I SEMESTER

15CS01/ 15CN01 APPLIED STATISTICS AND RELIABILITY

2 2 0 3

REVISION: Probability, axioms of probability, conditional probability, Baye's theorem, probability distributions - random variables, binomial distribution, Poisson distribution, normal distribution, exponential distribution, and Weibull distribution. (4+4)

TWO DIMENSIONAL RANDOM VARIABLES: Joint distributions - discrete and continuous, marginal distributions. (3+3)

ESTIMATION: Point estimation, confidence intervals for mean, difference of two means, variances and proportions, maximum likelihood estimators. (3+3)

TESTS OF STATISTICAL HYPOTHESES: Tests about proportions, one mean and one variance, tests of the equality of two normal distributions, chi-square goodness of fit tests, contingency tables, one factor and two factor analysis of variance. (4+4)

REGRESSION AND CORRELATION: Introduction**,** estimation using the regression line, correlation analysis, making inferences about population parameters, multiple regression and modelling - multiple regression and correlation analysis, finding the multiple regression equation. (4+4)

TIME SERIES ANALYSIS: Introduction, variations in time series, trend analysis, cyclical and seasonal variation. (3+3)

RELIABILITY: Introduction, failure distribution - reliability function, mean time to failure, Hazard rate function, bathtub curve, conditional reliability, constant failure rate model – exponential reliability function, failure models, time dependent failure models - Weibull and normal distribution. (3+3)

RELIABILITY OF SYSTEM AND MODELS: Serial configuration, parallel configuration, combined series parallel systems, system structure function, minimal cuts and minimal paths, state dependent systems – load sharing systems, standby systems, degraded systems, three state devices, physical reliability models - covariate models, static models, dynamic models, physics of failure models . (6+6)

Total L: 30 + T: 30 = 60

REFERENCES:

1. Richard A Johnson, "Miller and Freund's Probability and Statistics for Engineers", Prentice Hall, New Delhi, 2013.
2. Robert V Hogg, Elliot A Tanis and Jagan Mohan Rao, "Probability and Statistical Inference", Pearson, New Delhi, 2007.
3. Richard I Levin and David S Rubin, "Statistics for Management", Pearson, New Delhi, 2011.
4. Charles E Ebeling, "An Introduction to Reliability and Maintainability Engineering", Tata Mc Graw Hill, New Delhi, 2010.
5. Saeed Ghahramani, "Fundamentals of Probability with Stochastic Processes", Pearson, New Delhi, 2012.

15CS02/15CN02 CONCEPTS OF STRUCTURAL AND GEOTECHNICAL ENGINEERING

3 0 0 3

STRUCTURAL ANALYSIS:

Fundamentals of Analysis: Methods of analysis – concepts – review . (3)

Free body diagram of joint – free body diagram of member – shear force and bending moment diagram for continuous beams and rigid frames – plane and space frames . (6)

Energy principles: basic energy theorems and application to structural analysis - deflection of beams, Trusses, frames. (6)

STRUCTURAL DESIGN:

Structural loads: Dead load, live load, wind load, seismic load, settlement load . (3)

Design Philolsophies: Concepts of Working stress and limit state design methods. (2)

Structural Steel design (LSD): Structural design principles - tension member, compression member and beams. (5)

Reinforced Concrete Design (LSD): Structural design principles – rectangular beams subjected to flexure, shear and torsion - slabs – columns. (5)

GEOTECHNICAL ENGINEERING

Soil as a three phase system – Basic definitions and relations, Grain size distribution analysis for coarse grained soils – Atterberg limits for fine grained soils, Classification of soils as per Bureau of Indian Standards – examples . (6)

Compaction – Factors influencing compaction – I.S. specifications for light and heavy compaction tests – Relative compaction. (3)

Effective stress concept, Shear strength of soils, Earth pressure. (3)

Standard Penetration test – Procedure – Correlation between N-value and strength parameters, Load carrying capacity of piles. (3)

Total L : 45

REFERENCES:

1. Leet K M and Uang C M, “Fundamentals of Structural Analysis”, Tata MaGraw Hill Publishing Co., 2003.
2. Hibbeler R C, “Structural Analysis”, Pearson Education Asia, 2002.
3. Rajasekaran S and Sankarasubramanian G, “Computational Structural Mechanics”, PHI Learning, 2001.
4. Schodek, “Structures”, PHI Learning.
5. Unnikrishna PIllai S and Devdas Menon, “Reinforced Concrete Design”, Tata McGraw Hill Publishing Co., New Delhi, 2010.
6. Varghese P C, “Limit State Design of Reinforced Cocnrete”, PHI Learning, New Delhi, 2008.
7. Subramanian N, “Design of Steel Structures”, Oxford University Press, New Delhi, 2008.
8. Steven C Chapra and Raymond P Canale, “Numerical Methods for Engineers with Software and Programming Applications”, Tata McGraw Hill, 2004.

15CS03/15CN24 ADVANCED CONCRETE TECHNOLOGY

3 0 0 3

INTRODUCTION: Concrete: Past, present and future – constituent materials – Composition and properties of Portland cement – hydration of cement – structure of hydrated cement paste – physical properties – acceptance criteria – types of cements and applications – aggregates – bulking of sand – sieve analysis and significance – mechanical properties of coarse aggregates – acceptance criteria – alkali-aggregate reaction – grading requirements. (9)

PROPERTIES OF FRESH AND HARDENED CONCRETE: Workability - Factors affecting workability - Tests for workability - segregation - bleeding - Modern trends in concrete production , placement and compaction –- Vacuum dewatering and underwater concreting – special formwork - Factors affecting strength of concrete - Maturity of concrete – Rheological properties of concrete - Shrinkage - Creep of concrete - Factors affecting creep and shrinkage of concrete – Compression, Split Tension, Flexure ,Bond strength - IS code provisions - Factors affecting strength test results - Accelerated strength tests - Stress strain characteristics - Determination of modulus of elasticity – Non-destructive evaluation of reinforced concrete– load test on structural components . (9)

HARDENING OF CONCRETE AND DURABILITY ASPECTS: Microstructure of concrete – nanometer scale –C-S-H structure – transition zone and micro cracking - Permeability- Chemical attack - Sulphate attack - Quality of water - Marine atmosphere - Methods to improve durability - Thermal properties of concrete - Fire resistance and corrosion protection - use of admixtures**:** Accelerators - Retarders – plasticizers - Air entraining agents - Mineral admixtures. (9)

MIX DESIGN: Basic considerations – frequency of sampling – nominal and design mixes – statistical quality control and acceptance criteria -Factors in the choice of mix proportions - Mix design methods - ACI method, IS method - Mix proportions for weigh batching and volume batching - correction for moisture content and bulking - yield of concrete – design of high strength concrete (Shacklok and Entroy) – computer programming for the design of concrete mix. (9)

SPECIAL CONCRETES AND CONCRETE COMPOSITES: Light weight concrete - Fibre reinforced concrete - Polymer concrete - High Performance Concrete and future trends– Pumpable concrete – Self compacting concrete- tests for key properties and aspects of mix design- preplaced concrete – smart concrete – geo polymer concrete – concrete using industrial waste material – sprayed concrete- reactive powder concrete – ready mixed concrete – high toughness and ductile concrete -concrete composites. (9)

Total L: 45

REFERENCES:

1. Neville A M and Brooks J J, “Concrete Technology”, Pearson Education Asia Pvt. Ltd, 2013.
2. Mehta P K, Pauls J M and Monteiro, “Concrete Micro Structure – Properties of Materials”, Indian Concrete Institute, Chennai, 1997.
3. Santhakumar A R, “Concrete Technology”, Oxford University Press, New Delhi, 2007.
4. Ramachandran V S and James J. Beaudoin, “Hand Book on Analytical Techniques in Concrete Science and Technology: Principles, Techniques and Applications”, Elsevier, Amsterdam, 2013.
5. Jayant D Bapat, “Mineral Admixtures in Cement and Concrete”, CRC Press, New Delhi, 2013.
6. Edward G Nawy, “Fundamentals of High Performance Concrete”, John-Wiley & Sons Inc, New York, 2001.
7. Zongjin Li, “Advanced Concrete Technology”, John-Wiley & Sons inc, New York, 2012.
8. Malhotra V M and Carino N J, “Handbook on Non-destructive Testing of Concrete”, CRC Press, 2014.
9. Geert De Schutter, Peter J.M.Bartos, Peter Domone and John Gibbs, “Self – Compacting Concrete”, CRC Press, 2010.
10. Simon Austin and Peter Robins, “Sprayed Concrete – Properties, Design and Application”, Whittles Publishing, 2007.

15CS04/15CN04 REINFORCED CONCRETE DESIGN

3 0 0 3

SPECIAL RC ELEMENTS: Design of slender columns - design of shear walls - Design of corbels and deep beams - Tie and strut model - arch analogy – design of gird floors. (10)

FLAT SLABS : Design of flat slabs and flat plates according to IS and ACI method. Design for shear reinforcement and spandrel beams (7)

BUNKERS AND SILOS: Introduction – Janssen's theory, Airy's theory – Design of bunkers and silos. (7)

CHIMNEYS: Design of RC chimneys for combined effect of self load, wind load and temperature. (7)

RC MEMBERS FOR FIRE RESISTANCE: Introduction – Classification – Effects of high temperature on steel and concrete - Effects of high temperature on different structural members – Structural detailing – Ultimate moment capacity. (4)

DUCTILE DETAILING: Concepts of ductility – factors influencing ductility – design principles and codal provisions – beam to column junction. (5)

INELASTIC BEHAVIOUR OF CONCRETE BEAMS AND SLABS : Principles of moment - rotation curves, moment redistribution and Baker's method of plastic design – yield line theory of slabs. (5)

Total L: 45

REFERENCES:

1. Varghese P C, "Advanced Reinforced Concrete", Prentice-Hall of India Ltd., New Delhi, 2001.
2. Varghese P C, "Limit State Design of Reinforced Concrete", Prentice-Hall of India Ltd., New Delhi, 2006.
3. Pillai S U and Menon D, "Reinforced Concrete Design", Tata McGraw Hill Book Co., New Delhi, 2005.
4. Krishna Raju N and Pranesh R N, "Advanced Reinforced Concrete Design", New Age International Publishers, New Delhi, 2003.
5. Punmia B C, Ashok Kumar Jain and Arun Kumar Jain, "Comprehensive RCC Designs", Lakshmi Publications (P) Ltd., New Delhi, 2005.
6. Gamphir M L, "Design of Reinforced Concrete Structures", PHI Learning Private Ltd., NewDelhi 2011.
7. McGregar G J and James K Wight, "Reinforced Concrete Mechanics and Design", INC Pub., 2006.
8. Bondopadhyay J N, "Design of Concrete Structures", PHI learning 2004.

15CS05/15CN05 COMPUTER ANALYSIS OF STRUCTURES

3 0 0 3

REVIEW OF FUNDAMENTAL CONCEPTS: Introduction – Forces and Displacement Measurements – Principle of superposition– Methods of Structural Analysis – Betti's Law – Stiffness and Flexibility matrices of the Elements – a review. (8)

TRANSFORMATION OF INFORMATION: Indeterminate Structures – Transformation of system force to element forces – Element flexibility to System flexibility – system displacement to element displacement – Transformation of forces and displacement in general – Normal and orthogonal transformation. (7)

FLEXIBILITY METHOD: Choice of redundants – ill and well conditioned equations – Automatic choice of redundants – Rank technique – Transformation of one set of redundants to another set – Thermal expansion – Lack of fit – Application to pin jointed plane truss – continuous beams - frames and grids. (7)

STIFFNESS METHOD: Development of stiffness method – analogy between flexibility and stiffness – Analysis due to thermal expansion, lack of fit – Application to pin-jointed plane and space trusses – Continuous beams – frames and grids – problem solving. (7)

MATRIX DISPLACEMENT METHODS - SPECIAL TOPICS: Static condensation Technique – Substructure Technique - Transfer Matrix method – Symmetry & Anti symmetry of structures – Reanalysis Technique. (8)

DIRECT STIFFNESS METHOD: Discrete system – Direct stiffness approach – Application to two and three dimensional pin-jointed trusses - plane frames – Grids – Three dimensional space frames. (8)

Total L: 45

REFERENCES:

1. Mcguire and Gallagher R H, "Matrix Structural Analysis", John Wiley, 2001.
2. Rajasekaran S and Sankarasubramanian G, "Computational Structural Mechanics", Prentice Hall of India, New Delhi, 2001.
3. Beaufait F W, "Computer Methods of Structural Analysis Analysis", Prentice Hall 1970.
4. Holzer S M, "Computational Analysis of Structures", Elsevier Science Publishing Co., Inc, 1988.
5. Meek J L, "Computer methods in structural Analysis", Taylor and Francis, 1991.
6. Nelsm J K, Nelson K James and Mc Cormac J C, "Structural Analysis Using Classical and Matrix Methods", John Wiley & Sons, 2002.
7. Kanchi M B, "Matrix methods of Structural Analysis", New Age International, 1993.

15CS51/15CN51 CONCRETE TECHNOLOGY AND STRUCTURAL ENGINEERING LABORATORY

0 0 4 2

1. Quality control tests on cement, aggregates and concrete reinforcements, Concrete mix design.
2. Study on behaviour of Reinforced concrete beams.
3. Study on behaviour of reinforced concrete colulmns with and without retrofitting.
4. Study on Non destructive tests – Rebound hammer, Ultrasonic Pulse velocity, Corrosion analyser and Rebar locator.
5. Autoclave test – Accelerated curing of concrete – use of Data Acquisition system.

The students should design concrete mix and cast RCC Beam and Prestressed Concrete beam and calculate the theoretical load and conduct experiment on the beam and measure load, deformation and strain and plot load deformation curve & moment curvature relationship and discuss.

Total P: 60

15CS61/15CN61 INDUSTRIAL VISIT AND TECHNICAL SEMINAR

0 0 4 2

The student will make atleast two technical presentations on current topics related to the specialization. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation together with the observation in industry visits. A quiz covering the above will be held at the end of the semester.

Total P: 60

II SEMESTER

15CS06/15CN06 STRUCTURAL STEEL DESIGN

3 0 0 3

INTRODUCTION: Concept of design methodologies -Philosophies of Limit State Design, Working stress design, LRFD. (4)

AXIAL LOADED MEMBERS: TENSION MEMBERS: Introduction – net sectional area for concentrically and eccentrically loaded members – tension splices - bending of tension members – stress concentrations. COMPRESSION MEMBERS: Introduction – practical end conditions and effective length factors – elastic compression members – restrained compression members – torsional buckling - built up compression members with lacings and battens – column splices. (8)

LOCAL BUCKLING OF THIN PLATE ELEMENTS: Introduction – plate elements in compression –shear – bending – bending and shear – bearing – design against local buckling. (6)

FLEXURAL MEMBERS: Introduction – Inplane bending of beams – elastic analysis of beams – bending stresses – shear stresses – strength design – serviceability design – lateral buckling of beams – restrained beams – cantilever& over hanging beams- braced and continuous beams – mono symmetric beams – non uniform beams. (6)

BEAM – COLUMNS: Introduction – inplane behaviour of isolated beam-column – flexural torsional buckling – biaxial bending. (5)

FRAMES: Introduction – triangulated frames – two dimensional frames – three dimensional frames- semi rigid frames- braced frames. (5)

CONNECTIONS: Welded and bolted connections – framed connection – seated connection – moment resistant connection. (5)

TORSION MEMBERS: Introduction – uniform torsion – non uniform torsion – torsion design – torsion and bending – distorsion. (6)

Total L: 45

REFERENCES:

1. Trahair N S , Brandford M A , Nethercot D M, and Gardner L , “The Behaviour and Design of Steel Structures EC3”,
2. Taylor and Francis, London and Newyork, 2008.
3. Subramanian N, “Design of Steel Structures”, Oxford University Press, New Delhi 2008.
4 Englekirk R, “Steel Structures: Controlling Behaviour through Design”, John-Wiley &Sons, Inc, 2003.

15CS07 STRUCTURAL DYNAMICS

3 0 0 3

INTRODUCTION AND PRINCIPLES OF DYNAMICS: Vibration studies and their importance to structural engineering problems - elements of vibratory systems and simple harmonic motion - vibration with and without damping - constraints - generalized mass D`Alembert's principle - Hamilton's principle. (5)

SINGLE DEGREE OF FREEDOM SYSTEM: Degree of freedom - equation of motion for S.D.O.F. damped and undamped free vibrations - undamped forced vibration - critical damping - logarithmic decrement - response to support motion - response of one degree freedom system to harmonic excitation damped or undamped - evaluation of damping resonance - band width method to evaluate damping - force transmitted to foundation - vibration isolation. (6)

RESPONSE TO GENERAL DYNAMIC LOADING: Fourier series expression for loading-response to general dynamic loading - (blast or earthquake) - Duhamel's integral - numerical evaluation, Newmark’s method - Wilson -θ method – recurrence formula. (5)

GENERALIZED DISTRIBUTED FLEXIBILITY: Expression for generalised system properties - vibrational analysis with Rayleigh's variational method - Rayleigh - Ritz method. (5)

TWO DEGREE OF FREEDOM: Free and forced vibration of undamped and damped systems – Lagrange equations coupling. (5)

MULTIDEGREE FREEDOM SYSTEM: Evaluation of structural property matrices - natural vibration - solution of the eigen value problem - iteration due to Stodola - Transfer matrix method , Rayleigh – Ritz and Dunkerley approximation - Orthogonality of natural modes. (5)

DISTRIBUTED PARAMETER SYSTEM: Differential equation of motion - analysis of undamped free vibration of simply supported and cantilever beams - effect of axial loads - numerical evaluation of modes - frequencies and response system - vibration analysis using finite element method for beams and frames. (7)

ANALYSIS OF STRUCTURE SUBJECTED TO DYNAMIC LOADS: Idealisation of multi-storied frames for dynamic analysis - lumped S.D.O.F system - Wind induced vibration of Structures – Moving load, impact & blast loading. (7)

Total L: 45

REFERENCES:

1. Paz M, “Structural Dynamics - Theory and Computation", Springer, 2007.
2. Anil K Chopra, "Dynamics of Structures - Theory and Applications to Earthquake Engineering", Prentice Hall, New Delhi, 2004.
3. Clough R W and Penzien, "Dynamics of Structures", McGraw Hill Book Co. Ltd, 1986.
4. Craig R R, "Structural Dynamics - An Introduction to Computer Methods", John Wiley & Sons, 1989.
5. Thomson W T, "Theory of Vibration", Prentice Hall of India, 1975.

15CS08 APPLIED ELASTICITY AND PLASTICITY

3 0 0 3

ANALYSIS OF STRESS, STRAIN AND STRESS STRAIN RELATIONS: Analysis of stress (two and three dimensions) - Body force, surface forces and stresses, uniform state of stress - principal stresses - stress transformation laws - Differential equations of equilibrium. Analysis of Strain (two and three dimensions) - strain and displacement relation - compatibility equations - state of strain at a point - strain transformations - principle of superposition. - stress strain relation - generalised Hooke's law -Lame's constants. (8)

FORMULATION OF ELASTICITY PROBLEMS: Methods of Formulation - Equilibrium equations in terms of displacements - Compatibility equations in terms of stresses - boundary value problems - plane stress - plane strain problems. (6)

TWO DIMENSIONAL PROBLEMS IN CARTESIAN COORDINATES: Introduction - Boundary condition - Plane stress and strain problems - examples - Airy's stress function - polynomials - Direct method of determining Airy's stress functions - solution of Bi-harmonic equation - St.Venant`s principle - Two dimensional problems in Cartesian co-ordinates - bending of a cantilever loaded at end. (6)

TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES: General equations in polar co-ordinates - stress distribution symmetrical about an axis - pure bending of curved bars - strain components in polar co-ordinates - displacements for symmetrical stress distribution - bending of a curved bar - effect of a circular hole on stress distribution – Thick cylinder - Forces on wedges - a circular disk with diametric loading. (5)

TORSION OF CYLINDRICAL BARS: Torsion of prismatic bars - General solution of the problem by displacement (warping function) and force (Prandtl`s stress function) approaches-Torsion of shafts of circular and non circular (elliptic, triangular and rectangular) cross sectional shapes only-Torsion of thin rectangular section and hollow thin-walled sections. (5)

INTRODUCTION TO PLASTICITY: Introduction to stress strain curve - ideal plastic body - criterion of yielding - Rankine`s theory - St.Venant`s theory - Tresca criterion - Beltrami`s theory - Von Mises criterion - Mohr`s theory of yielding - yield surface - Flow rule (plastic stress - strain of relation) - Prandtl Reuss equations - Plastic work - stress - strain relation based on Tresca - Plastic potential. (6)

INRODUCTION TO FRACTURE MECHANICS: Failure criteria and fracture - fracture toughness – stress intensity factor. (4)

SOLUTION OF ELASTIC - PLASTIC PROBLEMS: Elastic plastic problems of beams in bending- thick hollow spheres and cylinders subjected to internal pressure - General relation - plastic torsion - perfect plasticity - bar of circular cross sections - Nadai`s sand heap analogy. (5)

Total L : 45

REFERENCES:

1. Sadhu Singh, "Theory of Elasticity", Khanna Publications, NewDelhi, 2000.
2. Sadhu Singh, "Theory of Plasticity & Metal forming Processes", Khanna Publications, NewDelhi, 1999.
3. Chow PC and Pagono NJ, "Elasticity Tensor Dynamic and Engg. Approaches", DVan Nostrand Co., Inc., 1967.
4. Mendelson A, "Plasticity:Theory & Applications", Macmillan Co., New York, 1968.
5. Timoshenko S and Goodier J N, "Theory of Elasticity" McGraw-Hill Book Co., 1988.
6. Chen WP and Henry D J, "Plasticity for Structural Engineers", Springer Verlag, New York, 1988.
7. Chakrabarty, “Theory of Plasticity”, McGraw Hill Book Co., 1987.

15CS09/15CN23 FOUNDATION STRUCTURES

3 0 0 3

CHOICE AND SIZING OF SHALLOW FOUNDATIONS: Choice of shallow foundations for different situations – Proportioning of foundations for equal settlement, Sizing of foundations based on bearing capacity – strip, isolated, combined and strap footing. (6)

STRUCTURAL DESIGN OF PILES AND PILE CAP: Provisions of IS 2911 (Part 1 and Part 3) on structural design of piles, Moments due to handling and hoisting, Structural design of straight and underreamed piles including grade beam, Different shapes of pile cap, Structural design of pile cap . (5)

WELL FOUNDATIONS: Different types based on shape in plan – Grip length – Load carrying capacity based on SPT results – Thickness of steining and bottom plug – Forces acting on the well – Stability of well subjected to lateral load by Terzaghi's approach – Methods to rectify tilt of well foundation. (5)

SHEET PILE WALL AND ANCHORED BULKHEADS: Different types of sheet pile – Cantilever sheet pile wall in granular soils, in cohesive soils with granular backfill – Anchored bulkhead- Free earth and Fixed earth support methods – in cohesive soils, in cohesive soil with cohesionless backfill . (8)

INTRODUCTION TO DESIGN OF MACHINE FOUNDATIONS: Fundamentals of soil dynamics – Determination of dynamic properties of soil based on Block Vibration Test and Cyclic plate load test – Barkan's method of design of block foundation subjected to vertical vibrations – Vibration Isolation – Transmissibility – Methods of Isolation. (8)

SOIL-STRUCTURE INTERACTION PROBLEMS: Modulus of subgrade reaction – Winkler model – Analysis of infinite beams resting on elastic medium and subjected to point load, uniformly distributed load and moment – Deflection equation for finite beams – Analysis of plates resting on elastic medium by Finite Difference Method – Analysis of raft foundation based on IS 2950. (8)

LIQUEFACTION AND SEISMIC SLOPE STABILITY: Liquefaction – Evaluation of liquefaction susceptibility – Effects of liquefaction – seismic slope stability analysis. (5)

Total L: 45

REFERENCES:

1. Varghese P C, "Foundation Engineering", Prentice Hall of India Ltd., New Delhi, 2007.
2. Kurian K P, "Design of Foundation Systems", Narosa Publishing House, New Delhi, 2005.
3. Selvadurai A P S, "Elastic Analysis of Soil Foundation Interaction", Elsevier, 1979.
4. Kramer S L, "Geotechnical Earthquake Engineering", Pearson Education (Singapore) Private. Ltd. (Indian Branch), New Delhi, 2003.

15CS10/15CN25 PRESTRESSED CONCRETE STRUCTURES

3 0 0 3

PRINCIPLES AND ANALYSIS FOR FLEXURE: Principles - types - prestressing - materials definition of Type I, Type II and Type III structures – requirements - behaviour of PSC elements - force transmitted by pretensioned and post tensioned systems- analysis - service loads - methods - losses - ultimate strength. (6)

DESIGN FOR FLEXURE AND DEFLECTION: Philosophy - limit states - concepts - collapse and serviceability - service load - basic requirements - stress range approach - Lin's approach - Magnel's approach - cable layouts. Deflection - importance - short and long term deflection of uncracked and cracked members. (7)

DESIGN FOR SHEAR AND TORSION: Shear and principal stresses - limit state shearing resistance of cracked and uncracked sections - design of shear reinforcement by limit state approach. Behaviour under torsion - modes of failure - design for combined torsion, shear and bending. (5)

TRANSFER OF PRESTRESS: Transmission of prestressing force by bond in pretensioned members - Transmission length - Factors affecting transmission length - check for transmission length - transverse tensile stresses - end zone reinforcement. Anchorage zone stresses in post-tensioned members - Magnel's method - Calculation of bearing stress and bursting tensile forces - code provisions - Reinforcement in anchorage zone. (5)

COMPOSITE CONSTRUCTION OF PRESTRESSED & INSITU CONCRETE: Need - types of composite construction - behaviour - analysis for flexural stresses - shear - differential shrinkage - design for flexure and shear. (5)

TANKS AND PIPES: Circular prestressing in liquid retaining tanks - analysis for stresses - design of tank wall. PSC pipes - types - design of non cylinder pipes. (5)

STATICALLY INDETERMINATE STRUCTURES: Methods of achieving continuity - assumptions in elastic analysis - pressure line - linear transformation - concordant cables - Guyon's theorem - analysis and design of continuous beams. (7)

OTHER STRUCTURES: Design of prestressed concrete columns, sleepers, poles and tension members - Methods of achieving partial prestressing - Advantages and disadvantages - use of non-prestressed reinforcement. (5)

Total L : 45

REFERENCES:

1. Rajagopalan N, "Prestressed Concrete", Narosa Publishing House, New Delhi, 2002.
2. Krishna Raju N, "Prestressed Concrete", Tata McGraw Hill Publishing Company Ltd., New Delhi 1995.
3. Lin T Y and Ned H Burns, "Design of Prestressed Concrete Structures", John Wiley and Sons, Newyork, 1982.

15CS52 SYMBOLIC AND NUMERICAL COMPUTATION LABORATORY

0 0 2 1

This laboratory is concerned with the use of symbolic computation and numerical methods to study phenomenon governed by the Principle of Mechanics. After 5 to 6 hours of introductory lectures to the use of packages like MATLAB, MATHEMATICA and MATHCAD, the students are advised to follow the list of tasks.

1. Students should make a mathematical model of a physical phenomenon.
2. Understand the assumptions made.
3. Express the natural or Engineering system in terms of partial or total differential equations.
4. Mathematical equations are converted to a form suitable for digital computation. Convert partial or total differential equations to algebraic equations.
5. Computer programs are made to solve discretized equation by direct or iterative methods.
6. The mathematical model, numerical procedures and the computer code are verified with experimental results or simple methods for which exact analytical solution is available.

Problems:
Preliminaries – Symbolic data structures – Multi precision arithmetic – Polynomial algorithm – Solving system of equations – Mathematical function – Differentiation and Integration – Power series – Two or three dimensions Graphics – Differential equations – Curve fitting – minimization – Linear programming.

Examples:
1. Free and forced vibration of damped and undamped systems.
2. Newmarks – Wilson Theta methods.
3. Extracting frequencies and mode shapes.
4. Vibration of beams and strings.
5. Finite Element method.
6. Differential quadrature and transformation methods.
7. Response spectrum.
8. Problems of base excavation.

Total P: 30

III SEMESTER

15CS53 COMPUTER AIDED STRUCTURAL ANALYSIS AND DESIGN LABORATORY

0 0 4 2

ANALYSIS - DISCRETISATION: Matrix methods of Structural Analysis - programs for semi automatic techniques for flexibility and stiffness approaches -- Direct Stiffness approach by MATLAB and EXCEL.

STRUCTURAL ANALYSIS – Modelling – loads and load combinations – calculation of deflections – stress resultants.

STRUCTURAL DESIGN: Design of RC and Steel members – concepts – design principles as per IS codes

GENERAL PURPOSE PACKAGES: Analysis & Design of Steel, RC & Pre-stressed Structures using commercially available software packages.

Introduction to neural network & genetic algorithm application to structural engineering problems – concepts and case studies from literature.

Total P: 60

15CS71/15CN71 PROJECT WORK – PHASE I

0 0 6 3

* Identification of thrust areas
* Developing a mathematical model for solving the above problem
* Finalisation of system requirements and specification
* Proposing different solutions for the problem based on literature survey
* Future trends in providing alternate solutions
* Consolidated report preparation of the above

IV SEMESTER

15CS72/15CN72 PROJECT WORK – PHASE II

0 0 28 14

The Project work involves the following:

* **Preparing a project – brief proposal including**
  Problem Identification

Methodology specifying the process/specifications/parameters
List of alternate methodology if available
Justification for the methodology adopted
Time line of activities

* **Carrying out experimental/theoretical work as per the specified time line of activities.**
* **A presentation including all the above along with final results and conclusions.**
* **Consolidated report preparation.**

ELECTIVE THEORY COURSES

15CS21/15CN22 BRIDGE ENGINEERING

3 0 0 3

INTRODUCTION: Definition and components of a bridge – layout and planning of a bridge – classification – investigation of a bridge – preliminary data collection – choice and type of a bridge – hydraulic design of a bridge – traffic design - loading – highway and railway loading – specification. (9)

SUBSTRUCTURE AND BEARINGS: Piers and abutments – bridge bearings – steel rocker and roller bearings – reinforced concrete rocker and roller bearings – elastomeric bearings. (9)

SUPERSTRUCTURE:

REINFORCE CONCRETE BRIDGES: Straight and curved bridge decks – decks of various types – slab hollow and voided slab – beam – slab box – reinforced concrete slab bridges – load distribution – Pigeaud's theory – skew slab deck – RC tee beam and slab bridge – Continuous beam bridge – Fixed point method- influence lines – Balanced Cantilever bridge – rigid frame bridge – box girder bridge – Bow string girder bridge. (5)

PRESTRESSED CONCRETE BRIDGES: Pre-stressed concrete bridge – Analysis and design for static , moving and dynamic loading. (5)

STEEL BRIDGES: Plate girder bridge – box girder bridge – truss bridge – influence lines for forces in members – suspension bridge – cable stayed bridge – Analysis for static, moving and dynamic loading. (9)

PRESTRESSED CONCRETE BRIDGES: Composite beam bridge.

CONSTRUCTION AND MAINTENANCE: Construction methods – short span – long span – false work for concrete bridges – construction management – inspection and maintenance – lessons from bridge failures – rehabilitation of a bridge – load testing of bridges (8)

Total L : 45

REFERENCES:

1. Johnson Victor D, "Essentials of Bridge Engineering", Oxford & IBH publishing co. Pvt. Ltd., New Delhi, 1999.
2. Krishna Raju N, "Design of Bridges", Oxford Publishing co Pvt. Ltd., New Delhi, 1998.
3. Bakht B and Jaeger L G, "Bridge Deck Analysis Simplified", McGraw-Hill, International Students' edition, Singapore, 1987.
4. Ponnuswamy S, "Bridge Engineering", Tata McGraw-Hill Pub co., New Delhi, 1986.
5. Raina V K "Concrete Bridge Practice", Tata McGraw-Hill publishing co, New Delhi, 1991.
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15CS22 FINITE ELEMENT METHOD

3 0 0 3

INTRODUCTION: Concepts - Two dimensional truss element – algorithm to generate stiffness matrix – Assembly & Boundary conditions.

NUMERICAL METHODS:– Gaussian elimination method – band and skyline form of storage – band solver – interpolation – Lagrangian and Hermitian – Numerical integration using Gaussian quadrature. (7)

ENERGY PRINCIPLES AND METHOD OF WEIGHTED RESIDUAL: Variational principles - Rayleigh Ritz method - Method of collocation - Subdomain method - Galerkin`s method - Method of least squares.

CONVERGENCE & COMPATIBILITY REQUIREMENTS: Properties of single element - assumed displacement field - various element shapes - Pascal triangle - Melosh criteria. (5)

ELEMENT STIFFNESS IN PLANE STRESS/STRAIN: Constant strain triangle - Element stiffness matrix -Various method of evaluating element stiffness - Higher order triangular elements - comparison of different methods - rectangular element - serendipity family - Lagrangian family - Hermitian family. (6)

ISO PARAMETRIC ELEMENTS: sub- iso – super parametric elements – shape functions mapping – linear Iso-parametric quadrilateral. – Simple problems - Axisymmetric stress analysis Concepts. (5)

THREE DIMENSIONAL ELEMENTS: Tetrahedron element family - Hexahedron element family- ZIB8 and ZIB 20 elements – comparison. (5)

PLATE/SHELL ELEMENTS: Triangular and rectangular elements - BFS element – Concepts of Shell elements - Degenerated shell elements - **FINITE STRIP METHOD:** Development of stiffness matrix and consistent load vector - Application to folded plates and bridges decks. (6)

NONLINEAR ANALYSIS: Types of non-linearities - solution techniques - stability analysis - Load deformation response considering geometric, material and both non-linearities– Newton Raphson and Riks Wempner methods - eigen value analysis. (6)

APPLICATION TO FIELD PROBLEMS: Finite Element Modelling - Field problems such as seepage - torsion etc - programming organization of finite element schemes - mesh generation aspects, adaptive mesh refinement- software packages - Introduction to meshless methods – principles-applications. (5)

Total L: 45

REFERENCES:

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2. Zienkiewicz O C and Taylor, R L, "The Finite Element Method", Butterworth and Heimann, Vol.1 The basis, Vol.2 Solid mechanics and Vol.3 fluid dynamics , 2000.
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15CS23 ASEISMIC DESIGN OF STRUCTURES

3 0 0 3

INTRODUCTION: Elements of Engineering Seismology – Indian Seismology – Earth Quake History – Catastrophes- Failures – lessons learnt in past Earth Quakes –Review of structural dynamics. (5)

FORCED VIBRATION: Time history and response spectrum method - modal analysis – Earth quake response to linear systems - Response spectrum characteristics – ground motion parameters – lumped mass system – shear building – symmetrical and unsymmetrical buildings. (7)

IS CODE PROVISIONS: Modal response contribution – modal participation factor – Response history – Spectral analysis - Multiple support excitation – introduction to deterministic Earth quake response to continuous systems on rigid base – Approximate methods for lateral load analysis - IS 1893 – 2002 provisions – IS 4326 provisions – Behaviour and design of masonry structures – discussion of codes IS 13827 and 13828. (9)

BEHAVIOUR OF RC STRUCTURES: Capacity design – detailing as per IS 13920 - Behaviour of RC structures – cyclic load – shear wall frame system – Khan and Saboronis method – Coupled shear wall system – Rosman's method – ductility requirements in concrete structures – beam column junction. (8)

BEHAVIOUR OF STEEL STRUCTURES: Behaviour of steel structures – design – cyclic load behaviour – different bracing systems – compact and non compact sections – buckling – beam column joints - Push over analysis - Introduction - Modern concepts – base isolation – soil structure interaction – adaptive structures – case studies - Retrofitting – case studies – reconstruction – rehabilitation. (8)

COMPUTER AIDED ANALYSIS AND DESIGN: Computer Analysis and design of Building systems to Earthquake loads – response spectrum and time history methods – Hands on session using packages like SAP2000. (8)

Total L : 45

REFERENCES:

1. Chopra A K, "Dynamics of Structures - Theory and Applications to Earthquake Engineering", Prentice- Hall of India Pvt Ltd., New Delhi, 2002.
2. Agarwal P and Shrikande M, "Earthquake Resistant Design of Structures", Prentice Hall of India, 2006.
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7. Paz M and Leigh W, "Structural Dynamics - Theory and Computation", Springer, 2007.

15CS24 BEHAVIOUR AND DESIGN OF TALL BUILDINGS

3 0 0 3

STRUCTURAL SYSTEMS AND CONCEPTS: History – structural systems and concepts – criteria and loading – materials and construction – Strcutural steel system – reinforced concrete – pre-stressed concrete – composite system – gravity and lateral systems – loads – gravity – wind – earthquake – temperature load – creep – shrinkage – fire loading – blast loading. (7)

GRAVITY SYSTEMS – DESIGN AND BEHAVIOUR: Floor systems in concrete and steel – one way and two way slabs – flat slabs with capitals – prestressed concrete floor – shell systems- bearing walls – composite steel concrete floors – columns – open web truss system in steel – stub girder system. (7)

LATERAL SYSTEMS – DESIGN AND BEHAVIOUR: Static and dynamic approach, analytical method, Wind Tunnel , Earthquake loading – Equivalent lateral load analysis- Response spectrum method, Combination of loads.
SHEAR WALL: Moment resisting frame – braced – shear trsses –shear wall- frame system – framed tube – outrigger – bundled tube system – diagonal trussed tube – mega tube system – approximate methods of analysis – design of frames for lateral load – p-delta effects – detailing of shear walls for ductility . (7)

FRAMED TUBE SYSTEM: Behaviour – approximate methods – preliminary design – design of frame work – design of transfer girders. (5)

OUTRIGGER: Behaviour – approximate methods – belt trusses – columns – dynamics of outrigger systems. (4)

BUNDLED TUBE – DIAGONAL TRUSS – MEGA TUBES:-Behaviour – approximate methods – preliminary design – damping in mega tubes – design of modular tubes. (5)

DESIGN OF CONNECTIONS:- Behaviour of connections – design of moment connections- simple and semi-rigid – beam – column connections- braced frame connection – connections in outriggers – connections for plastic design – design of connection for ductility. (5)

EXPLOSION AND FIRE ON BUILDINGS Review of bombed buildings – explosions – case studies – threats – wave scaling law – fire loading – restraints – codal provisions – limit state and plastic analysis – nonlinear behaviour- Nonlinear finite element – inelastic finite element analysis- design for ductility – plastic design and behaviour – limit analysis – Translational and torsional instability – out of plumb effects – Computer software for tall buildings. (5)

Total L: 45

REFERENCES:

1. Taranath B.S., “Analysis and Desgin of Tall Buildings”, McGraw-Hill co, 1988.
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15CS25 STRUCTURAL STABILITY

3 0 0 3

CONCEPTS OF STABILITY: Introduction – Stability Criteria – Equilibrium , Energy and dynamic approaches- South well Plot – Stability of Link models. (5)

COMPRESSION MEMBERS: Higher order Differential equations –Analysis for Various boundary conditions – behaviour of imperfect column – initially bent column – eccentrically loaded column- Energy method- Rayleigh Ritz , Galerkin methods – Numerical techniques – Newmark’s method – Finite element method- Effect of shear on buckling. (6)

INELASTIC BUCKLING: Introduction – Double modulus theory (reduced modulus) – tangent modulus theory – Shanley’s theory – determination of double modulus for various sections. (6)

BUCKLING OF THIN-WALLED OPEN & CLOSED SECTIONS: Introduction – torsional buckling – torsional flexural buckling – Equilibrium and energy approaches. (5)

LATERAL STABILITY OF BEAMS: Differential equations for lateral buckling – lateral buckling of beams in pure bending – lateral buckling of cantilever and simply supported I beams. (5)

BEAM COLUMNS: Introdution – Beam-columns with concentrated lateral loads – distributed loads – effect of axial loads on bending stiffneess – stability of frames – stability functions – PΔ effect. (6)

STABILITY OF PLATES: Governing Differential equation –Equilibrium, energy concepts – Buckling of plates of various end conditions – Finite difference method – post-buckling strength – finite element method. (6)

ELEMENTS OF NON LINEAR THEORY OF BUCKLING: Perfect Systems – Imperfect Systems – Imperfection in-sensitive and sensitive systems – Symmetric and Asymmetric Bifurcation – non linear analysis of shell and spatial structures – basic concepts. (6)

Total L : 45

REFERENCES:

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5. El Naschie M. S., “Stress, Stability and Chaos in Structural Engineering: An Energy Approach”, McGraw Hill International Editions, 1992.

15CS26/15CN27 OPTIMIZATION TECHNIQUES

3 0 0 3

INTRODUCTION TO OPTIMIZATION: Introduction – Engineering applications of optimization – statement of an optimization problem - classification of optimization problems – introduction to traditional and non-traditional optimization technique. (4)

LINEAR PROGRAMMING : Standard form of a Linear Programming Problem –Geometry of linear Programming Problems – plastic design of frames – Graphical method – simplex method – Basic solution – computation – maximization and minimization. Duality in Linear Programming – General Primal – Dual relations – Dual simplex method – Revised simplex method - sensitivity or post optimality analysis – Transportation problem – Assignment method. (15)

NONLINEAR PROGRAMMING: One dimensional minimization methods – Dichotomous search, Fibonacci method and Golden section method. Unconstrained optimization techniques – classification – Direct search, Pattern search, Cauchy’s steepest Descent method, Conjugate Gradient method and Davidon Fletcher Powell method – Constrained function of a single variable – several variables. (8)

DYNAMIC PROGRAMMING: Multistage decision processes – representation and types – concept of sub optimization and the principle of optimality – conversion of a final value problem into an initial value problem – Linear Programming as a case of dynamic Programming. (8)

GENETIC ALGORITHM AND EVOLUTION STRATEGIES: Introduction – Representation of design variables , objective function and constraints – Choice of population – Genetic operators – survival of the fittest – generation – generation history – application to trusses. (6)

ANT COLONY OPTIMIZATION: Probability – finding the shortest path – pheromone trail – travelling salesman problem – Application to Structural Engineering problems. (4)

Total L : 45

REFERENCES:

1. Rao S.S. “Optimization Theory and Applications”, Wiley Eastern, 1995.
2. Belegundu A.D., “Optimization Concepts and Applications in Engineering”, Pearson Education, 2002.
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15CS27/15CN28 MAINTENANCE AND REHABILITATION OF STRUCTURES

3 0 0 3

INTRODUCTION: Need for study - Types of maintenance – Routine maintenance works in buildings – Inspection – Structural appraisal. (5)

DIAGONISE AND CONDITIONAL ASSESSMENT OF EXISTING STRUCTURE: causes of distresss in concrete structure – holistic models for deterioration of concrete – permeability of concrete – aggressive chemical agents, durability aspects. Conditional survey – visual inspection – field and laboratory testing stage – concrete strength assessment - chemical tests – corrosion potential assessment- interpretation and evaluation of results. (9)

SELECTION OF REPAIR MATERIALS: construction chemicals – repair chemicals – epoxies – polymers and latex – acrylic polymers – polyester resins- corrosion inhibitors as admixture – bonding coats for reinforcement –shrinkage compensating compounds - water proofing compounds. Special materials for construction and repair of buildings and special methods of placing concrete. (8)

REPAIR OF STRUCTURAL ELEMENTS: Repair of RC Slabs, RC beams and columns damaged by steel corrosion, Repair against rising dampness and efflorescence in masonry wall, repair of cracks in masonry wall and concrete member. (8)

REPAIR OF NON STRUCTURAL ELEMENTS: repair against rainwater leakage in building, renovation of water proofing works of RC flat roofs against rain, repair of valley gutters of sloping roof, leakage of basements due to ground water, leakage of bathing area of toilets, sunken floors of toilets in multistoreyed building. (7)

STRENGTHENING OF EXISTING STRUCTURES: Strengthening of superstructure - Conversion to composite construction – Post stressing – Jacketing – Bonded overlays – Addition of reinforcement – Strengthening of substructure – Underpinning. (8)

Total L: 45

REFERENCES:

1. Varghese P.C, “Maintenance, Repair and Rehabilitation& Minor works of Buildings”, PHI Learning Pvt Ltd, Delhi 2014.
2. Malhotra V.M., “Handbook on Non- Destructive testing of Concrete”, CRC Press, 2014.
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15CS28 SHELL AND SPATIAL STRUCTURES

3 0 0 3

INTRODUCTION TO THEORY OF SHELLS AND SPATIAL STRUCTURES: Definition – Historical development – Types – Materials – practical difficulties – construction – support conditions – cladding – aesthetics - Structural behaviour of thin shells - General specification of shells - Analysis of shells - Membrane theory of shells - Edge disturbances - classification of shells - methods of generating the surface of different shells like conoid, hyperbolic and elliptic paraboloid - . formex data generation of space structure. (7)

DESIGN OF CYLINDRICAL SHELLS: Surface definition - Design of cylindrical shells with edge beam using theory for long shells – Design of cylindrical shell with ASCE manual coefficients - Detailing of reinforcement in shells and edge beams. (7)

DESIGN OF HYPERBOLIC PARABOLOID SHELLS: Geometry of hypar shell - Analysis of membrane forces and moments - Determination of forces - forces in the edge members - types of hyperbolic paraboloid roofs - Design of hypar shell roof of the inverted and tilted inverted umbrella type. (7)

SINGLE AND MULTI-LAYER GRIDS AND DOMES: Advantages – cladding – water drainage – progressive collapse and composite space trusses - Network domes – geodesic domes – double dome – ice dome – erection -connectors - **ORS:** Classification – ball joint systems – socket joint – plate joint – slot joint – shell joint – modular system – composite system – prefabricated systems – patented systems – MERO joints – some simple connectors. (9)

STRESSED SKIN – CABLE SUSPENDED STRUCTURES: Stressed skin steel buildings – stressed skin grids – cable suspended roofs – design of cable roofs – erection of cable roofs – economy – new trends. (7)

ANALYSIS AND DESIGN - Finite element analysis of skeletal structures – approximate methods – optimal design of space structures – Failure of shell and space structures – case histories. (8)

Total L : 45

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1. Ramaswamy G.S, "Design and Construction of Concrete Shell roofs", CBS Publishers & Distributors, New Delhi, 1999.
2. Bairagi N. K., “Shell Analysis”, Kanna Publishers, 1990.
3. Chatterjee B.K., "Theory and Design of Concrete Shells", Chapman and Hall Ltd., London, 1988.
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15CS29/15CN30 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION

3 0 0 3

FORCES AND STRAIN MEASUREMENT: Strain gauge, principle, types, performance and uses. Photo elasticity - principle and applications - Moire Fringe - Hydraulic jacks and pressure gauges - Electronic load cells - Proving Rings - Calibration of Testing Machines. (9)

VIBRATION MEASUREMENTS: Characteristics of Structural Vibrations - Linear Variable Differential Transformer (LVDT) - Transducers for velocity and acceleration measurements. Vibration meter - Seismographs - Vibration Analyzer - Display and recording of signals - Cathode Ray Oscilloscope - XY Plotter - Chart Plotters - Digital Data Acquisition Systems. (9)

ACOUSTICS AND WIND FLOW MEASURES : Principles of Pressure and flow measurements - pressure transducers - sound level meter - Venturimeter and flow meters - wind tunnel and its use in structural analysis - structural modeling - direct and indirect model analysis. (9)

DISTRESS MEASUREMENTS AND CONTROL: Diagnosis of distress in structures - crack observation and measurements - corrosion of reinforcement in concrete - Half cell, construction and use - damage assessment - controlled blasting for demolition. (9)

NON DESTRUCTIVE TESTING METHODS: Load testing on structures, buildings, bridges and towers - Rebound Hammer - acoustic emission - ultrasonic testing principles and application - Holography - use of laser for structural testing - Brittle coating. (9)

Total L: 45

REFERENCES :

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7. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford University Press, 1999.

15CS30 SOIL STRUCTURE INTERACTION

3 0 0 3

SOIL-FOUNDATION INTERACTION: Introduction to soil-foundation interaction problems – Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, Soil response models, Winkler, Elastic continuum, two parameter models, Elastic plastic behaviour, Time dependent behaviour. (8)

BEAM ON ELASTIC FOUNDATION-SOIL MODELS: Infinite beams, two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams based on their stiffness. (10)

PLATE ON ELASTIC MEDIUM: Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates – Simple solutions. (9)

ELASTIC ANALYSIS OF PILE: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap. (9)

LATERALLY LOADED PILE: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Pile raft system, Solutions by influence charts. (9)

Total L : 45

REFERENCES:

1. Selvadurai A.P.S. "Elastic Analysis of Soil Foundation Interaction", Elsevier, 1979.
2. Poulos H.G. and Davis, E.H. "Pile Foundation Analysis and Design", John Wiley, 1980.
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15CS31 THEORY OF PLATES

3 0 0 3

ELEMENTS OF PLATE - BENDING THEORY: Introduction - General behaviour of plates - Assumptions - Small deflection theory of thin plates - Governing differential equation for deflection of plate -Boundary conditions – Kirchoff's theory. (8)

BENDING OF ISOTROPIC RECTANGULAR PLATES: Navier solution for an all - round simply supported rectangular plate subjected to uniformly distributed load, sinusoidal load and Patch load - Levy's solution for a rectangular plate with different boundary conditions and subjected to uniformly distributed load. (10)

BENDING OF CIRCULAR PLATES: Symmetrical bending of circular plates - Simply supported solid circular plate subjected to an uniformly distributed load, an end moment and partially distributed load. (8)

NUMERICAL METHODS: Finite difference method - Isotropic Rectangular plates - Boundary conditions - All round simply supported square plate and fixed square plate subjected to uniformly distributed load. Plates of various shapes - Rectangular plate - All round clamped square plate subjected to an uniform load. (10)

ADVANCED TOPICS: Bending of anisotropic plates – large deflections of plates - plates on elastic foundation. (9)

Total L: 45

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1. Chandrashekhara, K., "Theory of Plates", Universities Press (India) Ltd., Hyderabad, 2001.
2. Ansel C. Ugural, "Stresses in Plates and Shells", second edition, Mc Graw-Hill International Editions, 1999.
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5. Bairagi N. K., "A text book on Plate Analysis", Kanna Publications, 1986.

15CS32 INDUSTRIAL STRUCTURES

3 0 0 3

PLANNING AND FUNCTIONAL REQUIREMENTS: Classification of Industries and Industrial Structures – planning for layout requirements regarding lighting, ventilation and fire safety - protection against noise and vibration – guidelines from factories act – material handling systems - structural loads. (10)

SINGLE STOREY INDUSTRIAL STRUCTURES: Types of roofing – roofing sheets – purlins – light gauge sections – built-up sections – roof trusses – pre-engineered structures. Foundations for industrial structures. (8)

MATERIAL HANDING SYSTEMS: Cranes – Types design of EOT over head travelling cranes, zib cranes and Goaliath cranes. Design of Gantry girders for over head cranes. Conveyor systems – Supports for conveyor systems. (9)

INDUSTRIAL STORAGE STRUCTURES: Silos, Bins and Bunkers – Design of supporting system for storage hoppers and bunkers. (9)

ENVIRONMENTAL CONTROL STRUCTURES FOR INDUSTRIES : Various components – Concept of Electro Static Precipitators functioning and components – Wet and dry Scrubbers – Chimneys – Self supporting, Guyed and Braced chimneys. (9)

Total L: 45

REFERENCES:

1. Alexander Newman, "Metal Building Systems – Design and Specifictions", Mc Graw Hill, New Delhi, 2004.
2. Gaylord E. H., Gaylord N. C. and Stallmeyer J. E., "Design of Steel Structures", McGraw Hill Publications, 1992.
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4. Subramanian N., "Design of Steel Structures", Oxford University Press, New Delhi 2008.

15CS33 MECHANICS OF COMPOSITE MATERIALS

3 0 0 3

INTRODUCTION: Classification – polymer- metal – ceramic – carbon-carbon – recycling of fiber reinforced composites – mechanics terminology – advantages. (7)

MACROMECHANICS OF COMPOSITES: Stess and strain – Hooke's law - Engineering Constants of angle lamina – strength failure theories – Tsai – Hill failure theory – Tsai –Wu failure theory – Hygrothermal stresses. (7)

MICROMECHANICAL ANALYSIS OF A LAMINA: Volume and mass fraction – density – evaluation of elastic moduli – semi-empirical models – elasticity approach – ultimate strength of uni-directional lamina – coefficients of thermal expansion. (8)

MICROMECHANICAL ANALSYSIS OF LAMINATE : Introduction – laminate code – stress –strain for a laminate – in-plane and flexural modulus of a laminate – hygrothermal effects – warpage of laminates. (8)

FAILURE, ANALYSIS AND DESIGN OF LAMINATES: Special cases of laminates – symmetric – cross-ply , angle –ply, antisymmetric , Balanced , Quasi-isotropic – failure criterion- design of a laminated composite – long term environmental effects – interlaminar stress – impact resistance – fracture resistance – fatigue resistance. (8)

SOFTWARE PACKAGES: Lamina properties and database – macromechanical analysis of a lamina – micromechanical analysis of a lamina – macromechanical analysis of a laminate – properties of thin-walled section made of laminates – static , buckling and vibration analysis of beams, plates and shells made of composite materials using packages. (7)

Total L: 45

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1. Kaw A.K. "Mechanics of Composite Materials", CRC Press, 1997, USA.
2. Jones R.M., "Mechanics of Composite Materials", McGraw-Hill Koghkusha Internation students, 1975.
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15CS34 SOFT COMPUTING IN STRUCTURAL ENGINEERING

3 0 0 3

INTRODUCTION TO ARTIFICIAL INTELLIGENT SYSTEMS: Neural Networks – Fuzzy logic - genetic algorithm. (7)

NEURAL NETWORKS: Basic Concepts - Artificial Neural Network (ANN) Architecture - Learning Methods -Back Propagation Network (BPN)- Single layer ANN - Multilayer Perception - Learning Method of Effect of tuning parameters - New technologies - application to Structural Engineering. (6)

ASSOCIATIVE MEMORY AND ADAPTIVE RESONANCE THEORY: Kosko's Discrete (Bi-directional Associative Memory) BAM - input normalization - Evolution Equation - vector quantization - simplified ART architecture - Architecture of ART1 and ART2 - Application to structural engineering problems. (6)

FUZZY LOGIC: Fuzzy sets and relations - Predicate logic - Fuzzy quantifiers - Fuzzy Rule based systems - Defuzzification method - Application to controllers- Application to Structural Engineering problems. (6)

GENETIC ALGORITHMS: Basic concepts - incoding - Equation functions - genetic operators - reproduction - selection - cross over - mutation - convergence of GA - optimal design using GA - Application to structural engineering problems. (6)

HYBRID SYSTEMS: Neuro - Fuzzy Hybrids - Fuzzy genetic hybrids - Neuro genetic hybrid - Fuzzy BPN - Fuzzy Art Map - Fuzzy controlled GA. (7)

SUPPORT VECTOR MACHINES: Support vector regression – Classifications. (7)

Total L: 45

REFERENCES:

1. Rajasekaran S. and Vijayalakshmi Pai G. A., "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India, New Delhi, 2004.
2. Adeli H. and Hung S. L., "Machine Learning, Neural Networks, Genetic Algorithms and Fuzzy Systems, John Wiley and Sons, New York, 1995.
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5. Tsoukalas H. L. and Uhrig E. R., "Fuzzy in Neural Approaches in Engineering", John Wiley and Sons, USA, 1997.
6. Gunn S. R., "Support Vector Machines for Classification and Regression", Technical report ISIS-I-98 - University of Southampton, 1998.

15CS35 GEOTECHNICAL EARTHQUAKE ENGINEERING

3 0 0 3

SEISMIC HAZARDS AND DYNAMIC SOIL PROPERTIES: Seismic Hazards – Dynamic soil properties – Representation of state of stresses by Mohr circle, Measurement of soil properties – Field and laboratory tests – Stress-strain Behaviour of cyclically loaded soils and their strength. (8)

LIQUEFACTION: Liquefaction and its related phenomena, Evaluation of liquefaction hazards, Liquefaction susceptibility – Historical, geologic, compositional and state criteria – Initiation of liquefaction, Effects of liquefaction – Alteration of ground motion, sand boils, settlement and instability. (8)

SEISMIC SLOPE STABILITY: Types of earthquake induced landslides, Earthquake induced landslide activity, Evaluation of slope stability. Review of static slope stability analysis, Seismic slope stability analysis – Analysis for inertial and weakening instability. (7)

SEISMIC DESIGN OF RETAINING WALLS: Review of calculation of static pressures on retaining walls, Dynamic response of retaining walls, Seismic pressures on retaining walls – Yielding and non yielding walls, Effect of water, finite element analysis, Seismic displacements on retaining walls, seismic design considerations. (8)

DYNAMIC ANALYSIS OF SOLID WASTE LANDFILLS AND LINING SYSTEMS: Performance of solid waste landfills during earthquakes, Analysis of solid waste landfills stability during earthquakes, Monitoring and safety control of landfills, Safety and risk analyses. (7)

SOIL IMPROVEMENT FOR REMEDIATION OF SEISMIC HAZARDS: Densification techniques – vibro techniques, dynamic compaction, blasting, compaction grouting, Reinforcement techniques – stone columns, compaction piles, Grouting and mixing techniques, drainage techniques, Verification of soil improvement by laboratory and in situ testing. (7)

Total L: 45

REFERENCES:

1. Kramer S. L., "Geotechnical Earthquake Engineering", Pearson Education (Singapore) Private. Ltd. (Indian Branch), New Delhi, 2003.
2. Ansal A., "Recent Advances in Earthquake Geotechnical Engineering and Microzonation", Kluwer Academic Publishers, The Netherlands, 2004.
3. Prasad B. B., "Fundamentals of Soil Dynamics and Earthquake Engineering", PHI Learning Private Limited, New Delhi, 2009.

15CS36 RELIABILITY ANAYSIS AND PERFORMANCE BASED DESIGN

3 0 0 3

INTRODUCTION TO PROBABILITY THEORY: Basic statistics – histograms – sample correlation – Random events and variables functions of random variables – moments and expectation – common probability distributions–external distributions. (9)

RESISTANCE DISTRIBUTION AND PARAMETERS: Statistics of properties of concrete – statistics of properties of steel – statistics of strength of bricks and mortar – dimensional variations – characterization of variables – allowable stress based on specified reliability. (9)

STRUCTURAL RELIABILITY AND SAFETY: Probabilistic analysis of loads, Gravity load, live load and wind load. Computation of reliability – Monte carlo method of structural safety – applications, Level 2 reliability methods – first order second moment methods (FOSM). (9)

RELIABILITY BASED DESIGN: Determination of partial safety factors, code calibration, reliability of structural system; Applications to steel and concrete structures. (9)

PERFORMANCE BASED DESIGN: Concepts of Performance based design. Applications to Bridge structures – Long term effects – Examples. (9)

Total L: 45

REFERENCES:

1. Ranganathan R., "Reliability Analysis and Design of Structures", Tata McGraw – Hill Publishing Company Limited, 1990.
2. Fabio Casciati and John Brian Roberts, "Mathematical Models for Structural Reliability Analysis", Contributor: John Brian Roberts, CRC Press, 1996.

3. Qing Quan Liang and Quan Liang Qing, “Performance-Based Optimization of Structures: Theory and Appplications”, Taylor & Francis, 2004.
4. Wai-Fah Chen, “Lian Duan Bridge Engineering Handbook”, CRC Press, 1999.
5. FEMA Documents FEMA-273 Seismic Rehabilitation Guidelines.
6. Milton E. Harr, “Reliability – Based d Design in Civil Engineering”, Dover Publications Inc., 1997.
7. Madsent H.O. Krenk,. S. and Lind N.C., “Methods of Structural Safety”, Dover Publications, 2003.

ONE CREDIT COURSES

For the detailed syllabi of the electives and one credit courses offered by other departments refer to the syllabi of M.E- Automotive Engineering offered by Automobile Engineering Department.