STRUCTURAL ENGINEERING

CEMAC501 ADVANCED ENGINEERING MATHEMATICS

(Common to all Specializations)

L + T / week : 3+1 Hrs — Sessional Marks : 20+20
University Exam: 3 Hrs — End Exam Marks : 60

UNIT – I

PARTIAL DIFFERENTIAL EQUATIONS

Formation by elimination of arbitrary constants and arbitrary functions – Solutions of equations by the methods of separation of variables in case of simple boundary conditions pertaining to (i) one dimensional wave equation and (ii) two dimensional wave equation satisfied by vibrating membrane (No numerical problems).

UNIT – II

SPECIAL FUNCTIONS

Gamma and Beta functions Bessel – function – Legendre polynomials – Recurrence relations for $J_m(x)$ and $P_n(x)$. Orthogonality of Legendre Polynomials – Rodrigues formula.

UNIT – III

STATISTICS

Emperical distributions – Log-normal-Binomial, poisson, gamma, extreme value and uniform distributions – Estimation of parameters by method of moments and maximum likely hood methods – Multiple correlation and regression.

UNIT – IV

COMPLEX VARIABLES & LAPLACE TRANSFORMS

Complex variables – Cauchy – Reimann equations – Laplace equation – Conformal transformations including Joukowski's and Schwaz and Christoffel transformations.

Laplace transformation of Impulse function (Dirac-Delta function) and its applications to differential equation.

UNIT – V

NUMERICAL METHODS

Numerical solutions of partial differential equations – Laplace and Poisson equations by iteration method, heat equation by Schmidt method.

Reference Books :

1. Dr. B.S. Grewal, Higher Engineering Mathematics.
2. S.C. Guptha, V.K. Kapur Foundations of Mathematics Statistics.

--oOo--

CESEC 502 THEORY OF ELASTICITY

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

Definition and notation of stress. Components of stress and strain. Generalised Hooke's Law. Stress and strain in three dimensions. Stress components on oblique plane. Transformation of stress components under change of co-ordinate system.

Principal stresses and principal planes. Stress invariants. Mean and deviator stress. Strain energy per unit volume. Distortion strain energy per unit volume. Octahedral shear stress. Strain of a line element. Principal strains, Volumetric strain.

Equation of equilibrium and compatibility in cartesian co-ordinates in three dimensions.

UNIT – II
TWO DIMENSIONAL PROBLEMS IN ELASTICITY :

Plane stress and plane strain situations. Equlibrium equations. Compatibility equation. Saint Venant's principle. Uniqueness of solution. Stress components in terms of Airy's stress functions. Application to cantilever, simply supported and fixed beams with simple loading.

UNIT – III
SOLUTION OF PROBLEMS IN POLAR CO-ORDINATES :

Equilibrium equations. Stress strain components. Compatibility equation. Applications using Airy's stress function in Polar co-ordinates for stress distributions symmetric about an axis. Effect of hole on stress distribution in a plate in tension, stresses due to load at a point on a semi-infinite straight boundary, stresses in a circular disc under diametral loading.

UNIT – IV
TORSION :

Stress function method of solution. Torsion of Circular and elliptical bars. Thin walled tubes-applications. Prandtl's membrane analogy solution of torsion of rectangular bars by (1) Rayleigh Ritz method (2) Finite difference method.

UNIT – V
BEAMS ON ELASTIC FOUNDATION :

Beams of infinite and finite lengths with single point load, two point loads and u.d.l.

REFERENCES :

1. Theory of Elasticity by Timoshanko and Goodier.
2. Applied Elasticity by Wang.
3. Applied Stress Analysis by sadhu singh.
4. Beams on Elastic Foundation by Hetenyi.

--oOo--

CESEC 503 MATRIX METHODS OF STRUCTURAL ANALYSIS

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

CHARACTERISTICS OF STRUCTURES :
Methods of structural analysis - Static and kinematic indeterminacy of the structures - Principles of Superposition -Flexibility and stiffness matrices - Stiffness and flexibility of systems and elements- Computing displacements and forces from virtual work. Computing stiffness and flexibility coefficients.

ENERGY CONCEPTS IN STRUCTURES :
Strain energy in terms of stiffness and flexibility matrices - Properties of stiffness and flexibility matrices - Interpretation of coefficients - Betti's law - Other energy theorems using matrix notation.

UNIT – II

TRANSFORMATION OF INFORMATION IN STRUCTURES :
Transformation of system forces to element - Element flexibility to system flexibility - system displacements to element displacements - Element stiffness to system stiffness - Transformation of forces and displacements in general - Stiffness and flexibility in general - Normal coordinates and orthogonal transformation.

UNIT – III

THE FLEXIBILITY METHOD :
Statically determinate structures - Indeterminate structures - Choice of redundants - Transformation to one set of redundants to another - Internal forces due to thermal, expansion and lack of fit. Reducing the size of flexibility matrix - Application to pin-jointed plane truss - Continuous beams - frames.
Problems solving by Computer (Not for Examination)

UNIT – IV

THE STIFFNESS METHOD :
Introduction - Development of the stiffness method - Stiffness matrix for structures with zero force at same coordinates - Analoging between flexibility and stiffness - Lack of fit - Application of stiffness approach to pin-jointed plane and space trusses

UNIT – V

THE STIFFNESS METHOD
Continuous beams - Frames - Static condensation technique - Choice of method - Direct Stiffness Approach.
Problem solving by Computer (Not for examination)

REFERENCES :

1. Rubinstein, M.F. "Matrix Computer Analysis of Structures", Prentice Hall International INC, Canada.
2. Gere, J.M. and Weaver,W.W. "Analysis of Framed Structures".
3. Livesely, R.K. "Matrix Methods in Structural Analysis".
4. Mallick, S.K. and Rangasamy, K.S. "Introduction to Matrix Analysis of Structures".
5. Elements of Matrix and Stability Analysis of Structures
   by V.K.Manicka Selvam, Khanna Publishers, Delhi.

--oOo--

CESEC 504 ADVANCED PRE-STRESSED CONCRETE

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

Losses of prestress – Estimation of the loss of prestress due to various causes like Elastic shortening of concrete – Creep of concrete – Shrinkage of concrete – Relaxation of steel – Slip in anchorage – Friction in tendon and duct etc.

UNIT – II

Design of prestressed concrete beams in flexure – Design for shear and torsion – Pre tensioned and post tensioned – Types of rectangular and flanged sections.

UNIT – III

Advantages and Disadvantages of Continuity – Primary and Secondary moments – Elastic analysis of continuous beams – Linear transformation – Concordant cable profile – Design of Continuous beams.

UNIT – IV

Design and provision of prestressed concrete slabs – Circular slabs – One way slabs – Two way slabs – Flat slabs.

UNIT – V

Types of composite construction – Stress distribution in composite construction – Differential shrinkage – Analysis of stresses – Design of simple composite sections – Circular prestressing – Design of prestressed concrete pipes.

Text

T.Y. Lin Ned. H. Burns, Design of pre-stressed concrete structures, John Wiley & Sons.

References

1. James R. Libby, Modern Pre-stressed Concrete, Design Principles and Construction methods, Van Standard Rainford Co., New York.
2. Krishna Raju, N. Prestressed Concrete, Tata McGraw Hill.
3. Arthur H Nilson, Design of Pre-stressed Concrete, John Wiley & Sons.

--oOo--

CESEP 507 ADVANCED STRUCTURAL ENGINEERING (PRACTICAL)

Practicals / week : 3 Hrs — Sessional Marks : 40
University Exam : 3 Hrs — End Exam Marks : 60

CONCRETE : Properties and testing of fresh and hardened concrete, concrete mix design, destructive testing of concrete - Pullout test, Non-destructive testing of concrete. Reinforced concrete : under reinforced and over-reinforced beams, columns under eccentric loading.

STEEL : Testing of steel beams and columns under static loading including measurement of strains.

--oOo--

CESEC 601 FINITE ELEMENT STRUCTURAL ANALYSIS

Lectures Time	: 3+1 Hours	Sessional marks	: 40
University Exam	: 3 Hrs	University Exam Marks	:60

COURSE OBJECTIVES:

- To Provide an overview and basic fundamentals of Finite Element Analysis.
- To introduce basic aspects of finite element theory, including domain discretization, interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
- To explain the underlying concepts behind variational methods and weighted residual methods in FEM.
- Formulate simple structural Problems in to finite elements.
- Derivation of element stiffness matrix for 1-D,2-D and 3-D Problems.

UNIT-I

Introduction: Review of stiffness method – Principal of Stationary potential energy-Potential energy of an elastic body-Rayleigh-Ritz method of functional approximation-variational approaches-weighted residual methods.

UNIT-II

Finite Element formulation of truss element: Stiffness matrix-properties of stiffness matrix-Selection of approximate displacement functions-solution of a plane truss-transformation matrix and stiffness matrix for a 3-D truss-element.

UNIT-III

Finite element formulation of Beam elements: Beam stiffness-assemblage of beam stiffness matrix-Examples of beam analysis for concentrated and distributed loading-Galerkin's method-2-D Arbitrarily oriented beam element-inclined and skewed supports-rigid plane frame examples.

UNIT-IV

Finite element formulation for plane stress, plane strain and axisymmetric problems- Derivation of CST and LST stiffness matrix and equations-treatment of body and surface forces-Finite Element solution for plane stress and axisymmetric problems-comparision of CST and LST elements-convergence of solution-interpretation of stresses.

UNIT-V

Iso-parametric Formulation: An isoparametric bar element-plane bilinear isoparametric element-quadratic plane element-shape function, evaluation of stiffness matrix, consistent nodal load vector-Gauss quadrature-appropriate order of quadrature-element and mesh instabilities-spurious zero energy modes, stress computation-patch test.

REFERENCES:

1. Concepts and applications of Finite Element Analysis-Rebert D. Cook, Michael E Plesha, John Wiley & sons Publications.
2. A first course in the Finite Element Method-Dary L. Logan, Thomson Publications.
3. Introduction to Finite Elements in Engineering-Tirupati R. Chandrupatla, Ashok D. Belgunda, PHI publications.
4. Finite Element methods for Engineers - U.S. Dixit cengage hearing India Private Limited – Delhi
5. Finite Element analysis – P.Seshu –Practice Hals of India private Limited, New Delhi
6. Finite element analysis-S.S.Bhavikatti-New age International publishers
7. Rudiments of finite element method- V.K.Manicka selvam-Dhanpat Rai Publications (P) Ltd

COURSE OUT COMES

- Analyse and build FEA models for various Engineering Problems.
- Able to indentify Information requirements and sources for analysis design and evaluation
- Use professional-level finite element software to solve engineering problems.
- Interpret results obtained from FEA software solution, not only in terms of conclusions but also awareness of limitations

CESEC 602 THEORY OF PLATES

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

PLATES:

CYLINDRICAL BENDING OF PLATES : Differential equation of cylindrical bending of plates Uniformly loaded rectangular plates with simply supported and built-in edges.

PURE BENDING: Slope and curvature; moment - curvature relations; strain energy.

UNIT – II

LATERALLY LOADED RECTANGULAR PLATES : The differential equation of the deflected surface, boundary conditions, solution of simply supported rectangular plates under various loading conditions viz. sinusoidal load, uniformly distributed load, hydrostatic pressure; Navier and Levy type solutions with various boundary conditions.

UNIT – III

CIRCULAR PLATES: Symmetrical bending of circular plates - Differential equation; uniformly loaded and concentrically loaded plates; plates loaded at the centre.

BENDING OF PLATES UNDER COMBINED ACTION OF LATERAL AND INPLANE LOADS : Differential Equation - Simply supported rectangular plates.

UNIT – IV

SPECIAL AND APPROXIMATE METHOD: Energy Methods – Finite Difference and Finite Element Methods.

UNIT – V

ANISOTROPIC PLATES: Orthotropic Plates and grids – Large deflection theory.

References :

1. Theory of Plates and Shells by Timoshenko, S. & Krieger.
2. Theory and Analysis of Plates by Szilard, E.
3. Advanced RC Design by Krishna Raju, N.

--oOo--

CESEC 603 : STRUCTURAL DYNAMICS

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I
RESPONSE OF SDOF SYSTEM – FREE VIBRATION
Definition of DOF – Idealization of structure as SDOF system – Formulation of equations of motion for various SDOF systems – Free vibration of undamped systems – Damping in structures - Free vibration of viscous damped systems - Experimental determination of damping.

UNIT –II
RESPONSE OF SDOF SYSTEM - FORCED VIBRATION
Formulation of equation of motion - Steady state and Transient response to Harmonic forces - Duhamel's integral.

UNIT – III
ANALYSIS OF MULTI-DEGREE OF FREEDOM SYSTEMS
Formal Derivations – Formulation of equations of motion – Evaluation of natural frequencies and mode shapes – Free vibration of undamped systems – Forced vibration of damped systems.

UNIT – IV
APPROXIMATE METHODS OF COMPUTING NATURAL FREQUENCIES
Rayleigh's method – Dunkerley's method – Methods of iteration – Stodola – Holzer method – Rayleigh – Ritz method.

UNIT – V
OVERVIEW OF DYNAMICS OF CONTINUOUS SYSTEM
Vibration of flexural beams – Equation of motion – Free vibration of beams – Forced vibration.

BASE EXCITED SYSTEMS
Formulation of equations of motion for SDOF system – Concept of Spectral Quantities – Response spectrum.

Texts

1. Anil, K. Chopra, Structural Dynamics and Earthquake Engineering, Prentice Hall.
2. Mario Paz, Structural Dynamics Theory and Computation, CBS Publishers.

References :

1. R.W. Clough and J. Penzien, Dynamics of Structures, McGraw Hill.
2. Thompson, Theory of Vibration with Applications, Prentice Hall.
3. Roy, R. Craig - Structural Dynamics : Introduction to Computational Methods, John Wiley & Sons.
4. J.L. Humar, Dynamics of Structures, Prentice Hall.
5. Hurty and Rubinstein, Dynamics of Structures.

--oOo--

CESEC 604 ADVANCED STRUCTURAL CONCRETE DESIGN

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

ESTIMATION OF CRACK WIDTH AND REDISTRIBUTION OF MOMENTS IN REINFORCED CONCRETE BEAMS :
Factors affecting crack width in beams - Calculation of crack width - Empirical Method - Estimation of crack width in beams by IS 456 - Shrinkage and thermal cracking - Redistribution of moments in a fixed beam and a two-span continuous beam - Advantage and disadvantages of moment redistribution.

UNIT – II

DESIGN OF RIBBED (VOIDED) SLABS & GRID FLOORS :
Analysis of the ribbed slabs for moment and shears - Design for shear - Deflections - Arrangement of reinforcements.

Analysis of grid floors by Timoshenko's plate theory, stiffness matrix method - Equating joint deflections - Detailing of steel.

UNIT – III

DESIGN OF DEEP BEAMS :
Steps of designing deep beams by IS 456 - Detailing of deep beams.

DESIGN OF PLAIN CONCRETE WALLS :
Braced and unbraced walls - Eccentricities of vertical loads - Empirical design method (walls carrying axial load) - Design of wall for In-plane horizontal forces.

UNIT – IV

DESIGN OF EARTHQUAKE RESISTANT ELEMENTS
Earthquake magnitude and intensity - Determination of lateral forces - Torsion in buildings - Ductile detailing of beams - Columns and frame members with axial force and moment.

DESIGN OF SHEAR WALLS :
Classification of shear walls - Loads in shear walls - Design of rectangular and flanged shear walls - Moment of resistance of rectangular shear walls.

UNIT – V

SEISMIC EVALUATION AND RETROFITTING OF RC AND MASONRY BUILDINGS

Condition assessment – Field assessment – ND evaluation.

Sources of weekness in RC frames – Retrofitting strategies for RC Buildings – Structural level (Global) and Member level (Local) Retrofit methods.

Failure modes of masonry buildings – Methods for Retrofit of Masonry buildings – Repairs – Local Retrofitting and Global Retrofitting.

REFERENCES :

1) P.C.Varghese, "Advanced Reinforced Concrete Design", Prentice-Hall of India, Private Ltd., New Delhi.
2) P.C.Varghese, "Limit State Design of Reinforce Concrete", Prentice-Hall of India, Private Ltd., New Delhi.
3) Krishna Raju, "Advanced Reinforced Concrete Design - SI Units" CBS, New Delhi, 1986.
4) Blume, J.A., Newmark, N.M. and Corning, L.M. "Design of Multi-Storey Reinforced Concrete Buildings for Earth Quake Motion", Portland Cement Association, Chicogo, 1961.
5) Pankaj Agarwal, "Earthquake Resistant Structures", Prentice-Hall of India, Private Ltd., New Delhi.

--oOo--

CESEP 607 COMPUTING TECHNIQUES (PRACTICAL)

Practicals / week : 3 Hrs
University Exam : 3 Hrs

Sessional Marks : 40
End Exam Marks : 60

Use of spread sheets, Software like MATLAB, Statistical Software, AUTOCAD and FEM Software, etc.

--oOo--

ELECTIVES

01 ADVANCED REINFORCED CONCRETE DESIGN

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

ESTIMATION OF CRACK WIDTH AND REDISTRIBUTION OF MOMENTS IN REINFORCED CONCRETE BEAMS :
Factors affecting crack width in beams - Calculation of crack width - Empirical Method - Estimation of crack width in beams by IS 456 - Shrinkage and thermal cracking - Redistribution of moments in a fixed beam and a two-span continuous beam - Advantage and disadvantages of moment redistribution - Moment - Curvature relation of reinforced concrete sections.

UNIT – II

DESIGN OF DEEP BEAMS & RIBBED (VOIDED) SLABS :
Steps of designing deep beams by IS 456 - Detailing of deep beams - Analysis of the ribbed slabs for moment and shears - Design for shear - Deflections - Arrangement of reinforcements.

UNIT – III

APPROXIMATE ANALYSIS & DESIGN OF GRID FLOORS :
Analysis of flat grid floors by Timoshenko's plate theory, stiffness matrix method - Equating joint deflections - Detailing of steel.

DESIGN OF PLAIN CONCRETE WALLS :
Braced and unbraced walls - Eccentricities of vertical loads - Empirical design method (walls carrying axial load) - Design of wall for In-plane horizontal forces.

UNIT – IV

DESIGN OF SHEAR WALLS :
Classification of shear walls - Loads in shear walls - Design of rectangular and flanged shear walls - Moment of reistance of rectangular shear walls.

UNIT – V

EARTH QUAKE FORCES AND STRUCTURAL RESPONSE:
Earthquake magnitude and intensity - Determination of design forces - Torsion in buildings - Ductile detailing of beams - Columns and frame members with axial force and moment-Shear walls.

DESIGN OF REINFORCED CONCRTE MEMBERS FOR FIRE RESISTANCE :
IS0 834 standard heating conditions - Effect of high temperature on steel, concrete and different types of structural members - Analytical determination of ultimate bending moment capacity of beams under fire.

REFERENCES :

1) P.C.Varghese, "Advanced Reinforced Concrete Design", Prentice-Hall of India, Private Ltd., New Delhi.
2) P.C.Varghese, "Limit State Design of Reinforce Concrete", Prentice-Hall of India, Private Ltd., New Delhi.
3) Krishna Raju, "Advanced Reinforced Concrete Design - SI Units" CBS, New Delhi, 1986.
4) Blume, J.A., Newmark, N.M. and Corning, L.M. "Design of Multi-Storey Reinforced Concrete Buildings for Earth Quake Motion", Portland Cement Association, Chicogo, 1961.

--oOo--

02 ADVANCED CONCRETE TECHNOLOGY

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

Cements and Admixtures : Portland cement – Chemical composition – Hydration, setting and fineness of cement – Structures of hydrated cement – Mechanical of cement gel Necgabucak strength if cent gek – Water held in hydrate cement paste – Heat of hydration of cement – Influence of compound composition on properties of cement – Tests on physical properties of cement – I.S. specifications – Different types of cements – Admixtures.

Aggregates : Classification of aggregate – Particle shape and texture – Bond, strength and other mechanical properties of aggregate specific gravity, Bulk density, porosity, absorption and moisture in aggregate – Soundness of aggregate – Alkali – Aggregate reaction I Thermal properties – Sieve analysis – Fineness modulus – Grading curves – Grading requirements – Practical grading – Road note No. grading of line and coarse aggregates gap graded aggregate – Maximum aggregate size.

UNIT – II

Fresh Concrete : Workability – Factors affecting workability – Measurement of workability by different tests – Effect of time and temperature on workability – Segregation and bleeding – Mixing and vibration of concrete – Quality of mixing water.

Hardened Concrete : Water/cement ratio – Abram's law – Gel space ratio – Effective water in mix – Nature of strength of concrete – Strength in tension and compression – Griffith's hypothesis – Factors affecting strength – Autogeneous healing – Relation between compression and tensile strength – Curing and maturity of concrete influence of temperature on strength – Steam curing – Testing of Hardened concrete – Compression tests – Tension tests – Factors affecting strength – Flexure tests – Splitting tests – Non destructive testing methods.

UNIT – III

Elasticity, Shrinkage and Creep : Modulus of elasticity – Dynamic modulus of elasticity – Poission's ratio – Early volume changes – Swelling – Drying shrinkage – Mechanism of shrinkage – Factors affecting shrinkage – Differential shrinkage – Moisture movement carbonation shrinkage – Creep of concrete – Factors influencing creep – Relation between creep and time – Nature of creep – Effect of creep.

UNIT – IV

Mix Design : Proportioning of concrete mixes by various methods – Fineness modulus, trial and error, mix density, Road Note No.4, ACI and ISI code methods – Factors in the choice of mix proportions – Durability of concrete – Quality control of concrete – Statistical methods – High strength concrete mix design.

UNIT – V

Special Concrete's : Light weight ciberates – Light weight aggregate light weight aggregate concrete – Mix design – Cellular concrete No. – Fines concrete – High density concrete – Fiber reinforced concrete – Different types of fibers – Factors affecting properties of FRC – Applications polymer concrete – Types of polymer concrete properties of polymer concrete applications.

References :

1. Neville A.M., Properties of Concrete, English Language Book Society / Longman Publication, 1996.
2. Mehta P.K., and Paulo J.M.M., Concrete - Microstructure - Properties and Material, McGraw Hill Publishers, 1997.
3. Krishnaraju N., Design of Concrete Mix, CBS Publishers, 1985.
4. Orchard D.F., Concrete Technology, Vol. I & II.
5. Neville AM, Concrete Technology.
6. Taylor W.H., Concrete Technology & Practice.
7. Shetty, Concrete Technology.

--oOo--

03 ADVANCED STRUCTURAL STEEL DESIGN

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

DESIGN OF BEAMS IN BENDING AND TORSION : Torsion of thin walled members of open cross section prevented from warping - Beams subjected to unsymmetrical bending - combined bending and torsion of thin walled members of open section - Design problems.

UNIT – II

LIGHT GAUGE STEEL STRUCTURES : Light Gauge Steel - Types of Sections - Specifications permissible stresses.

Compression members - Local buckling of elements - Stiffened compression elements - Computation of permissible stresses - Design of columns.

Flexural members - bending, deflection - local buckling of compression elements - laterally supported and unsupported beams - Computation of permissible stresses - Design of Beams. Connections - Various methods - Welding.

UNIT – III

ALUMINIUM STRUCTURES : Structural aluminium - Specification - permissible stresses.

Tension members - Design of tension members.

COMPRESSION MEMBERS : Modes of failure - lacing and battening - beam columns - Design of columns.

FLEXURAL MEMBERS : bending, deflection - local buckling of compression elements - Design of beams.

Connections - Riveting or bolting etc.

UNIT – IV

PLASTIC DESIGN : Secondary design considerations - Influence of axial force and shear force on plastic Design of columns. Analysis and Design of single span gable frames.

UNIT – V

LIMIT STATE DESIGN : Characteristic strength -characteristic load - partial safety factor - limit state of collapse in flexure and shear - limit state of serviceability. Design of laterally restrained and unrestrained beams.

REFERENCES :

1. Plastic design of steel frames by L.S. Beedle.
2. Structural Engineers Hand Book (ISI) - No.6.
3. Design of Steel Structures by Arya and Ajmani.
4. Cold-Formed Steel Structures - Wei-Wen Yu (Mc Graw-Hill Book Co.), 1973.
5. Design of steel structures by Ramachandra - Vol.II.
6. Structural Steel Design INSDAG Vol.1.

--oOo--

04 FRACTURE MECHANICS

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

LINEAR ELASTIC FRACTURE MECHANICS :

History and overview of fracture mechanics, fracture at atomic level, Stress concentration effect of holes,

UNIT – II

Griffith's energy theory, energy release rate, stress intensity factors, evaluation of stress intensity factor, relationship between K and G, instability and crack resistance (R-curve).

UNIT – III

Effect of finite size, crack tip plasticity, CTOD, J-integral, mixed mode fracture.

UNIT – IV

FRACTURE MECHANICS OF CONCRETE :

Compelling reasons for fracture mechanics of concrete, nonlinear fracture models.

UNIT – V

Experimental techniques, RILEM fracture energy, softening, fracture process zone, interface fracture, size effect, fracture behaviour of HSC and HPC.

References :

1. Broek, D. (1982), "Elementary Engineering Mechanics", Martinus, Nijhoff Publishers, The Hague.
2. Prashant Kumar (1999), "Elements of Fracture Mechanics", Wheeler Publishers, India.
3. Anderson, T.L. (1995), "Fracture Mechanics - Fundamentals and Applications", 2nd Edition, CRC Press, Boca Raton.
4. Karihaloo, B.L. (1995), "Fracture Mechanics and Structural Concrete", Longman Scientific and Technical, USA.
5. Recent technical papers on various aspects of fracture of HSC/HPC.

--oOo--

05 INDUSTRIAL STRUCTURES

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

INDUSTRIAL BUILDINGS

Industrial Building Frames. Framing systems, Bracings, Walls, Lighting and Ventilation, Floors, Crane girder and Columns,

UNIT – II

INDUSTRIAL BUILDINGS

Design of simple Rigid Frame bent using plastic theory. Design of North Light shell roof.

UNIT – III

STEEL CHIMNEYS : Various forces, Joints, Lining, Flue openings - Design of self supporting chimneys and guyed steel stacks.

UNIT – IV

R.C. CHIMNEYS : Stresses due to self weight, wind pressure and temperature differences - Design of the chimney including foundation.

UNIT – V

BUNKERS AND SILOS

Bunkers and Silos Principles and design.

REFERENCES :

1. Dunham - Planning and Design of Industrial Oriented Structures.
2. Ketchum Milo - Steel Structural Engineering Hand Book.
3. Leele and Turner - Design of R.C.Chimneys.
4. Jain and jaikrishna - Plain and Reinforced concrete Vol-II, Nemchand & Bros., Roorkee, India.
5. Arya and Ajmani - Design of Steel Structures.
6. Manohar - Design of R.C.C Chenneys, T.M.H., New Delhi.

--oOo--

06 PRE FABRICATED CONCRETE STRUCTURES

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

Types of RC Prefabricated Structures

Long wall and cross wall large panel buildings – one way and two way prefabricated slabs – Framed buildings with partial and curtain walls, single storey industrial buildings with trusses and shells – crane – gantry systems.

Functional Design Principles

Modular coordination – Standardization – Disuniting, Diversity of prefabricates – Production – Transportation – Erection – Stages of loading and codal provisions – Safety factors – Material properties – Deflection control – Lateral load resistance – Location and types of shear walls.

UNIT – II

Floors, Stairs and Roofs

Types and floor slabs – Analysis and design example of cored and panel types and two-way systems – Staircase slab design, types of roof slabs and insulation requirements description of joints, their behaviours and requirements, deflection control for short term and long term loads – Ultimate strength calculations in shear and flexure.

UNIT – III

Walls

Types of wall panels – Blocks an large panels – Curtain – Partition and load bearing walls – Load transfer from floor to wall panels vertical loads – Eccentricity and stability of wall panels – Design curves, Types of wall joints, their behaviour and design, Leak prevention, Joint sealants, Sandwich wall panels – Approximate design of shear walls.

UNIT – IV

Industrial Buildings

Components of single storey industrial sheds with crane gantry systems – Design of R.C. Roof Trusses Roof panels – Design of R.C. Crane – Gantry Girders – Corbels and columns – Wind bracing design.

UNIT – V

Cylindrical, Folder plate and hypar prefabricated shells, Erection and joining, joint design – Hand book based design.

References

1. B.Leweicki, Building with large prefabrication, Elsevier Publishing Co.
2. SERC, Design & Construction of Prefabricated Residential & Industrial Buildings, Organized by SERC, Chennai.
3. Marashev, V.I. Sigalov, E.Y., Baikov, U.N., Design of RC Structures, Mir Publishers, Moscow.

--oOo--

07 TALL STRUCTURES

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

Design Criteria

Design philosophy – Loading – Sequential loading – Strength and stability – Stiffness and drift limitations – Human comfort criteria – Creep – Shrinkage and temperature effects – Fire – Foundation settlement and soil structures interaction.

Load on Tall Buildings – Code Recommendations

Gravity Loading	:	Dead load & live load – Live load reduction methods – impact load – Gravity load – construction load.
Wind Loading	:	Static & dynamic approach – Analytical and wind tunnel experimental method.
Earthquake Loading	:	Equivalent lateral force – Model analysis – Combination of loading.

UNIT – II

Behaviour of Structural Systems
Rigid frames – braced frames – Infilled frames – shear walls – coupled shear walls – wall frames tubular – cores and hybrid mega systems.

UNIT – III

Analysis & Design
Modelling for approximate analysis – Accurate analysis and reduction techniques – Analysis of buildings as total structural system considering overall integrity and major subsystem interaction – Analysis for member forces – drift and twist – computerized general 3D analysis.

UNIT – IV

Structural Elements
Sectional shapes – Properties and resisting capacity – Design deflection, cracking – pre-stressing – Shear flow – Design for differential movement – Creep and shrinkage effects temperature effects and fire resistance.

UNIT – V

Stability of Tall Building

Overall buckling analysis of frames – Wall – Frames – Approximate methods – Second – Order effects of gravity loading – p – Delta analysis simultaneous first order and P-Delta analysis, Translational – Torsional instability out of plumb effects – Stiffness of member instability – Effect of foundation rotation.

References

1. Wolf Gang Schuller, High rise Building Structures, John Willey & Sons.
2. Taranath, B.S., Structural Analysis & Design of Tall Buildings, Tata McGraw Hill.
3. Bryan Stafford Smith, Alexcoull, Tall Building Structure Analysis and Design, John Wiley & Sons.
4. Lynn, S. Beedle, Advances in Tall Buildings, CBS Publishers.

--oOo--

08 SOIL STRUCTURE INTERACTION

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

Introduction

Soil behaviour – Elasticity, Plasticity, Viscoelasticity – Non-linear behaviour – Strain hardening – Dilatancy – Classification of interaction problems.

UNIT – II

Modulus of Sub-grade Reaction

Vertical and horizontal modulus of sub-grade reaction – Determination of modulii – Factors affecting them.

UNIT – III

Beams and Slabs

Winkler foundation – Modified Winkler modler models – Two parameter formulations of Vlasov and Leontey – Elastic continuum – Baker's method for rafts.

UNIT – IV

Piles

Elastic analysis of axial, torsional and laterally loaded piles – Yielding of plies under axial and lateral loads p-y-curves.

UNIT – V

Pile Groups

Displacement of pile groups under axial and lateral loads, pile-raft systems.

References

1. Desai, C. and Christian, J.T., "Numerical methods in Geotechnical Engineering", McGraw Hill Book Co., 1977.
2. Hetenyi, M., "Beams on Elastic Foundation", University of Michigan Press, 1946.

--oOo--

09 STRUCTURAL OPTIMIZATION

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

Introduction

Introduction to optimization techniques, Problem formation and merit function. Linear optimization Geometry of linear programming – simple algorithm – Duality in Linear Programming.

UNIT – II

Non-Linear Optimization – I

One dimensional minimization methods – Exhaustic search, Dichotomous search and direct root methods.

UNIT – III

Non-Linear Optimization – II

Direct search method – Random search methods – Descent methods – Steepest – Descent method – Fletcher – Reeeves method, Davidon – Fletcher – Powell method.

UNIT – IV

Linear Constrained Optimization

Cutting plane method and penalty function methods. Geometric plane programming – Dynamic Programming and integer programming.

UNIT – V

Application of Optimization techniques for simple structures of homogeneous materials – Problem formulation for structures of non-homogeneous materials. Minimum weight design of structures using plastic theory.

Texts

1. S.S. Rao, Optimum Theory & Applications, Wiley Eastern Ltd.
2. Urikirsch, Optimum Structural Design, McGraw Hill.

References

1. Spunt, Optimum Structural Design, Civil Engineering and Engineering Mechanics, Prentice Hall.
2. Richard Bronson, Operations Research, Schaum's outlines, McGraw Hill Ltd.

--oOo--

10 EXPERIMENTAL STRESS ANALYSIS AND INSTRUMENTATION

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

ELEMENTARY ELASTICITY :

Introduction, stress-strain relationships, Principal stresses and principal strains, maximum shear stress, Theories of failure.

UNIT – II

MODEL METHODS FOR STRUCTURAL ANALYSIS :

Models-Definition and purpose - Application of model analysis - standard methods - Properties of model materials and design of models. Indirect methods - Muller Breslau's principle, Begg's deformator, Eney's deformator, R.P.I. deformator and moment indicator.

UNIT – III

STRAIN GAUGES :

Mechanical strain gauges-optical and Acoustic strain gauges - pneumatic strain gauges and electrical strain gauges - determination of stresses due to static and dynamic loads - Instrumentation - reduction of strain gauge data for computation of stresses.

UNIT – IV

NON-DESTRUCTIVITY TESTING :

Ultrasonic techniques for non destructive testing, Grid Techniques : Grid and Moire Methods of stress Analysis.

ANALOGIES :

Membrance analogy - Hydrodynamic analogy - Electric analogy.

UNIT – V

PHOTO ELASTICITY :
Polariscopes-photoelastic model materials-Calibration methods - isochromatic and isoclinic fringe patterns and their interpretation - stress coat and its application in photoela-ticity.

BRITTLE COATING METHOD :
Coating stress-failure theories-crack detection-effects of a biaxial stress field.

REFERENCES :
1. Lee, G.H.: An Introduction to Experimental stress Analysis.
2. Dally, J.W. and Riley, W.F.: Experimental Stress Analysis (McGraw Hill Book Co.).
3. Dove, R.C. and Adams, P.H. : Experimental Stress Analysis and Motion Measurements (Prentice Hall India).
4. Perry, C.C. and Lissner, H.R. : The strain gauge primer (McGraw Hill Book Co.).
5. Durelli and Reiley W.f. : Introduction to Photomechanic (Printice Hall India, 1965).
6. Zinny, S. : Structural Analysis (Addision-Wesley).

--oOo--

11 MAINTENANCE AND REHABILITATION OF STRUCTURES

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

Influence on serviceability and durability:
Effects due to climate, temperature, chemicals, wear and corrosion. Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking methods of corrosion protection, inhibitors, resistant steels, coatings cathodic protection.

UNIT – II

Maintenance and Repair strategies:
Inspection, structural Appraisal, Economic appraisal, components of quality assurance, conceptual bases for quality assurance schemes.

UNIT – III

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

UNIT – IV

Techniques for Repair: Rust elimators and polymer 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 repairs to structures: Repairs to overcome low member strength Deflection, cracking, chemical disruption, weathering wear, fire, leakage, marine exposure.

Text/Reference Books

1. Dension Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical, U.K,1991.
2. RT. Allen and S.C.Edwards, Repair of concrte Structures, Blakie and sons, UK, 1987.
3. MS.Shetty, Concrete Technology – Theory and practice, S. Chand and company, New Delhi,1992.
4. Santhakumar, S.R Training course notes on damage assessment and Repair in low cost housing RHDC-NBO Anna University, Madras,July,1992.
5. Raikar, R.N.Learning from failures- deficiencies in Design, construction and service – R&D centre (SDCPL), Raikar Bhavan, Bombay, 1987.
6. N.palaniappan, Estate Management, Anna Institute of Management, Madras Sep. 1992.
7. F.k.Garas, J.l.Clarke, GST Armer, Structural Assessment, Butterworths, UK April 1987.
8. A.R.Santhakumar, Concrete chemicals- Theory and applications, Indian society for construction Engineering and Technology, Madras. 1993(In press)

--oOo--

12 STABILITY OF STRUCTURES

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

BUCKLING OF COLUMNS :

Concepts of stability - Buckling of axially and Eccentrically loaded columns - Elastic and inelastic buckling of straight columns - Tangent modulus theory of inelastic buckling - Effect of shear on buckling of eccentrically and laterally loaded columns.

UNIT – II

Beam - Column theory and its application to buckling of rotationally restrained columns - Rectangular rigid frames - Simply supported portal frames.

UNIT – III

MATHEMATICAL TREATMENT :

Buckling problem as an Eigen value problem - Orthogonality relation - Rayleigh - Ritz method - Tim shenkos method - Galerkin method.

UNIT – IV

BUCKLING OF THIN PLATES:

Buckling of simply supported rectangular plates compressed in one and two directions - Buckling of circular plates.

UNIT – V

COLUMNS ON ELASTIC FOUNDATION :

Buckling equation for columns on elastic foundation with different end conditions - Rayleigh - Ritz solution.

REFERENCES :

1. Timoshenko, S. and Gere, J.M. : Theory of Elastic Stability (Mc Graw Hill Book Co.).
2. Simitees, G.J.: An introduction to the Elastic Stability of Structures (Prentice-Hall).
3. Bleich, F : Buckling Strength of Metal Structures (Mc Graw Hill Book Co.).
4. Bulson, C.S. : Theory of Buckling.

--oOo--

13 ADVANCED METAL STRUCTURES

L + T / week : 3+1 Hrs | Sessional Marks : 20+20
University Exam : 3 Hrs | End Exam Marks : 60

UNIT – I

General

Design of members subjected to lateral loads and axial loads – Analysis and Design of industrial building bents – Cranes Gantry Girders and Crane columns – Bracing of Industrial Buildings and Bents.

UNIT – II

Connections

Types of connections – Design of framed beam connections – Seated beam connections – Unstiffened – Stiffned seat connections – Continuous beam–to–beam connections and continuous beam-to-column connections.

UNIT – III

Design of Tall Structures

Analysis & Design of Steel Towers Trestles and Mast – Design of self supporting chimneys (lined and unlined) and guyed steel stacks – Stresses due to wind and earthquake forces – Design of base plates.

UNIT – IV

Plastic Analysis

Introduction – Shape factors – Moment redistribution – Static – Kinematic and uniqueness theorems – Combined mechanisms – Analysis of single bay and tow bay portal frames – Methods of plastic moment distribution – Effect of Axial force and shear force on plastic moment – Connections – Moment resisting connection.

UNIT – V

Cold Formed Sections

Types of cross sections – Design of cold formed thin walled members – Local Buckling and post Buckling strength – Beams – Columns – Beam columns – Connections.

Aluminium

Aluminium structures – Design principles

Text

Dayaratnam, Design of Steel Structures – A.H. Wheeler, 1990.

References

1. Arya, Design of Steel Structures, Nem Chand & Bros., Roorkee.
2. Gaylord, Steel Structures, McGraw Hill Book Company, New York.
3. Loathers, Advanced Design in Structural Steel, Prentice Hall.
4. Lin. S. Beedle, Plastic Design of Steel Frames, John Wiley & Sons.
5. B.G. Neal, The Plastic Methods of Structural Analysis, Chapman and Hall Ltd., London.

--oOo--

14 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

Introduction to engineering seismology – Characteristics of Earthquake ground motion and response spectra – Dynamic response of buildings – Seismic analysis of building systems- Indian seismology.

UNIT – II

Design code provisions – Architectural considerations. Design for drift and lateral stability.

UNIT – III

Seismic design of floor diaphragms – Steel structures – Reinforced concrete structures – Masonry structures – Non-structural systems and components.

UNIT – IV

Earthquake Resistant Design-Concept –Provisions of Seismic code IS-1983:(Part-1): 2002-Response Spectrum

UNIT – V

Ductile Detailing-Ductile Detailing of RC Earthquake Resistant Structures – Provisions of IS-13920:1993- Detailing of RC Beam , Column and Beam Column Joints.

Texts

1. Jaikrishna & Chandrasekar, Elements of Earthquake Engineering.
2. Dowrick, D.J., Earthquake Resistant Design.

References

1. Chopra, Structural Dynamics and Earthquake Engineering, Prentice Hall.
2. SP:22 : 1982, Explanatory Handbook on Codes for Earthquake Engineering.
3. Arnold C & Reitherman, R, Building Configuration & Seismic Design.
4. Newmark, N.M. and Resenbleuth, E. Fundamentals of Earthquake Engg.

--oOo--

15 DESIGN OF SHELL STRUCTURES

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

GEOMETRY OF SHELLS : Classification of shells.

MEMBRANE THEORY : Membrane analysis of spherical and conical shells of revolution; hyperbolic paraboloid and conoid shells of double curvature.

UNIT – II

BENDING THEORY : Application to cylindrical shells : Detailed design of cylindrical, spherical, hyperbolic paraboloid and conoid shells in reinforced concrete.

UNIT – III

OTHER THEORIES OF CYLINDRICALS : ASCE manual for the design of cylindrical shell.

UNIT – IV

BUCKLINES OF SHELLS : Element of Buckling of shells.

UNIT – V

FOLDED PLATES : Plate and slab action, edge shears; Whitney's method of analysis and design.

References :

1. Theory of Plates and Shells by Timoshenko, S. & Krieger.
2. Design and Construction of Concrete Shells Roofs by Ramaswamy, G.S.
3. Advanced RC Design by Krishna Raju, N.

--oOo--

16 BRIDGE ENGINEERING

L + T / week : 3+1 Hrs
University Exam : 3 Hrs

Sessional Marks : 20+20
End Exam Marks : 60

UNIT – I

Introduction

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

Load distribution theories – Analysis and design of slab culverts – Tee beam and slab bridges.

UNIT – III

Long span girder bridges

Design principles of continuous bridges – Box girder bridges balanced cantilever bridges.

UNIT – IV

Handling – Hoisting & Other Launching techniques of pre-stressed Girders.

UNIT – V

Bearings – Substructures and Foundation for bridges.

Texts

1. Victor, D.J. Essentials of Bridge Engineering, Oxford IBH.
2. Ponnuswamy, S, Bridge Engineering, Tata McGraw Hill.

References

1. Rowe, R.E., Concrete Bridges Design C.R. Books & Co.
2. Derrick Beckett, An Introduction to Structural Design of Concrete, Bridges, Surry University Press, Oxford.
3. Taylor, F.N, Thomson, S.E. & Smulshi, E. Reinforced Concrete Bridges John Wiley Sons.
4. Balcht, B & Jaegar, L.G., Bridge Analysis simplified McGraw Hill.

--oOo--