and line load. Plates under distributed edge moments.

Raleigh- Ritz approach for simple cases in rectangular plates.

Introduction to shear deformation theories.

Unit-3:

Circular Plates: Analysis of circular plates under axi-symmetric loading. Moment Curvature relations. Governing differential equation in polar co-ordinates.

Simply supported and fixed edges. Distributed load, ring load, a plate with a central hole.

Section II

Unit-4:

Introduction: Classification of shells on geometry, thin shell theory, equations to shell surfaces, stress resultants, stress- displacement relations, compatibility and equilibrium equations.

Shells of Revolution: Membrane theory, equilibrium equations, strain displacement relations, boundary conditions, cylindrical, conical and spherical shells.

Unit-5:

Circular cylindrical shells: Membrane theory: Equilibrium equations, strain displacement relations, boundary conditions.

Bending Theory: Equilibrium equation, strain displacement relations, governing differential equation, solution for a simply supported cylindrical shell, various boundary conditions. Application to pipes and pressure vessels.

Unit-6:

Beam theory of cylindrical shells: Principles of Lundgren's beam theory, beam analysis, arch analysis, application to cylindrical roof shells.

Reference Books

1. S. Timoshenko and W. Krieger, Theory of Plates and Shells, Mc Graw Hill.
2. Ansel C. Ugural, Stresses in Plates and Shells, Mc Graw Hill
3. G. S Ramaswamy, Design and Construction of Concrete Shell Roofs, CBS Publications
4. Chandrashekhara K., Analysis of Concrete Shells, New Age International Edition
5. Chandrashekhara K., Analysis of Plates, New Age International Edition

501409: FINITE ELEMENT METHOD

Teaching Scheme:

Lectures: 3Hrs/Week

Examination Scheme:

Theory Paper:100 Marks

Duration :4Hrs.

Section I

Unit 1:

Review of one dimensioned elements of skeletal structures Principle of minimum potential energy, Use of polynomial displacement function. Variational approach for

formulation of element stiffness matrix for truss & beam elements.

Unit 2:

Two dimensional elements in plane stress / strain problems. CST, LST & Rectangular

elements, Standard formulation procedure using variational principle. Use of polynomial displacement functions, Pascal triangle. Requirements for convergence

Unit 3:

Shape functions in Cartesian & natural coordinate systems, shape functions for one dimensional element such as truss & beam. Shape function for two dimensioned elements. Concept of isoparametric elements, Jacobion Matrix, Formulation procedure for 2 D quadrilateral isoparametric element in plane elasticity problem.

Section II

Unit 4:

Three dimensional elements such as Tetrahydron, Hexahydron, shape functions, stress strain relations, isoparametric elements.

Axisymmetric elements in axisymmetric problems, stress strain relations, triangular and Quadrilateral elements.

Unit 5:

Thin Plate bending elements, various Triangular and Rectangular elements, ACM (Adini, Clough, Melosh) and BFS (Bogner, Fox, Schimdt) elements, Conforming & nonconforming elements, Concept of four noded & eight nodded isoparametric elements, Mindlin's hypothesis for plate bending element.

Unit 6:

Flat & curved shell element, elements for cylindried shells, curved solid element, Ahmad's degenerated solid element, Pawsey's eight nodded shell element.

Reference Books

1. J.N. Reddy – An Introduction to the finite element method – Tata McGraw Hill Publishing Co. Ltd

2. C.S. Krishnamoorthy – Finite Element Analysis – Theory & Programming - Tata

McGraw Hill Publishing Co. Ltd

3. Zienkiewicz & Taylor - The Finite Element Method 4th Edition – Vol – I & II – McGraw Hill International Edition
4. G.R. Buchanan – Finite Element Analysis Schaum's outlines - Tata McGraw Hill Publishing Co. Ltd
5. S.S. Bhavikatti - Finite Element Analysis – New Age International Publishers, Delhi
6. S.S. Rao - The Finite Element Method in Engineering 4th Edition - ELSEVIER Publication
7. Robert D. Cook, D.S. Malkus, M.E. Plesha – Concepts & Applications of Finite Element Analysis – John Wiley & Sons.
8. Segerlind L.J. – Applied Finite Element Analysis - John Wiley & Sons.

501410: MANAGEMENT IN STRUCTURAL ENGINEERING

Teaching Scheme:

Lectures: 3Hrs/Week

Examination Scheme:

Theory Paper:100 Marks

Duration : 4Hrs.

Section I

Unit 1: Resource Management

Human, Time, Materials & Equipments, Finance & Logistic Management.

Unit 2: Structural Health, factors affecting health of structures, effect of leakage, age, creep,

corrosion, fatigue on life of structure. Structural health monitoring. Various measures, regular maintenance, structural safety in alteration.

Quality control & assurance of materials of structure, durability of concrete, Factors affecting durability of concrete, Corrosion in structures, Testing and prevention of corrosion, fire safety.

Unit 3: Structural Audit, Assessment of health of structure, study of structural drawings,

nature of distress, visual observations,

Collapse and investigation, limitations on investigator, tools for investigation, Various NDT Methods for assessing strength of distressed materials, investigation management, review of assimilated information, interviews and statements, evaluation and reporting, presentation of report, communication gap among client, architect, consulting engineer & contractor.

Section II

Unit 4: Retrofitting of Structures, parameters for assessment for restoration strategies,

selection of construction chemicals during restoration, Specification for important items of work in restoration, Structural detailing for restoration, Various techniques of retrofitting.

Unit 5: Safety during construction, formwork and staging, material handling, Existing methods of formwork, Modular formwork, Structural aspects for formwork in buildings & bridges.

Unit 6: Demolition of Structure, study of structural system and structural drawings, need and importance for demolition, outline of various demolition methods and their evaluation, partial and controlled demolition, role of safety measures, temporary support structures in demolition. Recycling of demolished materials, contracts

References

1. Handbook of material management by Deananmmer, McGrawHills
2. Fundamentals of material management by Gopalkrishnan, Tata McGraw Hills.
3. Financial Management by M Y Khan and Jain, Tata McGraw Hills
4. Properties of Concrete by A M Neville, Longman
5. Durable Structures by R.N.Raikar, R & D Centre, (SDCPL), Raikar Bhavan, Sector 17, Vashi, Navi Mumbai.
5. R.N. Raikar, 'Learning from Failures', R & D Centre, (SDCPL), Raikar Bhavan, Sector 17, Vashi, Navi Mumbai.
6. R.N. Raikar, 'Diagnosis and treatment of structures in Distress', R & D Centre, (SDCPL), Raikar Bhavan, Sector 17, Vashi, Navi Mumbai.

7. Jayakumar J. Shah, A Book – A Handy Guide to Repairs, Rehabilitation and

Waterproofing of RCC Building (Structures), Third updated photo-copy set.

8. Formwork Construction and Practice by Richardson.J.G, VP

9. Formwork For Concrete Structures by Peurifoy. R.L., Tata McGraw-Hill

Publishing Company Limited

10. Formwork To Concrete by Austin.C.K, Chapman and Hall

11. Design & Construction Of Formwork For Concrete Structures by Wynn.A.E,

Concrete Publishing Limited

12. Demolition and reuse of concrete by Y Kasai, Chapman and Hall

13. Demolition by Colin Toplins, Construction Press

14. Demolition Techniques, Construction Press

15. Demolition of Structures, Report by Mr. Girish Kulkarni, Mumbai

16. Structural Audit, Report by Mr. Umesh Dhargalkar, Mumbai

17. Jayakumar J. Shah, An Article – House Keeping of RCC Buildings,

Published in April 2001 issue of the Housing Times, Vikas Premises, Fort Mumbai 400001.

18. Jayakumar J. Shah, An Article – Repairs & Rehabilitation of RCC Buildings

(Structures) – Materials and Techniques, Published in March 2002 issue of New Building Materials and Construction World, New Delhi.

19. Jayakumar J. Shah, An Article – Repairs, Rehabilitation of Structurally

Distressed RCC Members of Buildings, Published in July 2000 issue of Construction World, ASAP Media, Mumbai.

20. J. J. Shah, Point of View – Repair, Rehabilitation and Waterproofing of

structures-Some View, Published in April 1998 issue of The Indian Concrete Journal, Mumbai.

21. Krautkramer, J and Krautkramer,H., Ultrasonic Testing of Materials,

Springer-Verlag, Berlin, 1969.

22. Mani, K and Srinivasan, P., An Article 'Corrosion Damage and its Evaluation by Testing' in Advanced Testing and Evaluation of Structures and Components, Allied Publishres, Chennai, 2002 pp 14.01 – 14.33.

23. Ouyang, C., Landis, E., and Shah, S.P., An Article, 'Damage Assessment in Concrete using Acoustic Emission,' in Nondestructive Testing of Concrete Elements and Structures, ASCE, New York, 1992, pp 13-24.

24. Popovics S, and Popovics J.S., An Article, 'A Critique of the Ultrasonic Pulse Velocity Method for Testing Concrete' in Nondestructive Testing of Concrete Elements and Structures, ASCE, New York, 1992, pp 94-103.

25. Sreenath H.G., An Article, 'Safety Auditing of Concrete Structures. In Advanced Testing and Evaluation of Structures and Components, Allied Publishres, Chennai, 2002 pp 9.01 – 9.19.

26. Thandavamoorthy T.S., et al 'Health Assessment of Concrete Structures by Ultrasonic pulse Velocity Technique an experimental Investigation', in Building Materials, RRL Bhopal, February 26-27, 2004, pp. 284-89.

27. Websites for Formwork

a) http://www.dir.gld.gov.au/workplace/law/codes/formwork design

b) www.peri-usa.com/,www.specialformwork.com/

28. Websites for Demolition of Structures

a) www.Howstuffworks.com

b) www.Findarticles.com

c) www.historylinks.org

d) www.implosionworld.com

e) www.home.earthlik.com

f) www.seattlepi.com

g) www.seattletimes.com

h) www.phillyblast.com

i) www.usgs.gov

501411: ELECTIVE III

Teaching Scheme:

Lectures : 3 Hrs/Week

Examination Scheme:

Theory Paper : 100 Marks

Duration 4 Hrs.

501411 (a) EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

Section I

Unit 1:

Engineering Seismology, Elastic rebound theory, Theory of plate tectonics and movement of Indian plate. Seismic waves. Seismic intensity, Richter scale, Tsunami. Seismic zoning maps of India and comparison study. Response spectra. Strong motion characteristics.

Unit 2:

Earthquake effects on the structures, classification of loads, Seismic methods of analysis, seismic design methods. Seismic damages during past earthquakes and effect of irregularities and building architecture on the performance of RC structures. Mathematical modelling of multi-storeyed RC buildings with modelling of floor diaphragms and soil-foundation, Winkler model.

Unit 3:

Design of multi-story RC structure with foundation as per latest IS: 1893 by Equivalent static lateral load method and Response Spectrum Method. Introduction to Time history method.

Capacity based design of soft story RC building, design of Shear Walls. Ductile detailing as per latest IS:13920.

Section II

Unit 4:

Seismic design of multi-storeyed steel structures with various bracing systems.

Lateral load analysis and design of two- storied masonry buildings. P-delta analysis.

Unit 5:

Seismic design of Elevated RC Circular Water Tanks.

Ductility requirements, types of ductility, factors affecting ductility. IS code provisions

Unit 6:

Seismic retrofitting, Sources of weakness in RC framed buildings, Classification of retrofitting techniques, Conventional and non-conventional methods, Comparative study of various methods and case studies. Introduction to Base Isolation systems. IS code provisions for retrofitting of masonry structures, failure modes of masonry structures and repairing techniques.

Note: For this subject add in Lab Practice II the following assignment.

Modelling of multi-storeyed structures including shear walls and diaphragms using standard software for all load combinations.

Reference Books

1. P. Agarwal and M. Shrikhande – Earthquake Resistant Design of Structures, Prentice-Hall Publications.
2. IS:1893 – Indian Standard Criteria for Earthquake Resistant Design of Structures, Bureau of Indian Standards, New Delhi.
3. IS:13935 – Repair and Seismic Strengthening of Buildings – Guidelines, 1993
4. IS:4326 – Earthquake Resistant Design and Construction of Buildings – Code of Practice, 1993
5. IS:13828 – Improving Earthquake Resistance of Low Strength Masonry Buildings, 1993
6. IS:13827 - Improving Earthquake Resistance of Earthen Buildings, 1993
7. IS:13920 – Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Force, 1993
8. IS: 3370- Indian Standard code of practice for concrete structures for storage of liquids, Bureau of Indian Standards, New Delhi.
9. Clough and Penzin – Dynamics of Structures, Mc-Graw Hills Publications.
10. Jai Krishna, A.R. Chandrashekharan and B Chandra – Elements of Earthquake Engineering, South Asian Publishers Pvt. Ltd.
11. Joshi P S *et al.* - Design of Reinforced Concrete Structures for Earthquake Resistance Published by Indian Society of Structural Engineers, 2001

501411 (b) STRUCTURAL STABILITY

Unit 1:

Fundamental concepts, elastic structural stability, structural instability, analytical methods for the stability analysis, equilibrium, imperfections and energy methods.

Unit 2:

Elastic buckling of columns, assumptions, critical load for various boundary conditions, columns with geometric imperfection, large deflection theory of columns, Southwell plot, Orthogonality of buckling modes, eccentrically loaded columns, numerical techniques – Finite difference and Finite element approach.

Unit 3:

Elastic buckling of beam-column, differential equations of beam-column, beam-column with concentrated point load, several point loads, continuous lateral load, single couple, uniformly distributed load, end couples.

Unit 4:

Elastic buckling of frames, triangular, partial, multistory portal and box frames with symmetric &

anti symmetric buckling, stiffness method approach, approximate method, buckling of open sections, torsional buckling.

Unit 5:

Elastic buckling of thin plates, equilibrium approach, rectangular plate with axial load in one and two directions, various boundary conditions, Energy methods – Rayleigh Ritz and Gelerkin, large deformation theory of plates and effective width concept, post buckling behavior of plates.

Unit 6:

Dynamic stability of structures, objectives, Hamilton and Lagrange's equation for discrete and continuous systems, pulsating load on a column.

Reference books

1. Timoshenko S.P., and Gere J.M., Theory of Elastic Stability, Mc Graw Hill, Singapore
2. George Gerard, Introduction to Structural Stability Theory, Mc Graw Hill, New York
3. Iyenger N.G.R., Elastic Stability of Structural elements, Mc Millan, India
4. Ashwini Kumar, Stability of Structures, Allied Publishers, New Delhi

501411 (c) STRUCTURAL RELIABILITY

Section I

Unit-1:

Concepts of structural safety: Design methods, statistics and probability: Data reductions, Histograms, Sample correlation. Random variable, Discrete and continuous variables and common probability distribution.

Unit-2:

Resistance distribution and parameters**:** Statistical analysis of materials: steel, concrete bricks and mortar, Dimensional variations, characterization of variables and allowable stresses based on specified reliability.

Probabilistic Analysis for live load, gravity load and wind load.

Unit-3:

Computation of basic structural reliability, Reliability analysis of simple element such as beam and column.Reliability methods, basic variables, first order second moment methods (FOSM) and concept of reliability index. Reliability of structural systems: Redundant and non-redundant systems, series, parallel and mixed systems.

Section II

Unit-4:

Monte Carlo Methods of Analysis: Study of structural safety-generation of random numbers-continuous, discrete and jointly distributed variables-Application to reliability analysis of concrete structures.

Unit-5:

Reliability based design: Load and resistance factors of design, safety checking formats and code calibrations, I.S. code provision, Introduction to stochastic process.

Unit-6:

Decision Analysis: Introduction, simple risk decision problems, decision problems, decision model, decision tree, decision criteria, decision based on existing information, Prior analysis

Reference Books

4. R. Ranganathan, Reliability Analysis and Design of Structures, Mc Graw Hill.
5. Edward Haugen, Probabilistic Approaches to Design, John Wiley and Sons, London.
6. R. E. Melchers, Structural Reliability-Analysis and Prediction, Ellis Horwood Ltd. Chichester, UK.

501411 (d) NONLINEAR ANALYSIS OF STRUCTURES

Section I

Unit 1:

Types of Nonlinearities - Geometric Nonlinearity, Material Nonlinearity, Nonlinear Governing Equation for Beams: Moment-curvature Nonlinearity, Geometric Nonlinearity Due to Strectching, Material Nonlinearity,

Geometrically Nonlinear Beam Problems - Moment-Curvature Nonlinearity-Cantilever Beam, Centrally Loaded beam with two supports, Cantilever Beam subjected to Tip Load

Unit 2:

Nonlinear Static Analysis of Plates - Geometric and Material Nonlinearities, Governing Nonlinear Equations of Plates: Stress Function Approach, Displacement Equations Approach.

Unit 3: Nonlinear Static Analysis of Plates - Boundary Conditions and method of solution, Large Deflection of Rectangular Plates.

Section II

Unit 4:

Nonlinear Analysis of Columns- Post buckling of cantilever column, Large deflection of column with both ends hinged

Unit 5:

Nonlinear Analysis of Trusses and Nonlinear Elastic Analysis of Frames - Derivation of non linear stiffness matrix, Matrix displacement method for nonlinear analysis of structures, Nonlinear analysis of plane frames.

Unit 6:

Elastic-Plastic Analysis - The displacement Transformation matrix for a member with a hinge, The overall stiffness matrix. Elastic-Plastic analysis of a Propped cantilever, Elastic Plastic analysis of frames

Reference Books

1. M.Sathyamoorthy, 'Nonlinear Analysis of Structures', CRC Press, New York
2. K.I. Majid, 'Non Linear Structures', Butter worth Publishers, London.
3. N G R Iyengar, 'Elastic Stability of Structural elements', Macmillan India Ltd

501412 : ELECTIVE IV (Open)

Teaching Scheme:

Lectures : 3 Hrs/Week

Examination Scheme:

Theory Paper : 100 Marks

Duration 4 Hrs.

501412 (a) MECHANICS OF MODERN MATERIALS

Section I

Unit 1:

Introduction to Modern Materials: Fiber-Reinforced Polymer Composite (FRPC) Materials**:** Definition, Historical development, applications. Fibers and Matrix, types and their properties. Manufacturing process and methods for composites. Types and classification of composite materials, properties, advantages over conventional materials. Piezoelectric Materials: History, crystal structure, applications. Shape Memory Alloys (SMA), Functionally Graded Materials (FGM): definition and applications.

Unit 2:

Engineering Properties of Modern Materials: FRPC Composite Lamina: Micromechanics approach, methods. Longitudinal and transverse elastic properties of composite lamina, in-plane shear modulus for continuous fibers. Stress-strain relationship, compliance and stiffness matrices for generally anisotropic, specially orthotropic material, transversely isotropic material, orthotropic, isotropic materials, Plane stress condition for thin lamina, transformation of stress and elastic properties. Three dimensional transformations.

Piezoelectric Materials: Piezoelectric coefficients, electric displacements, piezoelectric strain matrix for Quartz, Lead Zirconate-titanate, Polyvinylidene fluoride. Stiffness matrix for Functionally Graded Materials.

Unit 3:

Strength of Composite Lamina: Introduction. Failure theories, Maximum stress theory, Maximum strain theory, Energy based interaction theory (Tsai-Hill), Interactive tensor polynomial theory (Tsai-Wu), Failure mode based theory (Hasin-Rotem). Computation of lamina strength by Tsai-Wu theory for plane stress condition. Comparison of various failure theories.

Section II

Unit 4:

Elastic behaviour of Composite Laminates: Basic assumptions, Laminate configurations, Strain-displacement relationship, Stress-strain relationship, Force and moment resultants, Laminate compliances and stiffness matrices, Transformation of matrices. Load deformation relationship for symmetric laminates, symmetric cross-ply, symmetric angle-ply, balanced, antisymmetric cross-ply and angle ply, orthotropic, quasi-isotropic laminates.

Unit 5:

Hygrothermal Expansion and Design of Composite Structure: Coefficients of thermal and moisture expansion of various unidirectional lamina, load deformation relationship, residual stresses for cross ply symmetric laminates.Design methodology, design of pressure vessel for various laminate configurations.

Unit 6:

Experimental Methods of Testing of Composite Materials: Characterisation of constituent materials, fiber, matrix, thermal fiber, interface/interphase characterisation, Fiber volume ratio, void volume ratio. Determination of hygrothermal expansion coefficients, tensile, compressive and shear properties of unidirectional laminates. Testing of interlaminar fracture toughness, Bi-axial testing. Introduction to stress concentration in laminates.

Reference Books

1. Isaac M. Daniel and Ori Ishai - Engineering Mechanics of Composite Materials, Oxford University Press, Second Edition, New Delhi.
2. Michael W. Hyer - Stress Analysis of Fiber-Reinforced Composite Materials, WCB/McGraw-Hill, Singapore.
3. Jones R. M. – Mechanics of Composite Materials, McGraw-Hill, New York

4. Roman Solecki and R Jay Conant – Advanced Mechanics of Materials, Oxford University Press, New York, Special Edition for sale in India.

501412 (b) THEORY OF PLASTICITY

Section I

Unit 1:

Basic equations of theory of elasticity: Index notation, equations of equilibrium, constitutive relations for isotropic bodies, strain-displacement relations, compatibility, displacement and traction boundary conditions, admissibility of displacement and stress fields, plane stress and plane strain problems.

Unit 2:

Plastic behaviour in simple tension, generalisation of results in simple tension, yield surfaces, uniqueness and stability postulates, convexity of yield surface and normality rule, limit surfaces.

Unit 3:

Initial Yield Surfaces for Polycrystalline Metals: Summary of general form of plastic constitutive equations, hydrostatic stress states and plastic volume change in metals, shear stress on a plane, the von Mises initial yield condition, the Tresca initial yield condition, consequences of isotropy.

Section II

Unit 4:

Plastic Behaviour under Plane Stress Conditions: Initial and subsequent yield surfaces in

tension-torsion, the isotropic hardening model, the kinematic hardening model, yield surfaces made of two or more yield functions, piecewise linear yield surfaces, elastic perfectly plastic materials.

Unit 5:

Plastic Behaviour of Bar Structures - Behaviour of a three bar truss, behaviour of a beam in pure bending, simply supported beam subjected to a central point load, fixed beams of an elastic perfectly plastic material, combined bending and axial force.

Theorems of Limit Analysis - Alternative statement of the limit theorems, the specific dissipation function, cold bending of bar beyond elastic limit, spring back, plastic bending with strain hardening material, plastic bending of wide plate.

Unit 6:

Limit Analysis in Plane Stress and Plane Strain: Discontinuities in stress and velocity fields, the Tresca yield condition in plane stress and plane strain, symmetrical internal and external notches in a rectangular bar, the punch problem in plane strain, remarks on friction.

Limit Analysis as a Programming Problem: Restatement of limit theorems, application to trusses and beams, use of finite elements in programming problem, incremental methods of determining limit load.

Reference Books

1. Martin, J.B., Plasticity, Fundamentals and General Results, MIT Press, London.

2. Kachanov, L.M., Fundamentals of the Theory of Plasticity, Mir Publishers, Moscow.

3. Chakrabarty, J, Theory of Plasticity, McGraw Hill, New York.

4. Hill, R., Mathematical Theory of Plasticity, Oxford University Press.

5. Chen, W.F., and Han, D.J., Plasticity for Structural Engineers, Springer Verlag.

6. Timoshenko, Theory of Plasticity, McGraw Hill

501412 (c) BIO MECHANICS AND BIO MATERIALS

Unit 1:

Structure of biomaterials, classification of bio materials, mechanical properties, iscoelasticity, elasticity of non-Hookean materials. Hard tissue replacements, internal fracture fixation devices, joint replacements, dental implants.

Unit 2:

Metallic Biomaterials and ceramic biomaterials steps involved in the fabrication of metalic implants, stainless steel Co-Cr-alloys Ti & its alloys, medical applications, corrosion of metallic implants.

Non-absorbable or relatively Bioinert bioceramics Bio-degradable or resorbable ceramics. Bio active or surface reactive ceramics, deterioration of ceramics.

Unit 3:

Polymeric Biomaterials and composite biomaterials, 80

Polymerization, polyolefins, Polyamides, acrylic polymers, rubbers, high strength thermoplastics, medical applications, deterioration of polymers. Structure, bounds on properties, anisotropy of composites, particulate composite fibrous composites, porous materials.

Section-II

Unit 4:

Mechanical properties of cartilage. Diffusias properties of articular cartilage mechanical properties of bone.

Unit 5:

Kinetics and kinematics of joints elobow, Hip, Knee joint; Evaluation of joint forces and moments. Equilibrium of joint fundamental concepts of Gait analysis

Unit 6:

Design of artificial fixation devices. Orthopedic fixation devices. Fundamentals of design of joint prosthesis.

Mechanical testing of joint prosthesis Principles involved in study of rehabilitation engineering.

Reference books

1. Y. C. Fung, Bio-mechanics,Mechanical Properties of Living Tissues Edition 2, 1993.
2. Dowson D.V., Wright, Introduction to Biomechanics of joints and joint replacement, Mechanical Engineering Publication 1987.
3. Van. C.Mow, Antony Ralcliffe, Savio, Bio-mechanics of diarthrodial joints, Springer Verlag 1990.
4. Frederick H.Silver, Bio-materials Medical Devices and Tissue Engineering, Chapman & Hall
5. Park Joon Bu, Bio-Materials Science & Engineering, Plenum Press 1990.
6. Buddy D. Ratner & Allen S.Hoffman, Bio-Materials Science an Introduction to Materials in Medicine, Academic Press 1996.
7. Hand book of Biomedical Engineering, Kline Jacob Academic Press 1988.

501412 (d) OPTIMIZATION TECHNIQUES

Teaching Scheme	Examination Scheme
Lectures : 3 Hrs / Week	Theory Paper : 100 Marks
	Duration : 4 Hours

Section I

Unit 1 :Introduction:

Engineering application of optimization, statement of an optimization problem with example for minimum weight and optimum cost consideration, classification of optimization problems and techniques, Single variable optimisation , multivariable optimization with equality and inequality constraints and without constraints.

Unit 2 : Linear Programming

Introduction,standard form of the problem, Geometry,basic terminology

Techniques of linear programming: Simplex method, Revised simplex method:Duality in linear programming,decomposition principle, post-optimality analysis, applications to engineering design

Unit 3: Non Linear Programming

Introduction,elimination methods:various search methods-Fibonacci method and golden section method

Interpolation method-Quadratic and cubic interpolation methods, Direct root method.

Section II

Unit 4: Unconstrained optimization Techniques:

Introduction; Standard form of the problem and basic terminology; Direct search method- Simplex method, Random search method, Univariate and pattern search method

Indirect search method-Steepest Descent (Cauchy) method, Conjugate gradient method, Newton's method, Application to engineering problems

Unit 5: Constrained Optimization

Introduction; Standard form of the problem and basic terminology; Direct method: Sequential Linear Programming; Generalised Reduced gradient method, Methods of feasible direction

Indirect method: Penalty function method Interior and exterior penalty function method, Convex programming problem, Check for convergence

Application to engineering problems

Unit 6 : Introduction to non-traditional methods:

Genetic Algorithm: Introduction, Representation of design variables, objective function and constraints, Genetic operators and numerical results.

Introduction to Neural network based optimisation

References

1. S.S.Rao, 'Engineering Optimisation- Theory and Practice', New Age International.
2. Deb K., 'Optimisation for Engineering Design-Algorithms and Example', Prentice Hall
3. Gallagher and O.C Zeinkiewicz, 'Optimum Structural Design – Theory & Applications', John Wiley and Sons, London
4. Jozsef Farkas, 'Optimum Design of Metal structures',Ellis Horwood Limited,Chichester
5. U.Kirsch, 'Optimum structural design',McGraw –Hill, New York

501413: LAB PRACTICE II

Teaching Scheme: Examination Scheme:

Lectures : 6 Hrs/Week Term work: 50 marks

This will be based on syllabi of theory subjects of Semester II.

It shall consist of one assignment on each unit of each subject of Semester II.

Besides this, following are subject wise additional requirements for term work.

A) Finite Element Method – Software applications of following cases

i. Plane stress / plane strain problem
ii. Axisymmetric problem
iii. Three dimensional problem
iv. Plate and shell structures

501414: SEMINAR II

Teaching Scheme: Examination Scheme:

Practical: 4 Hrs/Week Term Work: 50 Marks

1. Seminar II consists of case study and report of any one topic from the subject 'Management in Structural Engineering'.
2. Format of the report should be as per the standards of International Journals in Engineering.
3. Student should submit the report on the Seminar II and present in the presence of panel of internal examiners appointed by the Principal.

501415: SEMINAR III

Teaching Scheme: Examination Scheme:

Practical: 4 Hrs/Week Term Work: 50 Marks

1. Seminar III consist of literature review and report based on the topic of project.
2. Format of the report should be as per the standards of International Journals in Engineering.
3. Student should submit the report on the Seminar III and present in the presence of panel of examiners appointed by the University of Pune.

501416: PROJECT STAGE I

Teaching Scheme:

Practical: 18 Hrs/Week

The project work commences from Semester III, and it should preferably be a live problem in the construction industry or scientific research for determining solution by making individuals' contribution.

Project Stage I consists of report containing literature review, identification of problem, methodology and synopsis of the project.

501417: PROJECT STAGE II

Teaching Scheme: Examination Scheme:

Practical: 18 Hrs/Week Term work: 150 Marks

Oral: 100 Marks

Student should submit the final report in a standard format based on project and present in the presence of panel of examiners appointed by the University of Pune.