PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

M.E. STRUCTURAL ENGINEERING (PART TIME)

REGULATION 2016

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

SEMESTER III

Course Code	Course Title	L	T	P	C
PSE16103	Advanced Reinforced Concrete Structures	3	2	0	4
PSE1615*	Elective I	3	0	0	3
PSE1625*	Elective II	3	0	0	3
	Total	**9**	**2**	**0**	**10**

SEMESTER IV

Course Code	Course Title	L	T	P	C
PSE16204	Finite Element Method	3	2	0	4
PSE1635*	Elective III (Open)	3	0	0	3
PSE1645*	Elective IV	3	0	0	3
PSE16205	Advanced Structural Engineering Laboratory	0	0	4	2
	Total	**9**	**2**	**4**	**12**

LIST OF ELECTIVES

ELECTIVE I

Course Code	Course Title	L	T	P	C
PSE16151	Matrix Methods of Structural Analysis	3	0	0	3
PSE16152	Advanced Concrete Technology	3	0	0	3
PSE16153	Design of Tall Buildings	3	0	0	3
PSE16154	Structural Optimization	3	0	0	3

ELECTIVE II

Course Code	Course Title	L	T	P	C
PSE16251	Maintenance and Rehabilitation of Structures	3	0	0	3
PSE16252	Non - linear Analysis of Structures	3	0	0	3
PSE16253	Smart Structures	3	0	0	3

ELECTIVE III (OPEN)

Course Code	Course Title	L	T	P	C
PSE16351	Energy Efficient Structures	3	0	0	3
PSE16352	Structures in Disaster Prone Areas	3	0	0	3
PSE16353	Construction Safety and Management	3	0	0	3
PSE16354	Financial Management	3	0	0	3

ELECTIVE IV

Course Code	Course Title	L	T	P	C
PSE16451	Design of Sub Structure	3	0	0	3
PSE16452	Experimental Techniques and Instrumentation	3	0	0	3
PSE16453	Computer Aided Analysis and Design of Structures	3	0	0	3
PSE16454	Design of Bridges	3	0	0	3

SEMESTER III

PSE16103 ADVANCED REINFORCED CONCRETE STRUCTURES 3 2 0 4

COURSE OBJECTIVES

- To simplify a standard reinforced concrete building into a number of manageable idealized substructures, structural elements and to construct their load paths.
- To interpret ultimate and serviceability limit state approaches in current structural design philosophy.
- To estimate primary design loads on structural elements such as beams and columns consulting appropriate standards and handbooks.
- To combine primary design load cases as per design standards to find critical load combination that governs design.
- To model building structure and analyze structural elements for design actions such as design bending moment, designs shear force and deflections.

UNIT I DESIGN REGULATIONS 15

Review of limit state design of beams, slabs and columns according to IS code – serviceability limit state - Deflection and cracking – Calculation of deflection and crack width according to IS Code.

UNIT II DESIGN OF SPECIAL RC ELEMENTS 15

Design of slender columns – Design of RC walls – Strut and tie method of analysis for corbels and deep beams - Design of corbels, deep beams and girds floors.

UNIT III FLAT SLABS AND YIELD LINE THEORY 15

Design of column – Supported Slabs (with/without Beams) under Gravity Loads – Direct design method - Equivalent frame method – Shear and column – Supported two – way slabs – Design of spandrel beams - Yield line theory and Hillerborg's strip method of design of slabs.

UNIT IV PLACTIC DESIGN 15

Limit analysis – Moment redistribution – Codal recommendations for moment redistribution – Baker's method of plastic design – Design of cast –in-situ joints in frames.

UNIT V DETAILING AND FIELD PRACTICE 15

Detailing for ductility – Measures of ductility – Flexural yielding in frames and walls – Flexural members in ductile fames – Columns and frame members subject to bending and axial load – Joints in ductile frames - Shear walls – Fire resistance of structural members – Code requirements – Quality control of concrete.

TOTAL PERIODS 75

COURSE OUTCOMES

At the end of this course,studends will be able to

- understandand analyze the behaviors of reinforced concrete subjected to flexure, shear and axial loading.
- identity underlying plastic concepts in modern concrete design methods
- designreinforced concrete beams, slabs and columns in accordance to IS code.
- enumeratethe concept of reinforced concrete, using moment redistribution and Baker's method.
- producedesign calculations and drawings in appropriate professional formats.

REFERENCES

1. UnnikrishnaPillai and DevadasMenon " Reinforced concrete Design", Tata McGraw Hill Publishers Company Ltd., New Delhi,2010.
2. Varghese. P.C., "Limit State Design of Reinforced Concrete", Prentice Hall of India, 2007.
3. Varghese, P.C., "Advanced Reinforced Concrete ", Prentice Hall of India, 2005.
4. Dr.B.C.Punmia, Ashok kumar Jain, "Limit state design of Reinforced Concrete ", Laxmi Publications (P) Ltd, New Delhi,2007.
5. Sinha.N.C and Roy S.K., " Fundamentals of Reinforced Concrete" , S.Chand and Company Limited, New Delhi, 2003.
6. IS:13920-1993 – Ductile detailing of reinforced concrete structures subjected to seismic forces – Code of practice.
7. IS:456:2000 – Indian Standard Code of Practice for Plain and Reinforced Concrete.
8. SP16 – Design Aid for RC to IS 456 – 1978.

WEB LINKS

1. https://www.youtube.com/watch?v=pIdaC_16H_M
2. http://en.wikipedia.org/wiki/Reinforced_concrete
3. http://searchworks.stanford.edu/view/317818

ELECTIVE I

PSE16151 MATRIX METHODS OF STRUCTURAL ANALYSIS 3 0 0 3

COURSE OBJECTIVES

- To develop flexibility and stiffness matrices for the single and two coordinate system.
- To transform stiffness and flexibility matrices from system coordinate to element coordinate
- To expose flexibility method and its application to pin jointed plane truss, continuous beams, frames and grids.
- To develop stiffness matrix and their application to two and three dimensional pin- jointed trusses.
- To analyse substructures by iteration methods.

UNIT I FUNDAMENTAL CONCEPTS- STIFFNESS AND FLEXIBILITY 9

Introduction-Force and displacement measurement - Generalized or Independent measurement - Constrained or Dependent measurements- Behaviour of structures - Principle of superposition - Methods of Structural analysis - Introduction structure with single coordinate - Two coordinates - Flexibility and stiffness matrices in N coordinates- Examples, symmetric nature of matrices - Stiffness and flexibility matrices in constrained measurements - Stiffness and flexibility of systems and elements - Computing displacements and forces from virtual work- Computing stiffness and flexibility coefficients.

UNIT II ENERGY CONCEPTS & TRANSFORMATION IN STRUCTURES 9

Strain energy in terms of stiffness & flexibility matrices - Properties of stiffness and flexibility matrices - Interpretation of coefficients - Betti's law (forces not at the coordinates) - Other energy theorems - Using matrix notations - Determinate, indeterminate structures - Transformation of system forces to element forces - Element flexibility to system flexibility -System displacement to element displacement - Element stiffness to system stiffness - Transformation of forces and displacements in general - Stiffness and flexibility in general - Normal coordinates and orthogonal transformation - Principle of contragradience.

UNIT III FLEXIBILITY METHOD 9

Statically determinate structures - Indeterminate structures - Choice of redundant leading to ill and well-conditioned matrices - Automatic choice of redundant- Rank technique - Transformation to one set of redundant 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 -Grids.

UNIT IV STIFFNESS METHOD 9

Introduction - Development of the stiffness method - Stiffness matrix for structures with zero force at some coordinates- Analogy between flexibility and stiffness - lack of fit - Stiffness matrix with rigid motions - Application of stiffness approach to pin jointed plane & space trusses - Continuous beams - Frames - Grids - Space frames introduction only - Static condensation technique- Choice of method - Stiffness or flexibility - Direct stiffness approach - Application to two & three dimensional pin- Jointed trusses.

UNIT V ANALYSIS BY SUBSTRUCTURES &ITERATION 9

Analysis by substructures using the stiffness & the flexibility method with tridiagonalisation - Iteration method for frames with non-prismatic members - Iteration method applied to rigidly connected members - Computer program for the analysis of rigidly connected beams - Efficiency of the iteration method.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- understandthe basic concept of flexibility and stiffness, principle of superposition and methods of structural analysis.
- transformthe flexibility and stiffness matrices from system coordinates to element coordinates.
- identifythe degree of freedom and ability to formulate flexibility matrix of components of structure.
- formulatethe stiffness matrix and apply to 2D and 3D structure.
- analysethe frame through the iteration methods.

REFERENCES

1. Rubinstein F.M., "Matrix Computer methods of Structural Analysis", Prentice Hall, 1966.
2. William Weaver JR. and James M. Gere, "Matrix Analysis of framed Structures", CBS Publishers and Distributers,1990.
3. ManickaSelvam V.K, "Elements of Matrix Stability Analysis of Structures", Khanna Publishers, 2006.
4. Pandit G.S, Gupta S.P, "Structural Analysis-A matrix Approch", Tata McGraw Hill Publishing Company Ltd, 2008.
5. C. Natarajan and P.Revathy, "Matrix methods of structural analysis, (Theory and Practice)", PHI Publications, 2011

WEB LINKS

1. https://www.youtube.com/watch?v=O1LwyvdZdCc
2. https://en.wikipedia.org/wiki/Direct_stiffness_method
3. http://www.pucmmsti.edu.do/websise/estudiante/materias/201220131/ST-IC%20-424-T-01/Analisis%20Matricial,%201de%203.pdf

PSE16152 ADVANCED CONCRETE TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

- To summarize the properties of concrete making materials such as cement, aggregates and admixtures.
- To categories the properties and tests on fresh and hardened concrete.
- To acquire the practical knowledge on mix design principles, concepts and methods.
- To get an adequate knowledge about the special concretes and their applications in the diverse Construction field.
- To study the concrete manufacturing processes, concreting methods and different special formworks.

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UNIT I MATERIALS FOR CONCRETE 9

Cement-Manufacturing - Types and grades of cement - Chemical composition - Hydration of cement - Micro structure of hydrated cement – Testing of cement – Special cements – Aggregates – classification - IS Specifications – properties – Grading and specified grading – Methods of combining aggregates – Testing of Aggregates – Water – Physical and chemical properties – Admixtures – Chemical & mineral admixtures - Mineral additives.

UNIT II PROPERTIES OF CONCRETE 9

Properties of fresh concrete – Workability – Segregation – Bleeding – Latiance – Tests on fresh concrete - Properties & tests on hardened concrete – Structural properties – Strength, factors affecting the strength of Concrete – Maturity of concrete, modulus of elasticity, creep – Shrinkage, factors affecting creep and shrinkage concrete – Micro structure of concrete – Micro cracking – Testing of existing and aged structures using NDT - Variability of strength in concrete – Durability of concrete – Chemical attack on concrete.

UNIT III CONCRETE MIX DESIGNS 9

Principles of mix design – Methods of concrete mix design – Factors influencing mix proportions – IS, ACI and British methods of mix design – Statistical quality control – Sampling and acceptance criteria.

UNIT IV SPECIAL CONCRETES 9

Light weight concrete and types – Fly ash concrete – Fibre reinforced concrete types & applications - Sulphur concrete – Sulphur impregnated concrete – Polymer concrete & its types – Super plasticized and hyper Plasticized concretes – Epoxy resins and screeds, properties – Their applications in rehabilitation works - High Performance concrete, high performance fibre reinforced concrete – Roller compacted concrete – Self - Concrete and its applications – Bacterial concrete – Recycled aggregate concrete – Smart concrete - Ferro cement and its applications.

UNIT V CONCRETING METHODS 9

Concrete manufacturing process – Stages of manufacturing – Transportation, placing and curing methods - Extreme weather concreting – Special concreting methods – Vacuum dewatering – Underwater concreting - Special form work types.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- executeand test the concrete made with cement, aggregates and admixtures.
- describethe properties and durability of hardened concrete.
- executemix proportioning of concrete and describe how the strength of concrete can be modified by changing the proportions..
- usesuitable concrete for different structures considering the prevailing weathering conditions.
- decidethe correct concreting methods in the field depending upon the requirement and site conditions.

REFERENCES

1. Shetty.M.S., "Concrete Technology: Theory and Practice" ,S. Chand and Co. Pvt Ltd, Delhi, 2005
2. Santhakumar A.R., "Concrete Technology", Oxford University Press India, 2006.
3. Neville A.M., "Properties of Concrete ", Prentice Hall,5th Edition 2012.
4. Piett-Claude Aitcin, "High Performance Concrete", Talyor& Francis, 2011.
5. Mary KrumboltzHurd, "Formwork for Concrete", American Concrete Institute, 2005.
6. IS: 10262-2009, Indian Standard " Concrete Mix Proprotioning- Guide Lines" (First Revision)
7. IS: 456-2000, Plain and Reinforced Concrete-code of Practice (4th Edition)
8. Charts from ACI211.1-91-1991-American Standard Practice for normal, heavy weight and mass concrete, ACI Committee211.
9. Charts from DOE 1988 Teychenne,D.C, Franklin,R.E and Erntroy,H C. British code of Practice for Design of normal concrete mixes, Department of the Environment (DOE),UK,HMSO,1975 (1988).

WEB LINKS

1. https://en.Wikipedia.org /Wiki/Advance_Concrete
2. http://WWW.Concretematerialscompany,com/concrete
3. http://WWW.engineeringcivil.com/concrete-mix-design-calculations.html

PSE16153 **DESIGN OF TALL BUILDINGS** **3 0 0 3**

COURSE OBJECTIVES

- To paraphrasevarious aspects of planning of tall buildings and know about different types of loads
- To establish various structural systems for high rise buildings with their behaviour and analysis.
- To Illustrateknowledge about analysis involved in tall structures.
- To formulate about sectional shapes and design for differential movement, creep and shrinkage effects.
- To impart knowledge about stability analysis of various systems and to know about advanced topics.

UNIT I DESIGN PRINCIPLES AND LOADING **9**

General - Factors affecting growth, height and structural form - Design philosophy - Loading - Gravity loading - Wind loading - Earthquake loading - Combinations of loading - Strength and Stability - Stiffness and drift limitations - Human comfort criteria- Creep effects - Shrinkage effects - Temperature effects - Fire - Foundation settlement - Soil- structure interaction, Material.

UNIT II BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS **9**

High rise behaviour - Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, futrigger - braced and hybrid mega systems

UNIT III ANALYSIS OF TALL BUILDINGS **9**

Modeling for analysis - Assumptions - Modeling for approximate analyses - Modeling for accurate analysis - Reduction techniques - Dynamic analysis - Response to wind loading - Along-wind response - Across-windresponse - Estimation of natural frequencies & damping - Types of excitation - Design to minimise dynamic response - Response to earthquake motions - Response to ground accelerations - Response spectrum analysis - Estimation of natural frequencies and damping - Human response to building motions.

UNIT IV STRUCTURAL ELEMENTS **9**

Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow - Design for differential movement - creep and shrinkage effects - temperature effects and fire resistance.

UNIT V STABILITY **9**

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

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course the student will be able to

- know design principles and different types of loading
- describethe various structural systems used in the construction of tall structures.
- capable of analysing the tall structures
- design of structural elements for secondary effects
- executestability analysis, overall buckling analysis of frames, analysis for various secondary effects such as creep, shrinkage and temperature.

REFERENCES

1. Bryan Stafford Smith and Alexcoull, "Tall Building Structures - Analysis and Design", John Wiley and Sons, Inc., 1991.
2. Taranath B.S., "Structural Analysis and Design of Tall Buildings", McGrawHill, 2011.'
3. Gupta.Y.P.,(Editor), Proceedings of National Seminar on High Rise Structures- Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi,1995.
4. Lin T.Y and Stotes Burry D, "Structural Concepts& systems for Architects and Engineers", John Wiley, 1988.

WEB LINKS

1. http://www.sciencedirect.com/science/article/pii/S0307904X09003813
2. http://www.sciencedirect.com/science/article/pii/S016761050700089X
3. http://www.crcnetbase.com/isbn/9781439850893

PSE16154 STRUCTURAL OPTIMIZATION 3 0 0 3

COURSE OBJECTIVES

- To describe the fundamentals of optimization concepts and their applications in the Structural Engineering field.
- To categorize the linear programming methods of the optimization.
- To discriminate the constrained and unconstrained variables of the various Structural Engineering problems.
- To prepare the various methods of optimality involving geometric and dynamic programming.
- To summarize on the various advanced techniques in the structural optimization.

UNIT I OPTIMIZATION FUNDAMENTALS 9

Optimization methods – Introduction, Problem formulation, Introduction to mathematical principles in optimization – Mathematical models – Activity – Design methodology – Civil Engineering case study - Unconstrained functions – Single variable – Several variable – Equality constraints – Inequality constraints - Optimization – Design space – Feasible and Infeasible – Convex and Concave – Active constraints – Local and global optima – Differential calculus – Optimality criteria – Lagrange multiplier method – Kuhn Tucker criteria.

UNIT II LINEAR PROGRAMMING 9

Formulation of problems – Graphical solution – Analytical methods – Standard form – Slack, surplus and artificial variables – Canonical form – Basic feasible solution – Simplex method – Two phase method – Penalty Method – Duality theory – Primal – Dual algorithm.

UNIT III NON-LINEAR PROGRAMMING 9

Introduction to non-linear problems – One dimensional minimization methods – Unimodal function - Exhaustive and unrestricted search – Dichotomous search – Fibonacci method – Golden section method - Interpolation methods – Unconstrained multivariable function – Univariate method – Cauchy's steepest descent Method – Conjugate gradient method (Fletcher Reeves) – Variable metric methods (Davison-Fletcher-Powell) – Direct and indirect methods – Interior penalty functions – External Penalty function method.

UNIT IV GEOMETRIC PROGRAMMING AND DYNAMIC PROGRAMMING 9

Geometric programming – Polynomial – Degree of difficulty – Reducing G.P.P. to a set of simultaneous equations – Concepts of solving problems with zero and one degree of difficulty – Dynamic programming - Bellman's principle of optimality – Representation of a multi-stage decision problem – Concept of sub - optimization problems – Truss optimization.

UNIT V NON-TRADITIONAL METHODS 9

Genetic algorithm – Terminology – Natural law of evolutions – Genetic operators – Steps for solution of problems – Simulated Annealing – Algorithm – Boltzman's equation – ANT Colony optimization – Algorithm Pheromone trail – Travelling salesman problem – Introduction to TABU search – Sample problem – Artificial Neural network – Application characteristics.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- applythe basic ideas in optimization to make the structures as lightly as possible.
- classifythe linear programming techniques in engineering optimization.
- formulatethe unconstrained and constrained optimization problems in structural design.
- identifythe methods in solving the problems related to Geometric and Dynamic programming.
- standardizein advanced techniques of optimization such as Generic algorithm and Artificial Neural networks.

REFERENCES

1. Rao. S.S., "Optimization Theory and Applications", New Age International Private Limited Publisher, New Delhi, 2002.
2. Belegundu, A.D. and Chandrapatla, T.R., "Optimization Concepts and Applications in Engineering", Pearson Education, 2011.
3. Deb K, "Optimization for Engineering Design", Algorithms and examples, Prentice Hall, New Delhi, 2012.
4. Arora J.S., "Introduction to Optimum Design", McGraw-Hill Book Company, 2011.
5. Taha, H.A., "Operations Research – An Introduction", Prentice Hall of India, 2004.

WEB LINKS

1. http://www.structures.ethz.ch/education/master/ optimization
2. http://web.mit.edu/16.810/www/16.810_L8_ Optimization
3. http://nptel.ac.in/courses/105108127

ELECTIVE II

PSE16251 MAINTENANCE AND REHABILITATION OF STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To expertise the students to procure the accurate idea about the maintenance of repair strategies of building.
- To identify and apply appropriate structural and construction technologies to rectify maintenance problems.
- To formulate the students comprehend the basic concepts related to materials available for repair.
- To articulate the students to deal in practice with the recent repair and demolition.
- To create an ability to prepare repair and rehabilitation methods for various deteriorated structure.

UNIT I MAINTENANCE AND REPAIR STRATEGIES 9

Maintenance – Repair and Rehabilitation – Facets of maintenance, importance of maintenance – Various aspects of inspection – Assessment procedure for evaluating a damaged structure – Causes of deterioration

UNIT II SERVICEABILITY AND DURABILITY OF CONCRETE 9

Quality assurance for concrete – Concrete properties – Strength – Permeability – Thermal properties and cracking – Effects due to climate – Temperature – Chemicals – Corrosion – Design and construction errors – Effects of cover thickness and cracking.

UNIT III MATERIALS FOR REPAIR 9

Special concretes and mortar – Concrete chemicals – Special elements for accelerated strength gain – Expansive cement – Polymer concrete – Sulphur infiltrated concrete – Ferro cement – Fibre reinforced concrete.

UNIT IV TECHNIQUES FOR REPAIR AND DEMOLITION 9

Rust eliminators 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 – Methods of corrosion protection – Corrosion inhibitors – Corrosion resistant steels – Coatings and cathodic protection – Engineered demolition techniques for dilapidated structures – Case studies.

UNIT V REPAIRS, REHABILITATION AND RETROFITTING OF STRUCTURES 9

Repairs to overcome low member strength – Deflection, cracking and chemical disruption – Weathering Corrosion, wear, fire, leakage and marine exposure.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- executeand test the concrete made with cement, aggregates and admixtures.
- describethe properties and durability of fresh and hardened concrete.
- executemix proportioning of concrete and describe how the strength of the concrete can be modified by changing the proportions.
- usesuitable concrete for different structures considering the prevailing weather conditions.
- decidethe correct concreting methods in the field depending upon the requirements and site conditions.

REFERENCES

1. Shetty M.S., Concrete Technology – Theory and Practice, S.Chand and Company, New Delhi, 2005.
2. Santhakumar, A.R., Training Course notes on Damage Assessment and repair in Low Cost Housing, "RHDC-NBO", Anna University, July 1992.
3. Raikar, R.N., Learning from failures – Deficiencies in Design, Construction and Service – R&D Centre (SDCPL), RaikarBhavan, Bombay, 1987.
4. Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman scientific and Technical, UK, 1991.
5. Dr. B. Vidivelli, "Rehabilitation of Concrete Structures", Standard Publishers Distributors, 2007.

WEB LINKS

1. http://theconstructor.org/concrete/design-of-concrete-structures-for-durability/7268/
2. http://www.sustainableconcrete.org/?q=node/171
3. http://www.concreteconstruction.net/repair/demolition-the-easy-way.aspx

PSE16252 NON - LINEAR ANALYSIS OF STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To read the concept of nonlinear behaviour of beams and vibrations of beams.
- To distinguish the elastic analysis of statically determinate and indeterminate flexural members
- To differentiate the inelastic analysis of statically determinate and indeterminate flexural members.
- To evaluate the nonlinear analysis of plates and its governing equation.
- To discussthe governing equation of circular and non-circular shells.

UNIT I NONLINEAR BENDING AND VIBRATION OF BEAMS 9

Introduction - Types of nonlinearities - Nonlinear governing equation for beams - Geometrically nonlinear beamproblems - Vibrations of beams with various boundary conditions - Forced vibration of beams - Post buckling -

cantilever column - Behaviour of beams with material nonlinearity - Nonlinear vibration and instabilities of elastically supported beams

UNIT II ELASTIC ANALYSIS OF FLEXURAL MEMBERS 9

Flexural behaviour - Statically determinate and statically - Indeterminate bars - Uniform and varying thickness

UNIT III INELASTIC ANALYSIS OF FLEXURAL MEMBERS 9

Inelastic analysis of uniform and variable thickness members subjected to small deformations – inelastic analysis of flexible bars of uniform and variable stiffness - Members with and without axial restraints

UNIT IV NONLINEAR STATIC AND DYNAMIC ANALYSIS OF PLATES 9

Introduction - Governing nonlinear equations for plates - Boundary conditions and methods of solutions – Large deflection analysis of rectangular and non-rectangular plates - Free and forced vibrations of rectangular and non-rectangular plates - Post buckling behaviour of plates - Effects of transverse shear deformations and material nonlinearity.Introduction - Derivations of governing equations - Circular and noncircular cylindrical shells - Shallow cylindrical shells - Forced nonlinear vibration of shells - Post buckling of shells

UNIT V NONLINEAR ANALYSIS OF SHELLS 9

Introduction – Derivations of governing equations – Circular and noncircular cylindrical shells – Shallow cylindrical shells – Forced nonlinear vibration of shells – Post buckling of shells.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- describethe basic concepts of nonlinearity and its governing equation for various boundary conditions.
- categorize the elastic analysis with various boundary conditionsof thin walled structural members
- compare the inelastic analysis with various boundary conditions of thin walled structural members
- justifystatic and dynamic analysis of plates.
- expressnonlinear analysis of shells.

REFERENCES

1. Reddy.J.N, “Non linear Finite Element Analysis”, Oxford University Press,2008.
2. Sathyamoorthy, M.,”Nonlinear Analysis of Structures”, CRC Press, Boca Raton, Florida, 1997.
3. Fertis, D. G.,”Nonlinear Mechanics”, CRC Press, Boca Raton, Florida, 1998.
4. Majid K.I., “Non Linear Structures”, Butter worth Publishers, London, 1972.
5. Iyengar N G R, “Elastic Stability of Structural elements”, Macmillan India Ltd ,2007.

WEB LINKS

1. http://ocw.mit.edu/resources/res-2-002-finite-element-procedures-for-solids-and-structures-spring-2010/nonlinear
2. https://www.andrew.cmu.edu/course/24-688/handouts/Week%2010%20-%20Nonlinear%20Structural%20Analysis/Lecture%20Material/Week%2010%20-%20Nonlinear%20Structural%20Analysis%20-%20Lecture%20Presentation.pdf
3. http://mostreal.sk/html/guide_55/g-str/gstr8.html

PSE16253 **SMART STRUCTURES** **3 0 0 3**

COURSE OBJECTIVES

- To describe the basic principles and mechanisms of smart materials and devices.
- To demonstrate knowledge and understanding of the physical principles underlying the behavior of smart materials.
- To outline the basic principles and mechanisms of measuring techniques.
- To practice knowledge and understanding of the engineering principles in smart sensors, actuators and transducer technology.
- To propose improvement on the design, analysis, manufacturing and application issues involved inintegrating smart materials and devices.

UNIT I PROPERTIES OF MATERIALS AND ER AND MR FLUIDS 9

Piezoelectric Materials and properties - Actuation of structural components - Shape Memory Alloys - Constitutive modeling of the shape memory effect, vibration control - Embedded actuators - Electro rheological and magnetorheological fluids - Mechanisms and Properties - Fiber Optics - Fibre characteristics - Fiber optic strain sensors

UNIT II VIBRATION ABSORBERS 9

Parallel damped vibration absorber - Gyroscopic vibration absorber - Active vibration, absorber – Applications - Vibration Characteristics of mistuned systems - Analytical approach

UNIT III CONTROL OF STRUCTURES 9

Control modeling of structures - Control strategies and limitations - Classification of control systems - Classical control, Modern control, Optimal control and Digital control - Active structures in practice.

UNIT IV APPLICATIONS IN CIVIL ENGINEERING 9

Design of various types of springs, optimization of helical springs -- rubber springs -- Design of flywheels considering stresses in rims and arms, for engines and punching machines.

UNIT V DESIGN OF BEARINGS &MISCELLANEOUS ELEMENTS 9

Application of shape memory - Alloys in bridges - Concept of smart bridges - Application of ER fluids - Application of MR dampers in different structures - Application of MR dampers in bridges and high rise structures - Structural health monitoring - Application of optical fibres - Concept of smart concrete.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- selectvarious smart materials and devices.
- setup analytical approach on vibration absorbers.
- proposevarious strain measurement using smart materials.
- manipulatecontrol strategies of smart structures.
- applyprinciples of smart structures to civil engineering field.

REFERENCES

1. Gandhi, M.V and Thompson, B.S., “Smart Materials and Structures”, Chapman and Hall,1992.
2. Yoseph Bar Cohen, “Smart Structures and Materials”, The International Society for Optical Engineering, 2003.
3. Srinivasan, A.V., and Michael McFarland. D., “Smart Structures - Analysis and Design”,Cambridge University Press, 2001
4. Brian Culshaw, “Smart Structures and Materials”, Artech House, Boston, 1996.
5. P. Gaudenzi, “Smart Structures: Physical Behavior, Mathematical Modeling and Applications”, MacmillanIndiaLtd ,2007.

WEB LINKS

1. http://www.me.metu.edu.tr/courses/me493
2. http://nptel.ac.in/courses/112104173
3. http://theconstructor.org/structural-engg/smart-structures-and-materials/6/

ELECTIVE III (OPEN)

PSE16351 ENERGY EFFICIENT STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To create awareness of the necessity of energy needed for structures.
- To study the different climate types and their influence in building design.
- To focus on the thermal environment of structures
- To equip the knowledge of appliances and their utilisation in buildings.
- To elucidate the energy audit systems in buildings.

UNIT I ENERGY EFFICIENT CONCEPTS 9

Need of energy in buildings - assessment - Energy consumption pattern of various types of buildings - Factors influencing the energy use in building - Concepts of energy efficient building.

UNIT II CLIMATE 9

Study of Climate types - their influence in building design - Environmental factors affecting building design - Analysis of thermal and visual environment.

UNIT III HEAT AND LIGHT 9

Heat gain and loss phenomenon in buildings - Thermal performance parameters - Role of building enclosures, openings and materials in thermal environment - Basic principles of light and daylight - Energy efficient light design of buildings - Daylight design of buildings.

UNIT IV APPLIANCES IN BUILDINGS 9

Major appliances in building and their energy consumptions - Principles of solar heating, cooling and power (PV) systems - Integration of energy efficient appliances with the buildings.

UNIT V ENERGY AUDIT 9

Energy survey and energy audit of buildings - Calculation of energy inputs and utilization in buildings - Energy audit reports of buildings - Concepts of Green Buildings - energy rating of buildings.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- get introduced to various energy consumptions
- masterthe climate and environmental factors affecting building design.
- gainknowledge of design of buildings according to thermal environment.
- acquirethe skills of utilisation of appliances and the principles behind them.
- obtain the knowledge of energy audit in buildings

REFERENCES

1. Chand, I. and Bhargava,P.K., “The Climatic Data Handbook”, Tata McGraw Hill Publishing Company Limited, New Delhi 1999.
2. Threlkeld, J.L,”Thermal Environmental Engineering”, Printice-Hall, Englewood Cliffs, NJ, 1998.

3. LalJayamaha, “Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance”, McGraw Hill, 2007.
4. Krishnan, A., Baker, N., Yannas, S. and Szokolay, S.V., “Climate Responsive Architecture - A Design Hand Book for Energy Efficient Buildings”, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2001.
5. ShahinVassigh, Jason R. Chandler, “Building Systems Integration for Enhanced Environmental Performance” J. Ross Publishing, 2011.

WEB LINKS

1. https://en.wikipedia.org/wiki/Green_building
2. https://www.wbdg.org/resources/efficientlighting.php
3. http://www.institutebe.com/Green-Net-Zero-Buildings/renewable-energy-advantages.aspx

PSE16352 STRUCTURES IN DISASTER PRONE AREAS 3 0 0 3

COURSE OBJECTIVES

- To know the various types of disaster caused by the nature and disaster prone areas in India.
- To have a knowledge about the response of the structure for various disaster.
- To obtain a brief knowledge about the planning and preparedness for a disaster.
- To equip the knowledge of appliances and their utilisation in buildings. To know about the various modern materials and tools used in disaster reduction.
- To have knowledge about the various organisations involved in disaster management.

UNIT I DISASTER 9

Introduction - Types of disasters - Disaster mitigating agencies and their organization structure at different levels - Overview of disaster situations in India - Vulnerability profile of India and vulnerability mapping including disaster prone areas, communities and places.

UNIT II RESPONSE OF THE STRUCTURE 9

Philosophy for design to resist Earthquake, Cyclone and flood -By-laws of urban and Semi-Urban areas- Traditional and modern structures. Response of dams, bridges, buildings - Testing and evaluation - Classification of structures from safety point of view - Methods of strengthening for different disasters - Qualification test.

UNIT III SEISMIC VULNERABILITY OF URBAN AREAS 9

Seismic response of R.C frames buildings with soft first storey - Preparedness and planning for an urban earthquake disaster - Tsunami and its impact - Urban settlements.

UNIT IV MODERN MATERIALS AND TECHNIQUES 9

Use of modern materials their impact on disaster reduction - Use of modern analysis, design and construction techniques - Optimization for performance - Damage surveys - Maintenance and modifications to improve hazard resistance - Different types of foundation and its impact on safety.

UNIT V DISASTER MANAGEMENT 9

Landslide hazards zonation mapping - Geo-environmental problems associates with the occurrence of landslides - Role of remote sensing, science and technology - Rehabilitation programmes - Management of Relief Camp - information systems and decision making tools, voluntary agencies and community participation - various stages of disaster Management.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- knowthe various disasters, their characteristics, causes and impacts.
- knowabout the strengthening of structures by various methods which was affected by the disaster.
- understandthe response of building with soft first storey.

- useof various modern methodology and tools to reduce destructions.
- havea brief knowledge about disaster mitigating agencies.

REFERENCES

1. Allen, R.T. and Edwards, S.C., "Repair of Concrete Structures", Blakie and Sons, 2005.
2. Moskvin V, "Concrete and Reinforced Structures - Deterioration and Protection", MirPublishers, Moscow, 1983.
3. Singh R.B, "Disaster Management", Rawat Publications, 2000.
4. Sachindra Narayan, "Anthropology of Disaster management", Gyan Publishing house, 2000.
5. Harsh K Gupta, "Disaster Management", Orient Blackswan Pvt. Ltd., 2003
6. IS 1893 : 2002 (Part 1) - Criteria for Earthquake Resistant Design of Structures - General.
7. IS 4326 : 1993 - Code of Practice for Earthquake Resistant Design and Construction of Buildings .

WEB LINKS

1. https://en.wikipedia.org/wiki/Emergency_management
2. http://www.wcpt.org/disaster-management/what-is-disaster-management
3. http://www.slideshare.net/chaitanyakorra/disaster-resistant-architecture

PSE16353 CONSTRUCTION SAFETY AND MANAGEMENT 3 0 0 3

COURSE OBJECTIVES

- To provide comprehensive knowledge on the cause of accident and construction industry related laws.
- To know in detail about the safety in various aspects of construction.
- To have a knowledge about the preparation of accident report by analysing the key factors.
- To have a brief knowledge in construction management.
- To have a practical knowledge about the safety implementation by case studies.

UNIT I INTRODUCTION 9

Importance - Causes of accident, safety measures- Environmental issues in construction- Construction industry related laws - Occupation Safety and Health Act (OSHA), National Safety Council (NSC) - British Safety Council (BSC) - Council of industrial safety (CIS) - Loss Prevention Association (India)-Construction safety-Elements of an effective safety programmes job-Site assessment

UNIT II PLANNING 9

Safety aspects of building and plant-layout-Introduction to treatment and disposal on Industrial wastes & effluents-Planning and safe operations- Planning and site operations- Safe systems of storing in construction materials-Excavation-Demolition work-Blasting-Timbering- Scaffolding- Hoisting apparatus and conveyors-Manual handling- Safe use of Ladder- Safety in hand tools-Safety in use of mobile cranes-Trusses, girders and beams.

UNIT III ACCIDENT CAUSATION, REPORTING AND INVESTIGATION 9

Accidents and Hazards control-Cost of accidents- Accident reports- Accident reporting, investigations and statistics-Identification of the key factors-Safety organization-Types-Functions-Safety committees.

UNIT IV SAFETY MANAGEMENT IN CONSTRUCTION 9

Safety policy-safety meeting-Planning for safety and productivity-safety management techniques-Safety sampling-Safety Audit-Job safety analysis-Incident recall techniques- Safety and Health provision in the factories act.

UNIT V CASE STUDIES 9

Involvement in safety-Role of Government and voluntary agencies- Safety officers-Fire hazards and preventing methods- case studies - fire accidents.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- understandthe basic mandatory procedures to be followed in the construction industry.
- knowthe fundamental planning and safety practices commonly implemented on construction sites.
- knowthe key factor for causing accidents.

- understand the requirements for compliance and inspection imposed for the safety in construction site
- understandthe importance of agencies involved in rescue operation by various case studies.

REFERENCES

1. Jimmie Hinze, “Construction safety”, Prentice-Hall, 2013.
2. Herbert William Heinrich, “Industrial Accident Prevention”, McGraw-Hill, 1959.
3. Richard J. Coble, Jimmie Hinze and Theo C. Haupt, “Construction Safety and Health Management”, Prentice Hall Inc., 2001.
4. IS 3696 : 1987 (Part I) 1991 (PART II) -code of safety for Scaffolds and ladder.
5. IS 3764 : 1992 - Code of Safety for Excavation work
6. IS 4081 : 1986 - Code of Safety for blasting and related drilling operations.
7. IS 7293 : 1974 - Safety Code for Working with Construction Machinery.
8. IS 13416 : 1992 (Part I to V)- Preventive measures against Hazards at work places.
9. IS 15883 : 2009 (Part I) - Construction Project Management.
10. SP 70 : 2001, Hand Book of Construction Safety Practices, Bureau of Indian Standards, New Delhi.

PSE16354 FINANCIAL MANAGEMENT 3 0 0 3

COURSE OBJECTIVES

- To familiarize the student with a wide variety of financial decisionmaking
- To familiarize the situations focusing on Financial Management and Accounting.
- To prepare & appraise Financial Statements
- To use financial calculator and Excel in a variety of financial problems
- To Estimate cash flows from a project

UNIT I INTRODUCTION TO FINANCIAL ACCOUNTING, BOOK KEEPING AND RECORDING 9

Meaning, Scope andimportance of Financial Accounting. Financial Accounting - concepts and conventions, classificationof accounts, Rules and principles governing Double Entry Book-keeping system, Meaning,Preparation of Journal, Ledger , Cash book & Trial balance. (Practical application on tally)

UNIT II FINANCIAL STATEMENT PREPARATION, ANALYSIS AND INTERPRETATION 9

Preparation of financialstatement and Profit & Loss Account, Balance Sheet. , Ratio Analysis - classification of various ratios.(Calculation on Excel)

UNIT III INTRODUCTION TO FINANCIAL MANAGEMENT 9

Concept of business finance, Goals &objectivesof financial management, Sources of financing **-**LONG TERM: shares, debentures, term loans, lease& hire purchase, retained earnings, public deposits, bonds (Types, features & utility), SHORT TERM:bank finance, commercial paper, trade credit & bills discounting, INTERNAL: Retained earnings.

UNIT IV WORKING CAPITAL MANAGEMENT 9

Concept of working Capital, significance, types. Adequacyof working capital, Factors affecting working capital needs, Financing approaches for workingcapital, Methods of forecasting working capital requirements, meaning & importance of accountsreceivable.(Excel based)

UNIT V TIME VALUE OF MONEY AND CAPITAL BUDGETING 9

Concept of time value of money,Compounding& discounting; Future value of single amount & annuity, present value of singleamount& annuity; Practical application of time value technique. Capital budgeting - Nature andsignificance, techniques of capital budgeting –Pay Back Method, Accounting rate of return, InternalRate of Return, DCF, Net Present Value and profitability index. (Application on Excel)

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- understand and define basic terminology used in finance andaccounts
- prepare& appraise Financial Statements.

- compare and appraise theories that underlie current thinking in accounting, finance andinvestment; and evaluate how these theories can be and are applied in practical situations
- estimatecash flows from a project, including operating, net working capital, and capitalspending.
- estimatethe required return on projects of differing risk and how to use the required returnin evaluating investment decisions.

REFERENCES

1. Financial, Cost and Management Accounting: Dr. P. Pariasamy, HH Publication
2. Financial Management: Khan & Jain, Tata McGraw Hill publications
3. Financial Management: Dr. P. C. Tulsian, S. Chand Publications
4. Financial Management: Ravi Kishore, Taxmann

ELECTIVE IV

PSE16451 DESIGN OF SUB STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To assess the soil condition at a given location in order to suggest suitable foundation based upon bearing capacity.
- To composethe design of different type of shallow foundations like isolated, raft and combined footing.
- To familiarise with the design of pile foundation and pile caps.
- To outline the design of well and caissons foundations.
- To categorize various types of design of tower foundations.

UNIT I SITE INVESTIGATION, SELECTION OF FOUNDATION AND BEARING CAPACITY 9

Objectives - Methods of exploration - Depth of exploration - Sample disturbance - Factors governing location and depth of foundation - In situ testing of Soils - Plate load test - Geophysical methods - Selection of foundation- Bearing capacity of shallow foundations by Terzaghi's theory, Meyerhof's theory, and codal provisions - Bearing capacity of footing subjected to inclined and eccentric loading - Problems - Types of shear failure - General principles of foundation design – Foundations on expansive soil.

UNIT II DESIGN OF SHALLOW FOUNDATIONS 9

Types of shallow foundations - General principles of design of reinforced concrete shallow foundations - Structural design of isolated and combined footing - Structural design of rafts by conventional method - Principles of design of buoyancy raft and basement (no design problems).

UNIT III PILE FOUNDATION 9

Pile foundations - Types - General principles of design - Estimation of load capacity of piles by static and dynamic formulae - Detailing of reinforcement as per IS 2911 - Design of Piles and Pile caps - Settlement analysis of pile groups - Negative skin friction - Pile load tests.

UNIT IV WELL AND CAISSON FOUNDATIONS 9

Well and caisson foundations - Structural elements of Caisson and Well foundations - Elements of well foundation - Forces acting on Caisson and well foundations - Design of individual components of Caisson and well foundation(only forces acting and design principles) - Sinking of well - Shifts and tilts in well foundations - Preventive measures.

UNIT V FOUNDATIONS OF TRANSMISSION LINE TOWERS 9

Introduction - Necessary information - Forces on tower foundations - General design criteria - Choice and type of foundation - Design procedure -Types of Foundations - Design of foundation for transmission towers.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- attainthe perception of site investigation to select suitable type of foundation based on soil category.
- capable of ensuring design concepts of shallow foundation.
- efficient in selecting suitable type of pile for different soil stratum and in evaluation of group capacity by formulation

- designdifferent types of well foundation..
- deliver the design concepts for transmission line tower foundation

REFERENCES

2. Winterkorn. H. F., and Fang, H. Y., "Foundation Engineering Hand Book - Van Nostrard - Reinhold -1990.
3. Tomlinson. M.J. and Boorman, R., "Foundation design and construction", VI edition, ELBS Longman, 2001.
4. Nayak. N.V., "Foundation design manual for practicing engineers", DhanpatRai and Sons, 1985.
5. Arora. K.R, "Soil Mechanics & Foundation Engineering", Standard Publishers & Distributors, 2005.
6. "Dynamics of Bases and Foundations" by Barken.McGraw Hill Company.
7. IS 2911:Part 1 : Sec 1 : 1979 Code of practice for design and construction of pile foundations: Part 1 Concrete piles, Section 1 Driven cast in-situ concrete piles
8. IS 2911:Part 1 : Sec 2 : 1979 Code of practice for design and construction of pile foundations: Part 1 Concrete piles, Section 2 Bored cast-in-situ piles
9. IS 2911:Part 1 : Sec 3 : 1979 Code of practice for design and construction of pile foundations: Part 1 Concrete piles, Section 3 Driven precast concrete piles.
10. IS 2911:Part 1 : Sec 4 : 1984 Code of practice for design and construction of pile foundations: Part 1 concrete piles, Section 4 Bored precast concrete piles.
11. IS 2911:Part 2 : 1980 Code of practice for designing & construction of pile foundations: Part 2 Timber piles.
12. IS 2911:Part 3 : 1980 Code of practice for design & construction of pile foundations: Part 3 Under reamed piles
13. IS 2911:Part 4 : 1985 Code of practice for design and construction of pile foundations: Part 4 Load test on piles

WEB LINKS

1. http://theconstructor.org/geotechnical/site-investigation-or-soil-exploration/312/
2. http://www.gic-edu.com/908/Distance--Shallow-Foundation-Design-Settlement-Analysis-Workshop-12PDHs
3. http://www.nptel.ac.in/downloads/105104137/

PSE16452 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION 3 0 0 3

COURSE OBJECTIVES

- To define the errors in measurement and the principles of measurement using various electronic and physical testing machines.
- To dramatize with vibrating measuring instruments and digital and electronic display using different sensors.
- To define the wind flow measurement and pressure measurement and scale different models using direct model study and indirect model study.
- To measure the distress in concrete structures using various electrical and electronic machineries.
- To test various civil engineering structures using Non Destructive Testing methodologies.

UNIT I FORCES AND STRAIN MEASUREMENT 9

Choice of Experimental stress analysis methods, errors in measurements - Strain gauge - principle - types, performance and uses- Hydraulic jacks and pressure gauges - Electronic load cells - Proving Rings - Calibration of Testing Machines - Long-term monitoring - Vibrating wire sensors- Fibre optic sensors.

UNIT II VIBRATION MEASUREMENTS 9

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.

UNIT III ACOUSTICS AND WIND FLOW MEASURES 9

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 Model Study and Indirect Model study.

UNIT IV DISTRESS MEASUREMENTS AND CONTROL 9

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 - Techniques for residual stress measurements.

UNIT V NON DESTRUCTIVE TESTING METHODS 9

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, Advanced NDT methods - Ultrasonic pulse echo, Impact echo, impulse radar techniques, GECOR - Ground penetrating radar (GPR).

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- choosethe methodology of measuring errors and strains and calibrate the machineries and equipment used in the laboratory.
- operatevariousvibration measuring instruments and analyse the structures using digital display unit.
- indicatethe model using direct and indirect model analysis (Using Buckingham PI Theorem).

- measuredistress in the structures using various electronic equipment.
- employadvanced NDT methods in accessing the load testing of structures.

REFERENCES

1. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi,1996.
2. Ganesan T.P., “Model Analysis of Structures”, Universities Press (India) Ltd 2005.
3. Dalley .J.W and Riley.W.F, “Experimental Stress Analysis”, McGraw Hill Book Company, N.Y. 1991.
4. Srinath.L.S, Raghavan.M.R, Ingaiah.K, Gargesha.G, Pant.B and Ramachandra.K, “Experimental Stress Analysis”, Tata McGraw Hill Company,New Delhi, 1984.
5. Sirohi.R.S.,Radhakrishna.H.C, “Mechanical Measurements”, New Age International (P) Ltd. 1997.

WEB LINKS

1. http://textofvideo.nptel.iitm.ac.in/112106068
2. http://nptel.ac.in/downloads/112104039
3. http://nptel.ac.in/courses/Webcourse-contents/IIT-Delhi/Environmental%20Air%20Pollution/air%20pollution%20(Civil)/Module-2/2.html

PSE16453 COMPUTER AIDED ANALYSIS AND DESIGN OF STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To familiarise with graphic primitives, transformations and 2-D drafting of computer graphics.
- To get practiced with computer methods of structural analysis.
- To understand the structural design concepts.
- To be familiar with linear programming and CPM and PERT.
- To inculcate the students with Artificial Intelligence.

UNIT I COMPUTER GRAPHICS 9

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

UNIT II STRUCTURAL ANALYSIS 9

Computer aided analysis of steel and RC Structural elements – Application of software.

UNIT III STRUCTURAL DESIGN 9

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

UNIT IV OPTIMIZATION 9

Application of linear programming - Simplex algorithm - Post-optimality analysis - Project scheduling - CPM and PERT applications

UNIT V ARTIFICIAL INTELLIGENCE 9

Introduction - Heuristic search - knowledge based expert systems – Rules and decision tables – Inference mechanisms- Simple applications - Genetic algorithm and applications - Principles of Neural network - Architecture and applications of KBES - Expert system shells.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- befamiliar with 2 D drafting and can use drafting software.
- perform structural analysis using analysis package
- designthe structures with computer methodologies.
- optimizethe structural design with various computer packages and graphics.
- applyartificial intelligence to real life applications.

REFERENCES

1. Krishnamoorthy C.S and Rajeev S., “Computer Aided Design”, Narosa Publishing House, New Delhi, 2005.
2. Groover M.P. and Zimmers E.W. Jr.," CAD/CAM, Computer Aided Design and Manufacturing ", Prentice Hall of India Ltd, New Delhi, 2006.
3. Harrison H.B., “Structural Analysis and Design Vol.I and II”, Pergamon Press, 1991
4. Rao. S.S., " Optimisation Theory and Applications ", Wiley Eastern Limited, New Delhi, 2009.
5. Richard Forsyth (Ed.), “Expert System Principles and Case Studies”, Chapman and Hall, 1996.

WEB LINKS

1. http://www.colorado.edu/engineering/cas/courses.d/IFEM.d/
2. http://link.springer.com/article/10.1007%2Fs40069-012-0027-7#page-1
3. http://www.civil.northwestern.edu/people/bazant/PDFs/Papers/S12.pdf

PSE16454 **DESIGN OF BRIDGES** **3 0 0 3**

COURSE OBJECTIVES

- To study the various bridge forms and typical loadings on the bridges.
- To get familiarized with the design of short span bridges.
- To possess knowledge on the design concepts of long span bridges.
- To design the prestressed concrete bridges.
- To understand the concept of designing the substructure for bridges, plate girder to IRC loadings, foundation for bridges and bearings.

UNIT I DESIGN PRINCIPLES **9**

General basic bridge forms - Beam, arch, suspension, various types of bridges, selection of type of bridge and economic span length, drainage, road, kerb, classification, investigation and planning. design loads for bridges - Dead load, live load, IRC loading, IRS loading, Aashto loading, wind load, longitudinal forces, centrifugal forces, buoyancy, water current forces, thermal forces deformation and horizontal forces

UNIT II SHORT SPAN BRIDGES **9**

Design of culvert, Deck slab bridge - T - Beam girder bridge - Pigeaud's Theory - Courbon's Method

UNIT III LONG SPAN BRIDGES **9**

Design principles of continuous bridges - box girder bridges and balanced cantilever bridges.

UNIT IV DESIGN OF PRESTRESSED CONCRETE BRIDGES **9**

Flexural and Torsional parameters - Courbon's Theory - Distribution Coefficient by exact analysis - Design of girder section - maximum and minimum prestressing forces - Eccentricity - Live load and dead load shear forces - Cable Zone in Girder - Check for stresses at various sections - Check for diagonal tension - Diaphragms - End Block - Short term deflections.

UNIT V DESIGN OF PLATE GIRDER BRIDGES , BEARINGS AND SUBSTRUCTURES **9**

Design of riveted and welded plate girder bridges - Wind effects - Main section, splicing, curtailment, stiffeners - Different types of bearings - design of bearings - Design of masonry and concrete piers and abutments - Types of bridge foundations - Design of foundations - Footings - Pile foundations.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course,studends will be able to

- understand the design theories for super structure and sub structure of bridges
- designshort span bridges.
- understandthe behaviour of continuous bridges, box girder bridges.
- designprestressed concrete bridges.
- design railway bridges, plate girder bridges, different types of bearings , abutments, piers and various types of foundations for bridges

REFERENCES

1. Ponnuswamy.S "Bridge Engineering", Tata McGrawHill, 2008.
2. Johnson Victor.D, "Essentials of Bridge Engineering", Oxford & IBH, 2007.
3. Jagadeesh T.R. and Jayaram .M.A., "Design of Bridge Structures", Prentice Hall of India Pvt Ltd., 2004.

4. Raina V.K., “Concrete Bridge Practice”, Tata McGraw Hill Publishing Company, New Delhi, 1994.
5. Bakht.B and Jaegar.L.G., “Bridge Analysis Simplified”, McGraw Hill, 1985.
6. IRC:6-2010 Standard Specifications and Code of Practice for Road Bridges, Section II - Loads and Stresses (Fifth Revision).
7. IRC:18-2000 Design Criteria for Prestressed Concrete Road Bridges (Post-Tensioned Concrete) (Third Revision).
8. IRC:21-2000 Standard Specifications and Code of Practice for Road Bridges, Section III - Cement Concrete (Plain and Reinforced) (Third Revision).
9. IRC:22-2008 Standard Specifications and Code of Practice for Road Bridges, Section VI - Composite Construction (Limit States Design) (Second Revision).
10. IRC:24-2010 Standard Specifications and Code of Practice for Road Bridges, Steel Road Bridges (Limit State Method)Third Revision).
11. IRC:83-1999 (Part-I) Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part I : Metallic Bearings (First Revision).
12. IRC:83-1987 (Part II) Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part II: Elastomeric Bearings.
13. IRC:83-2002 (Part III) Standard Specifications and Code of Practice for Road Bridges, Section IX - Bearings, Part III: POT, POT-CUMPTFE,PIN and Metallic Guide Bearings.
14. Pigeaud’s curves

WEB LINKS

1. https://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_brid/cub_brid_lesson02.xml
2. http://handbook.uts.edu.au/subjects/49131.html
3. http://www.britannica.com/technology/bridge-engineering

SEMESTER IV

PSE16204 FINITE ELEMENT METHOD 3 2 0 4

COURSE OBJECTIVES

- To equip with the Finite Element Analysis fundamentals.
- To formulate the design problems into FEA.
- To perform engineering simulations using Finite Element Analysis software (ANSYS).
- To understand the ethical issues related to the utilization of FEA in the industry.
- To execute the CAD interfaces, joints and connections, non-linear behavior, optimization and analysis to code.

UNIT I FORMULATION OF BOUNDARY VALUES 15

Basic steps in finite element anlaysis - Boundary value problems – Approximate solutions – Variational and weighed residual methods – Ritz and Galerkin formulations – Concept of piecewise approximation and finite element – Displacement and shape functions – Weak formulation – Minimum potential energy – Generation of stiffness matrix and load vector.

UNIT II STRESS ANALYSIS 15

Two dimensional problems – Plane stress, plane strain and axisymmetric problems – Triangular and rectangular elements – Natural coordinates – Computation of stiffness matrix for isoparametric elements - Numerical integration (Gauss quadrature) - Brick elements - Elements for fracture analysis – Introduction to plate bending and shell elements

UNIT III MESHING AND SOLUTION 15

Higher order elements – P and H methods of mesh refinement – Ill conditioned elements – Discretisation errors – Auto and adaptive mesh generation techniques - Error evaluation

UNIT IV DYNAMIC ANALYSIS 15

Introduction – Vibrational problems – Equations of motion based on weak form – Longitudinal vibration of bars – Transverse vibration of beams – Consistent mass matrices – Element equations – Solution of eigenvalue problems – Vector iteration methods – Normal modes – Transient vibrations – Modeling of damping – Direct integration methods

UNIT V PLATE AND SHELL ELEMENTS 15

Formation of stiffness matrix for plate bending elements of triangular and quadrilateral elements - Concept of four node and eight node isoparametric elements - cylindrical thin shell elements.

TOTAL PERIODS 75

COURSE OUTCOMES

At the end of this course,studends will be able to

- develop finite element formulations of 1 degree of freedom problems and solve them
- use finite element analysis programs based upon either “p-method” or “h-method” finite element mathematical formulations
- use ansys software to perform stress, thermal and modal analysis
- computethe stiffness values of noded elements.
- performmodal analysis to determine its natural frequencies, and analyze harmonically-forced vibrations.

REFERENCES

1. S. S. Bhavikatti, “Finite Element Analysis”, New Age Publishers,2007.
2. C. S. Krishnamoorthy, “Finite Element Analysis: Theory and Programming”, Tata McGraw-Hill, 2008.
3. Zienkiewicz, O.C. and Taylor, R.L., “The Finite Element Method”, McGraw - Hill, 2005.
4. Chandrupatla, R.T. and Belegundu, A.D., “Introduction to Finite Elements in Engineering”, Prentice Hall of India, 2011.
5. Moaveni, S., “Finite Element Analysis Theory and Application with ANSYS”, Prentice Hall Inc., 2003.

WEB LINKS

1. http://www.colorado.edu/engineering/CAS/courses.d/IFEM.d/Home.html
2. http://nptel.ac.in/courses/112104115/
3. http://freevideolectures.com/Course/2357/Finite-Element-Method

PSE16205 ADVANCED STRUCTURAL ENGINEERING LABORATORY 0 0 4 2

COURSE OBJECTIVES

- To design concrete mixes, perform advanced laboratory experiments that emphasize the structure-property relationship, statistical analysis,technical manuscript preparation and get a practical knowledge about the non destructive tests, measuring devices and their field applications.

LIST OF EXPERIMENTS

1. Concrete mix design and study of mechanical properties of concrete
2. Fresh properties of Self Compacting Concrete using slump flow, L Box and V Funnel Tests
3. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour.
4. Testing of simply supported steel beam for strength and deflection behaviour.
5. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.
6. Dynamic testing of cantilever steel beam
    a. To determine the damping coefficients from free vibrations.
    b. To evaluate the mode shapes.
7. Static cyclic testing of single bay two storied steel frames and evaluate
    a. Drift of the frame.
    b. Stiffness of the frame.
    c. Energy dissipation capacity of the frame.
8. Determination of in-situ strength and quality of concrete using
    a. Rebound hammer.
    b. Ultrasonic Pulse Velocity Tester.
9. Study of Measuring devices such as
    a. BeggsDeformeter
    b. Mechanical Strain Gauge
    c. Optical strain gauge
    d. Electrical Strain Gauges

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course,studends will be able to

- describe the behaviour of reinforced concrete and steel beam for strength and deflection and the dynamic behaviour of cantilever steel beam and also able to understand the strength and quality of concrete

REFERENCES

1. Dally J W, and Riley W F, “Experimental Stress Analysis”, McGraw- Hill Inc. New York, 1991.
2. L.S Srinath, „Experimental Stress Analysis“, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1992.