

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech in STRUCTURAL ENGINEERING
Effective from Academic Year 2019 - 20 admitted batch

R19 COURSE STRUCTURE AND SYLLABUS

I YEAR I – SEMESTER

Course Code	Course Title	L	T	P	Credits
Professional Core - I	Theory of Elasticity	3	0	0	3
Professional Core - II	Advanced Structural Analysis	3	0	0	3
Professional Elective - I	1. Theory of Plates and Shells 2. Theory and Applications of Cement Composites 3. Theory of Structural Stability	3	0	0	3
Professional Elective - II	1. Advanced Reinforced Concrete Design 2. Advanced foundation Design of reinforced concrete 3. Numerical Methods in Structural Engineering	3	0	0	3
Lab - I	Numerical Analysis Lab	0	0	4	2
Lab - II	Advanced Concrete Technology Lab	0	0	4	2
	Research Methodology & IPR	2	0	0	2
Audit - I	Audit Course - I	2	0	0	0
	Total	16	0	8	18

I YEAR II – SEMESTER

Course Code	Course Title	L	T	P	Credits
Professional Core - III	FEM in Structural Engineering	3	0	0	3
Professional Core - IV	Structural Dynamics	3	0	0	3
Professional Elective - III	1. Advanced Steel Design 2. Design of High-Rise Buildings 3. Design of Masonry Structures	3	0	0	3
Professional Elective - IV	1. Soil Structure Interaction. 2. Design of Prestressed concrete Structures 3. Structural Optimization	3	0	0	3
Lab - III	Advanced Structural Engineering Lab	0	0	4	2
Lab - IV	Structural Design Lab	0	0	4	2
	Mini Project with Seminar	0	0	4	2
Audit - II	Audit Course - II	2	0	0	0
	Total	14	0	12	18

II YEAR I – SEMESTER

Course Code	Course Title	L	T	P	Credits
Professional Elective - V	1. Earthquake Resistance Design of Buildings 2. Industrial structures 3. Bridge Engineering	3	0	0	3
Open Elective	Open Elective	3	0	0	3
Dissertation	Dissertation Work Review - II	0	0	12	6
	Total	6	0	12	12

II YEAR II - SEMESTER

Course Code	Course Title	L	T	P	Credits
Dissertation	Dissertation Work Review - III	0	0	12	6
Dissertation	Dissertation Viva-Voce	0	0	28	14
	Total	0	0	40	20

***For Dissertation Work Review - I, Please refer 7.8 in R19 Academic Regulations.**

Audit Course I & II:

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by yoga
8. Personality Development Through Life Enlightenment Skills

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

THEORY OF ELASTICITY (PC – I)

Course Objectives: To impart knowledge on the basic concepts of theory of elasticity, and solve the Structural Engineering problems.

Course outcomes: The learner will be able to solve problems of elasticity and plasticity and be able to apply numerical methods to solve continuum problems.

Prerequisites: Strength of Materials I & II

UNIT-I

Introduction: Elasticity - notation for forces and stress - components of stresses - components of strain - Hooks law. Plane stress and plane strain analysis - differential equations of equilibrium 2D & 3D - boundary conditions – Strain Displacement Relations - compatibility equations – stress tensor and strain tensor.

UNIT II

Two dimensional problems in rectangular coordinates - solution by polynomials - Saint-Venants principle - determination of displacements - bending of simple beams stress function – Simply Supported and Cantilever Beams.

UNIT III

Two dimensional problems in polar coordinates - stress distribution symmetrical about an axis - pure bending of curved bars - strain components in polar coordinates - displacements for symmetrical stress distributions Edge Dislocation - general solution of two-dimensional problem in polar coordinates - application to Plates with Circular Holes – Rotating Disk. Bending of Prismatic Bars: Stress function - bending of cantilever - circular cross section - elliptical cross section - rectangular cross section.

UNIT IV

Analysis of stress and strain in three dimensions - principal stress - stress ellipsoid - director surface - determination of principal stresses Stress Invariants - max shear stresses - Homogeneous deformation - principal axes of strain-rotation. General Theorems: Differential equations of equilibrium - conditions of compatibility - determination of displacement - equations of equilibrium in terms of displacements - principle of super position - uniqueness of solution - the reciprocal theorem Strain Energy.

UNIT V

Torsion of Circular Shafts - Torsion of Straight Prismatic Bars – Saint Venants Method - torsion of prismatic bars - bars with elliptical cross sections - membrane analogy - torsion of a bar of narrow rectangular bars - torsion of shafts, tubes, bars etc.

REFERENCES:

1. Theory of Elasticity by Timoshenko, McGraw-Hill Publications
2. Theory of Elasticity by Y.C. Fung.
3. Theory of Elasticity by Gurucharan Singh.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

ADVANCED STRUCTURAL ANALYSIS (PC - II)

Pre-requisites: Structural Analysis I & II

Course Objectives: To impart knowledge on the analysis of indeterminate structures like continuous beams, trusses and portal frames.

Course Outcome: The learner will be able to analyse different indeterminate structures using Matrix methods.

UNIT I

Introduction to matrix methods of analysis - statical indeterminacy and kinematical indeterminacy - degree of freedom - coordinate system - structure idealization stiffness and flexibility matrices - suitability element stiffness equations - elements flexibility equations - mixed force - displacement equations - for truss element, beam element and torsional element.

Transformation of coordinates - element stiffness matrix - and load vector - local and global coordinates.

UNIT II

Assembly of stiffness matrix from element stiffness matrix - direct stiffness method - general procedure - banded matrix - semi bandwidth - assembly by direct stiffness matrix method.

UNIT III

Analysis of plane truss - continuous beams with and without settlement - plane frame including side sway single storey, single – bay and gable frame by flexibility method using system approach by flexibility methods and gables frames by Gable System Approach.

UNIT IV

Analysis of plane truss - continuous beams with and without settlement - plane frame including sides sway, grids and gable frames by stiffness methods, single bay – two storey, two bay single – storey.

UNIT V. Special analysis procedures - static condensation and sub structuring - initial and thermal stresses.

REFERENCES:

1. Matrix Analysis of Frames structures by William Weaver J.R and James M. Gere, CBS publications.
2. Advanced Structural Analysis by Ashok. K.Jain, New Channel Brothers.
3. Matrix method of S.A by Pandit & Gupta
4. Matrix Structural Analysis by Madhu B. Kanchi.
5. Matrix Methods of Structural Analysis by J.Meek.
6. Structural Analysis by Ghali and Neyveli.
7. Structural Analysis by Devdas Menon, Narosa Publishing Housing Pvt Ltd.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

THEORY OF PLATES AND SHELLS (PE – I)

Prerequisites: Theory of Elasticity, Structural Analysis

Course Objectives: To impart knowledge on the behavior and design of shells and Folded plates.

Course Outcomes: The learner will be able to analyse and design the shells and folded plates.

UNIT I

Introduction: Space Curves, Surfaces, Shell Co-ordinates, Strain Displacement Relations, Assumptions in Shell Theory, Displacement Field Approximations, Stress Resultants, Equation of Equilibrium using Principle of Virtual Work, Boundary Conditions.

UNIT II

Small Deflection Theory of Thin Rectangular Plates: Assumptions – Derivation of governing differential equation for thin plates – Boundary conditions – simply supported plate under sinusoidal load – Navier solution – Application to different cases – Levy's solution for various boundary conditions subjected to different loadings like uniform and hydrostatic pressure.

UNIT III

Circular Plates: Differential Equation for symmetrical bending of Laterally loaded circular Plates – Uniformly loaded circular plates – circular plate concentrically loaded – circular plate loaded at center

UNIT IV

Shells – functional behaviour – examples – structural behaviour of shells classification of shells – Definitions – various methods of analysis of shells – merits and demerits of each method – 2D. Membrane equation.

Equations of equilibrium: Derivation of stress resultants – cylindrical shells – Flugge's equations.

UNIT V

Introduction to the shells of Double curvatures: Geometry, analysis and design of elliptic paraboloid, conoid and hyperbolic parabolic shapes, inverted umbrella type.

Axi- Symmetrical shells: General equation - Analysis and axi-symmetrical by membrane theory. Application to spherical shell and hyperboloid of revolution cooling towers.

REFERENCES:

1. Theory of Plates & Shells –Stephen, P. Timoshenko, S. Woinowsky-Krieger – Tata MC Graw Hill Edition
2. Analysis and design of concrete shell roofs By G.S. Ramaswami. CBS publications.
3. Design of concrete shell roofs By Billington – Tata MC Graw Hill, New York
4. Shell Analysis By N.K. Bairagi. Khanna Publishers, New Delhi.
5. Design of Shells and Folded Plates by P.C. Varghese, PHI Learning Pvt. Ltd
6. Design of concrete shell roofs By Chaterjee. Oxford and IBH.,

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

THEORY AND APPLICATIONS OF CEMENT COMPOSITES (PE – 1)

Course Outcomes: At the end of the course, students will be able to

1. Formulate constitutive behaviour of composite materials – Ferrocement, SIFCON and Fibre Reinforced Concrete - by understanding their strain- stress behaviour.
2. Classify the materials as per orthotropic and anisotropic behaviour.
3. Estimate strain constants using theories applicable to composite materials.
4. Analyse and design structural elements made of cement composites.

UNIT – I

Introduction: Classification and Characteristics of Composite Materials- Basic Terminology, Advantages. Stress-Strain Relations- Orthotropic and Anisotropic Materials, Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Plane Stress Problem, Biaxial Strength, Theories for an Orthotropic Lamina.

UNIT – II

Mechanical Behaviour: Mechanics of Materials Approach to Stiffness- Determination of Relations between Elastic Constants, Elasticity Approach to Stiffness- Bounding Techniques of Elasticity, Exact Solutions - Elasticity Solutions with Continuity, Halpin, Tsai Equations, Comparison of approaches to Stiffness.

UNIT – III

Cement Composites: Types of Cement Composites, Terminology, Constituent Materials And their Properties, Construction Techniques for Fibre Reinforced Concrete – Ferro cement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing.

UNIT – IV

Mechanical Properties of Cement Composites: Behavior of Ferrocement, Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion.

UNIT – V

Application of Cement Composites: FRC and Ferrocement- Housing, Water Storage, Boats and Miscellaneous Structures. Composite Materials- Orthotropic and Anisotropic behaviour, Constitutive relationship, Elastic Constants.

Analysis and Design of Cement Composite Structural Elements – Ferro cement, SIFCON and Fibre Reinforced Concrete.

REFERENCE BOOKS:

1. Mechanics of Composite Materials, Jones R. M., 2nd Ed., Taylor and Francis, BSP Books, 1998.
2. Ferrocement – Theory and Applications, Pama R. P., IFIC, 1980.
3. New Concrete Materials, Swamy R.N., 1stEd., Blackie, Academic and Professional, Chapman &Hall, 1983.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

THEORY OF STRUCTURAL STABILITY (PE – I)

Course Outcomes: At the end of the course, students will be able to

1. Determine stability of columns and frames
2. Determine stability of beams and plates
3. Use stability criteria and concepts for analyzing discrete and continuous systems,

UNIT – I

Criteria for Design of Structures: Stability, Strength, and Stiffness, Classical Concept of Stability of Discrete and Continuous Systems, Linear and nonlinear behavior.

UNIT – II

Stability of Columns: Axial and Flexural Buckling, Lateral Bracing of Columns, Combined Axial, Flexural and Torsion Buckling.

UNIT – III

Stability of Frames: Member Buckling versus Global Buckling, Slenderness Ratio of Frame Members.

UNIT – IV

Stability of Beams: lateral torsion buckling.

Stability of Plates: axial flexural buckling, shear flexural buckling, buckling under combined loads.

UNIT – V

Introduction to Inelastic Buckling and Dynamic Stability.

REFERENCE BOOKS:

1. Theory of elastic stability, Timoshenko and Gere, Tata Mc Graw Hill, 1981
2. Principles of Structural Stability Theory, Alexander Chajes, Prentice Hall, New Jersey.
3. Structural Stability of columns and plates, Iyengar, N. G. R., Eastern west press Pvt. Ltd.
4. Strength of Metal Structures, Bleich F. Bucking, Tata McGraw Hill, New York.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

ADVANCED REINFORCED CONCRETE DESIGN (PE – II)

Prerequisites: Design of Reinforced Concrete Structures

Course Objectives : To impart knowledge on the behavior and design on various reinforced concrete structural elements.

Course Outcome: The learner will be able to design the reinforced concrete elements like beams, slabs and compression members.

UNIT I

Basic Design Concepts: Behavior in flexure, Design of singly Reinforced rectangular sections, Design of Doubly Reinforced rectangular sections, Design of flanged beam sections, Design for shear – Design for Torsion, Limit state of Serviceability: Deflections of Reinforced concrete beams and slabs short term deflections and long-term deflection estimation of crack width in RCC members, calculation of crack widths.

UNIT II

Limit Analysis of R.C. Structures: Rotation of a plastic hinge, Redistribution of moments, moment rotation characteristics of RC member, I.S. code provisions, applications for fixed and continuous beam. Yield line analysis for slabs: Upper bound and lower bound theorems – yield line criterion – Virtual work and equilibrium methods of analysis – For square and circular slabs with simple and continuous end conditions. Moment Curvature diagram.

UNIT III

Ribbed slabs: Analysis of the Slabs for Moment and Shears, Ultimate Moment of Resistance, Design for shear, Deflection, Arrangement of Reinforcements.

Flat slabs: Direct design method – Distribution of moments in column strips and middle strip-moment and shear transfer from slabs to columns – Shear in Flat Slabs-Check for one way and two-way shears-Introduction to Equivalent frame method. Limitations of Direct design method, Distribution of moments in column strips and middle strip sketch showing reinforcement details.

UNIT IV

Design of Reinforced Concrete Deep Beams & Corbels: Steps of Designing Deep Beams, Design by IS 456. Checking for Local Failures, Detailing of Deep Beams, Analysis of Forces in a Corbels, Design of Procedure of Corbels, Design of Nibs.

UNIT V

Design of Compression Members - Estimation of Effective Length of a Column – Code Requirements on Slenderness Limits, – Design of Short Columns Under Axial Compression – Design of Short Columns Under Compression With Uniaxial Bending – Design of Short Columns Under Axial Compression With Biaxial Bending – Design of Slender Columns sketch showing reinforcement details.

Design of Combined Footings - Distribution of Soil Pressure - Geometry of Two-column Combined Footing – Design Considerations in Two-Column Footings sketch showing reinforcement details.

REFERENCES:

1. "Reinforced Concrete Design" S. Unnikrishna Pillai & Devdas Menon; Tata Mc. Graw-Hill Publishing Company Ltd. New Delhi 2010.
2. "Advanced Reinforced Concrete" P.C. Varghese Prentice Hall of INDIA Private Ltd. 2008.
3. "Limit State Theory and Design of Reinforced Concrete" Dr. S. R. Karve and V.L Shah. Standard Publishers, PUNE 2004.
4. "Design of Reinforced Concrete Structures" by N.Subramanian, Oxford University Press.
5. Reinforced concrete structural elements – behaviour, Analysis and design by P. Purushotham, Tata Mc.Graw-Hill, 1994.
6. Design of concrete structures – Arthus H. Nilson, David Darwin, and Chorles W. Dolar, Tata Mc. Graw-Hill, 3rd Edition, 2005.
7. Reinforced Concrete design by Kennath Leet, Tata Mc. Graw-Hill International, editions, 2nd edition, 1991.
8. "Design Reinforced Concrete Foundations" P.C. Varghese Prentice Hall of INDIA Private Ltd.
9. IS 456-2000
10. SP 16
11. SP 34

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

ADVANCED FOUNDATION DESIGN OF REINFORCED CONCRETE (PE – II)

UNIT-I

Introduction -Principles of Design of Foundations, Types of shear failures in foundation soils, Types of foundations, Design Loads, Basic Concepts of safe and allowable bearing capacity. Shallow Foundations Bearing Capacity Analysis: Bearing capacity theories – Terzaghi, Meyerhof, Skempton, Hansen, Vesic and IS Methods, Bearing capacity evaluation from Standard Penetration test and Plate load test. Settlement Analysis:

UNIT-II

Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesionless soils by Schemmertmann and Hartman method, Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control.

UNIT-III

Proportioning of footings: Isolated column footings, Strip, combined Footings and Strap Footing. Raft Foundations: Bearing capacity of raft foundation, floating raft, Types of rafts, Beam on Elastic foundation and Conventional methods of Design, determination of modulus of subgrade reaction.

UNIT-IV

Deep Foundations - Pile Foundations: Types, load capacity- dynamic formulae, static formula; pile load tests- Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction.

Well Foundations: Types, Bearing Capacity of well foundations, Construction of pneumatic caissons, Tilts and Shifts: precautions, Remedial measures; Lateral stability analysis by Terzaghi's Method, Design aspects of Components of well foundation.

UNIT-V

Foundations in Expansive Solis Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and 'CNS' concepts. Foundations of Transmission Line Towers - Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

TEXT BOOKS:

1. Analysis and Design of Substructures by Swami Saran, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publications

REFERENCE BOOKS:

1. Foundation Analysis and Design by J.E. Bowles, Mc Graw Hill Publishing Co.
2. Foundation Design by W.C. Teng, John Wiley, New York.
3. Analysis and Design of Substructures by Swami Saran, Oxford & IBH Publishing Co.
4. Foundation Engineering by P.C. Varghese, Prentice Hall of India.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING

NUMERICAL METHODS IN STRUCTURAL ENGINEERING (PE – II)

Prerequisites: Mathematics I & II

Course Objectives : To impart knowledge about various methods of analysing linear equations and understand the different mathematical techniques.

Course Outcome: The learner will be able to apply various mathematical techniques to Structural engineering problems.

UNIT-I:

Solutions of linear equations: Direct method – Cramer’s rule, Gauss – Elimination method- Gauss – Jordan elimination – Triangulation (LU Decomposition) method – Iterative methods Jacobi – Iteration method – Gauss – Siedel iteration, Successive over –relaxation method. Eigen values and eigen vectors: Jacobi method for symmetric matrices- Given’s method for symmetric matrices- Householder’s method for symmetric matrices- Rutishauser method of arbitrary matrices – Power method.

UNIT-II:

Interpolation: Linear Interpolation_- Higher order Interpolation_- Lagrange Interpolation_- Interpolating polynomials using finites differences- Hermite Interpolation_- piece-wise and spline Interpolation_

UNIT-III

Finite Difference and their Applications: Introduction- Differentiation formulas by Interpolating parabolas – Backward and forward and central differences- Derivation of Differentiation formulas using Taylor series- Boundary conditions- Beam deflection – Solution of characteristic value problems- Richardson’s extrapolation- Use of unevenly spaced pivotal points- Integration formulae by interpolating parabolas- Numerical solution to spatial differential equations – Application to Simply Supported Beams, Columns & rectangular Plates.

UNIT-IV.

Numerical Differentiation: Difference methods based on undetermined coefficients- optimum choice of step length– Partial differentiation.

Numerical Integration: Method based on interpolation-method based on undetermined coefficient – Gauss – Lagrange interpolation method- Radaua integration method- composite integration method – Double integration using Trapezoidal and Simpson’s method – New Marks Method and Application to Beams – Calculations of Slopes & Deflections.

UNIT V

Ordinary Differential Equation: Euler’s method – Backward Euler method – Midpoint method – single step method, Taylor’s series method- Boundary value problems.

REFERENCES:

1. Numerical Methods For Scientific and Engineering Computations. M. K. Jain- S. R. K. Iyengar – R. K. Jain Willey Eastern Limited. New Age International (p) Ltd., Publishers, Reprint 2004, ISBN: 81-224-1461-3 56789101112.
2. Numerical Methods for Engineering Problems by N. Krishna Raju and K. U. Muthu, M.C. Millan Publishers, New Delhi

3. Numerical Methods for Engineers Stevan C. Chopra, Raymond P. Canal Mc. Graw Hill Book Company. April 2009
4. C Language and Numerical methods by C. Xavier – New Age International Publisher. Reprint March 2012 ISBN: 978-81-224-1174-4.
5. Computer based numerical analysis by Dr. M. Shanta Kumar, Khanna Book publishers New Delhi.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

NUMERICAL ANALYSIS LAB (Lab – I)

Course Outcomes: At the end of the course, students will be able to

1. Find Roots of non-linear equations by Bisection method and Newton's method.
2. Do curve fitting by least square approximations
3. Solve the system of Linear Equations using Gauss - Elimination/ Gauss - Seidal Iteration/ Gauss - Jordan Method
4. To Integrate Numerically Using Trapezoidal and Simpson's Rules
5. To Find Numerical Solution of Ordinary Differential Equations by Euler's Method, Runge-Kutta Method.

Syllabus Contents:

1. Find the Roots of Non-Linear Equation Using Bisection Method.
2. Find the Roots of Non-Linear Equation Using Newton's Method.
3. Curve Fitting by Least Square Approximations.
4. Solve the System of Linear Equations Using Gauss - Elimination Method.
5. Solve the System of Linear Equations Using Gauss - Seidal Iteration Method.
6. Solve the System of Linear Equations Using Gauss - Jordan Method.
7. Integrate numerically using Trapezoidal Rule.
8. Integrate numerically using Simpson's Rules.
9. Numerical Solution of Ordinary Differential Equations By Euler's Method.
10. Numerical Solution of Ordinary Differential Equations By Runge- Kutta Method.
11. Practice with MATLAB

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

ADVANCED CONCRETE TECHNOLOGY LAB (Lab – II)

Course Outcomes: At the end of the course, students will be able to

1. Design high grade concrete and study the parameters affecting its performance.
2. Conduct Non-Destructive Tests on existing concrete structures.
3. Apply engineering principles to understand behavior of structural/ elements.

List of Experiments/Assignments:

1. Mix design of standard grade and high strength concrete
2. Study of stress-strain curve of high strength concrete, Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture.
3. Behavior of Beams under flexure, Shear and Torsion.
4. Fresh properties of self-compacting concrete.
5. RCPT

REFERENCE BOOKS:

1. Properties of Concrete, Neville A. M., 5th Edition, Prentice Hall, 2012.
2. Concrete Technology, Shetty M. S., S. Chand and Co., 2006.
3. Concrete Technology by A.R. Santha Kumar, Oxford University Press

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

RESEARCH METHODOLOGY AND IPR

Prerequisite: None

Course Objectives:

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

Course Outcomes: At the end of this course, students will be able to

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT-I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II:

Effective literature studies approaches, analysis, Plagiarism, Research ethics

UNIT-III:

Effective technical writing, how to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-IV:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

REFERENCES:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
7. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

FEM IN STRUCTURAL ENGINEERING (PC – III)

Course Outcomes: At the end of the course, students will be able to

1. Use Finite Element Method for structural analysis.
2. Execute the Finite Element Program/ Software.
3. Solve continuum problems using finite element analysis.

UNIT - I

Introduction: History and Applications. Spring and Bar Elements, Minimum Potential Energy Principle, Direct Stiffness Method, Nodal Equilibrium equations, Assembly of Global Stiffness Matrix, Element Strain and Stress.

UNIT –II

Beam Elements: Flexure Element, Element Stiffness Matrix, Element Load Vector.

Method of Weighted Residuals: Galerkin Finite Element Method, Application to Structural Elements, Interpolation Functions, Compatibility and Completeness Requirements, Polynomial Forms, Applications.

UNIT –III

Types: Triangular Elements, Rectangular Elements, Three-Dimensional Elements, Isoparametric Formulation, Axi-Symmetric Elements, Numerical Integration, Gaussian Quadrature.

UNIT-IV

Application to Solid Mechanics: Plane Stress, CST Element, Plane Strain Rectangular Element, Isoparametric Formulation of the Plane Quadrilateral Element, Axi- Symmetric Stress Analysis, Strain and Stress Computations.

UNIT-V

Computer Implementation of FEM procedure, Pre-Processing, Solution, Post-Processing, Use of Commercial FEA Software.

REFERENCE BOOKS:

1. C.S. Krishna Murthy Finite Element Method. MC Graw-Hill Publishers.
2. Finite Element Analysis, Seshu P., Prentice-Hall of India, 2005.
3. Finite Element Methods in Engineering, Belegundu A.D., Chandrupatla, T.R., Prentice Hall India, 1991.
4. Concepts and Applications of Finite Element Analysis, Cook R. D., Wiley J., New York, 1995.
5. Fundamentals of Finite Element Analysis, Hutton David, Mc-Graw Hill, 2004.
6. Finite Element Analysis, Buchanan G.R., McGraw Hill Publications, New York, 1995.
7. Finite Element Method, Zienkiewicz O.C. & Taylor R.L. Vol. I, II & III, Elsevier, 2000.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

STRUCTURAL DYNAMICS (PC – IV)

Prerequisites: Structural Analysis I & II

Course Objectives: To impart knowledge on the fundamental of structural dynamics and their applications.

Course Outcomes: The learner will be able to understand the equation of motion, dynamics response of single and multi-degree-of freedom systems.

UNIT - I

Theory of vibrations: Introduction - Elements of vibratory system - Degrees of Freedom - Continuous System - Lumped mass idealization - Oscillatory motion - Simple Harmonic motion - Vectorial representation of S.H.M. - Free vibrations of single degree of freedom system - undamped and damped vibrations - critical damping - Logarithmic decrement - Forced vibration of SDOF systems - Harmonic excitation - Vibration Isolation -Dynamic magnification factor – Phase angle.

UNIT - II

Introduction to Structural Dynamics: Fundamental objectives of dynamic analysis -Types of prescribed loading - Methods of discretization - Formulation of equations of motion by different methods – Direct equilibration using Newton's law of motion / D'Alembert's principle, Principle of virtual work and Hamilton principle.

Single Degree of Freedom Systems: Formulation and solution of the equation of motion - Free vibration response - Response to Harmonic, Periodic, Impulsive and general dynamic loadings - Duhamel integral.

UNIT - III

Multi Degree of Freedom Systems: Selection of the degrees of Freedom - Evaluation of structural property matrices - Formulation of the MDOF equations of motion -Undamped free vibrations - Solutions of Eigen value problem for natural frequencies and mode shapes - Analysis of Dynamic response – Normal co-ordinates - Uncoupled equations of motion - Orthogonal properties of normal modes - Mode superposition procedure.

UNIT - IV

Practical Vibration Analysis: Introduction - Stodola method - Fundamental mode analysis - Analysis of second and higher modes - Holzer method - Basic procedure.

Continuous Systems: Introduction - Flexural vibrations of beams - Elementary case – Derivation of governing differential equation of motion - Analysis of undamped free vibrations of beams in flexure - Natural frequencies and mode-shapes of simple beams with different end conditions - Principles of application to continuous beams.

UNIT - V

Introduction to Earthquake Analysis: Deterministic Earthquake Response: Systems on Rigid Foundations: Types of Earthquake Excitations – Lumped SDOF Elastic Systems, Translational Excitations Grreliyed – coordinate SDOF Elastic Systems, Translational Excitations, Linear Static Method – Analysis for obtaining response of multi storeyes RC Building.

REFERENCES:

1. Dynamics of Structures by Clough & Penzien, McGraw Hill, New York
2. Dynamics of Structures by Anil K. Chopra, Pearson Education (Singapore), Delhi.
3. Structural Dynamics by Mario Paz, C.B.S Publishers, New Delhi.
4. Theory of vibrations by W.T. Thomson CBS Publishers and Distributors.
5. Structural Dynamics by Roy. R. Craig John willy & fours. I.S: 1893 (Part 1) - 2016, "Code of practice for Earthquake resistant design of Structures"

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

ADVANCED STEEL DESIGN (PE – III)

Pre-requisites: Design of Steel Structures & Structural Analysis

Course Objectives: To impart knowledge on behavior and design of various connections, industrial and steel girders.

Course Outcomes: The learner will be able to design different steel structures.

UNIT- I

SIMPLE CONNECTIONS – RIVETED, BOLTED PINNED AND WELDED CONNECTIONS: Riveted Connections – Bolted Connections –Load Transfer Mechanism – Failure of Bolted Joints – Specifications for Bolted Joints – Bearing – Type Connections – Tensile Strength of Plate – Strength and Efficiency of the Joint – Combined Shear and Tension – Slip-Critical connections – Prying Action – Combined Shear and Tension for Slip-Critical Connections. Design of Groove Welds - Design of Fillet Welds – Design of Intermittent Fillet Welds – Failure of Welds.

UNIT- II

ECCENTRIC AND MOMENT CONNECTIONS: Introduction – Beams – Column Connections – Connections Subjected to Eccentric Shear – Bolted Framed Connections –Bolted Seat Connections – Bolted Bracket Connections. Bolted Moment Connections – Welded Framed Connections- Welded Bracket Connections – Moment Resistant Connections.

UNIT- III

ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS: Dead loads, live loads and wind loads on roofs. Design wind speed and pressure, wind pressure on roofs; wind effect on cladding and louvers; Design of angular roof truss, tubular truss, truss for a railway platform.Design of purlins for roofs, design of built up purlins, design of knee braced trusses and stanchions. Design of bracings.

UNIT- IV

DESIGN OF STEEL TRUSS GIRDER BRIDGES: Types of truss bridges, component parts of a truss bridge, economic Proportions of trusses, self weight of truss girders, design of bridge Compression members, tension members; wind load on truss girder Bridges; wind effect on top lateral bracing; bottom lateral bracing; portal Bracing; sway bracing Design of Lacing.

UNIT- V

Plastic Analysis and Design: Introduction – Plastic Theory – Plastic neutral Axis plastic moment, Elastic & Plastic Section moduli shape factors plastic Hinge – Fundamental condition conditions in plastic analysis, methods of plastic analysis – collapse load – simply supported, propped cantilever beam, fixed beams continuous beams, portal frame single bay single storey portal frame at different level subjected to vertical and horizontal loads, Method of instantaneous center gable frame – Trial and error method – plastic moment distribution method – continuous beam– ultimate Deflections for beams and frames

REFERENCES:

1. Limit State Design of Steel Structures S.K. Duggal Mc Graw Hill Education Private Ltd. New Delhi.

2. Design of Steel Structures. P.Dayaratnam, Publisher : S. Chand, Edition 2011-12.
3. Design Steel Structures Volume – II, Dr. Ramachandra & Vivendra Gehlot Scientific Publishes Journals Department.
4. Design of Steel Structures. P.Dayaratnam, Publisher : S. Chand, Edition 2011-12.
5. Design of Steel Structures Galyord & Gaylord, Publisher: Tata Mc Graw Hill, Education. Edition 2012.
6. Indian Standard Code – IS – 800-2007.
7. Indian Standard Code – IS – 875 – Part III - 2015

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

DESIGN OF HIGH-RISE BUILDINGS (PE – III)

Course Outcomes: At the end of the course, students will be able to

1. Analyse, design and detail Transmission/ TV tower, Mast and Trestles with different loading conditions.
2. Analyse, design and detail the RC and Steel Chimney.
3. Analyse. design and detail the tall buildings subjected to different loading conditions using relevant codes.

UNIT- I

Design of transmission/ TV tower, Mast and trestles: Configuration, bracing system, analysis and design for vertical transverse and longitudinal loads.

UNIT-II

Analysis and Design of RC and Steel Chimney, Foundation design for varied soil strata.

UNIT- III

Tall Buildings: Structural Concept, Configurations, various systems, Wind and Seismic loads, Dynamic approach, structural design considerations and IS code provisions. Firefighting design provisions.

UNIT- IV

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

UNIT- V

Introduction to Overall buckling analysis of frames, translational, torsional instability, case studies

REFERENCE BOOKS:

1. Structural Analysis and Design of Tall Buildings, Taranath B. S., Mc Graw Hill, 1988.
2. Structural Design of Multi-storeyed Buildings, Varyani U. H., 2nd Ed., SouthAsian Publishers, New Delhi, 2002.
3. Illustrated Design of Reinforced Concrete Buildings (GF+3storeyed), Shah V. L. & Karve S. R., Structures Publications, Pune, 2013.
4. Design of Multi Storeyed Buildings, Vol. 1 & 2, CPWD Publications, 1976.
5. Tall Building Structures, Smith Byran S. and Coull Alex, Wiley India. 1991.
6. High Rise Building Structures, Wolfgang Schueller, Wiley., 1971.
7. Tall Chimneys, Manohar S. N., Tata Mc Graw Hill Publishing Company, New Delhi

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

DESIGN OF MASONRY STRUCTURES (PE – III)

Course outcomes: At the end of the course, students will be able to

1. Understand the masonry design approaches.
2. Analyse Reinforced Masonry Members.
3. Determine interactions between members.
4. Determine shear strength and ductility of Reinforced Masonry members.
5. Check the stability of walls
6. Perform elastic and Inelastic analysis of masonry walls.

UNIT- I

Introduction: Historical Perspective, Masonry Materials, Masonry Design Approaches, Overview of Load Conditions, Compression Behaviour of Masonry, Masonry Wall Configurations, Distribution of Lateral Forces.

UNIT- II

Flexural Strength of Reinforced Masonry Members: In plane and Out-of-plane Loading.

UNIT- III

Interactions: Structural Wall, Columns and Pilasters, Retaining Wall, Pier and Foundation.

UNIT- IV

Shear Strength and Ductility of Reinforced Masonry Members.

UNIT- V

Prestressed Masonry - Stability of Walls, Coupling of Masonry Walls, Openings, Columns, Beams.
Elastic and Inelastic Analysis, Modeling Techniques, Static Push Over Analysis and use of Capacity Design Spectra.

REFERENCE BOOKS:

1. Masonry Structures: Behavior and Design, Hamid Ahmad A. and Drysdale Robert G., 1994.
2. Design of Reinforced Masonry Structures, Narendra Taly, ICC, 2nd Edn,
3. Mechanics of Masonry Structures, Editor: Maurizio Angelillo, 2014.
4. Earthquake-resistant Design of Masonry Buildings, Toma_evi_Miha, Imperial College Press, 1999.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

SOIL STRUCTURE INTERACTION (PE – IV)

Course Outcomes: At the end of the course, students will be able to

- Understand soil structure interaction concept and complexities involved.
- Evaluate soil structure interaction for different types of structure under various conditions of loading and subsoil characteristics.
- Prepare comprehensive design-oriented computer programs for interaction problems based on theory of sub grade reaction such as beams, footings, rafts etc.
- Analyze different types of frame structure founded on stratified natural deposits with linear and non-linear stress-strain characteristics.
- Evaluate action of group of piles considering stress-strain characteristics of real soils.

UNIT- I

Critical Study of Conventional Methods of Foundation Design, Nature and Complexities of Soil Structure Interaction.

UNIT- II

Application of Advanced Techniques of Analysis such as FEM and Finite Difference Method.

UNIT- III

Relaxation and Interaction for the Evaluation of Soil Structure Interaction for Different Types of Structure under various Conditions of Loading and Subsoil Characteristics.

UNIT- IV

Preparation of Comprehensive Design Oriented Computer Programs for Specific Problems, Interaction Problems based on Theory of Sub Grade Reaction Such as Beams, Footings, Rafts Etc.

UNIT-V

Analysis of Different Types of Frame Structures Founded on Stratified Natural Deposits with Linear and Non-Linear Stress-Strain Characteristics.

Determination of Pile Capacities and Negative Skin Friction, Action of Group of

Piles Considering Stress-Strain Characteristics of Real Soils, Anchor Piles and Determination of Pullout Resistance.

REFERENCE BOOKS:

1. Analytical and Computer Methods in Foundation, Bowels J.E., McGraw Hill Book Co., New York, 1974.
2. Numerical Methods in Geotechnical Engineering, Desai C.S. and Christian J.T., McGraw Hill Book Co., New York.
3. Soil Structure Interaction - The real behaviour of structures, Institution of Structural Engineers.
4. Elastic Analysis of Soil Foundation Interaction, Developments in Geotechnical Engg. Vol-17, Elsevier Scientific Publishing Company.
5. Elastic Analysis of Soil-Foundation Interaction, Selvadurai A.P.S., Elsevier Scientific Publishing Company.
6. Analysis & Design of substructures, Swami Saran, Oxford & IBH Publishing Co. Pvt. Ltd.
7. Design of Foundation System- Principles & Practices, Kurian N. P., Narosa Publishing

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

DESIGN OF PRESTRESSED CONCRETE STRUCTURES (PE – IV)

Course outcomes: At the end of the course, students will be able to

1. Find out losses in the prestressed concrete. Understand the basic aspects of prestressed concrete fundamentals, including pre and post-tensioning processes.
2. Analyse prestressed concrete deck slab and beam/ girders.
3. Design prestressed concrete deck slab and beam/ girders.
4. Design of end blocks for prestressed members.

UNIT I:

Design of Prestressed Concrete Sections- Design of sections for flexure, Minimum section modulus- prestressing force- Limitation of prestress in long spans- limiting zone for the prestressing force- Design of sections for the limit state of collapse in flexure-Design of sections for axial tension.

UNIT II:

Statically Indeterminate Structures: Primary and secondary moments – methods of Analysis of secondary moments. –Analysis of continuous beams and simple portal frames (single bay and single storey)

Composite Beams: Different Types- Propped and Unpropped- stress distribution- Differential shrinkage- Analysis of composite beams- General design considerations.

UNIT III:

Design of sections for Compression and Bending: Load- Moment Interaction curves for prestressed concrete short columns-Design of long prestressed columns-design of prestressed concrete compression members in biaxial bending- practical design considerations-design of prestressed sections for shear and torsion.

UNIT IV:

Prestressed Concrete Slabs: Types of prestressed concrete floor slabs- design of prestressed concrete one way and two-way slabs—design of prestressed concrete simple flat slabs and continuous flat slab floors.

UNIT V:

Prestressed Concrete Pipes, Tanks, Poles and Piles: Circular prestressing- Types of prestressed concrete pipes- Design of prestressed concrete pipes- analysis and design of prestressed concrete tanks-Design of prestressed concrete poles, partially prestressed pretensioned poles-advantages of prestressed concrete piles-types of prestressed concrete piles- design considerations- pile reinforcements- pile shoes-sheet piles.

REFERENCES:

1. prestressed concrete, krishnanraju N, Tata Mc Graw Hill, New Delhi. 1981.
2. design of prestressed concrete structure, Lin T.Y., Asia Publication house, 1995.
3. prestressed concrete by k.v. muthu PHI learning Pvt. CEO
4. limited state design of prestressed concrete, Gutan Y, Applied science publishers, 1972.
5. Is:1343-2012-code of practice for prestressed concrete

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

STRUCTURAL OPTIMIZATION (PE – IV)

Course Outcomes: At the end of the course, students will be able to

1. Use Variational principle for optimization
2. Apply optimization techniques to structural steel and concrete members.
3. Design using frequency constraint.

UNIT –I

Introduction: Simultaneous Failure Mode and Design, Classical External Problems.

UNIT –II

Calculus of Variation: Variational Principles with Constraints,

UNIT –III

Linear Programming, Integer Programming, Nonlinear Programming, Dynamic Programming,

UNIT –IV

Geometric Programming and Stochastic Programming.

UNIT –V

Applications: Structural Steel and Concrete Members, Trusses and Frames.

Design: Frequency Constraint, Design of Layouts.

REFERENCE BOOKS:

1. Elements of Structural Optimization, Haftka, Raphael T., Gürdal, Zafer, Springer.
2. Variational methods for Structural optimization, Cherkaev Andrej, Springer

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

ADVANCED STRUCTURAL ENGINEERING LAB (Lab – III)

The objectives of this course is to make students to learn principles of design of experiments, To investigate the performance of structural elements. To evaluate the different testing methods and equipments.

Course Outcomes: On completion of this course, students are able to

1. Achieve Knowledge of design and development of experimenting skills.
2. Understand the principles of design of experiments
3. Design and develop analytical skills.
4. Summarize the testing methods and equipments.

List of Experiments

1. Testing of under reinforced R.C beam **12 Hrs**
2. Testing of over reinforced R.C beam **12 Hrs**
3. Testing of R.C beam without shear reinforcement **12 Hrs**
4. Experiments on concrete, including Mix design **12 Hrs**
5. Non-destructive testing (NDT) of concrete using **12 Hrs**
 - (a) Rebound hammer,
 - (b) Ultra sonic pulse velocity meter
6. Detection reinforcement in a structural member using profometer **12 Hrs**
7. Extraction of concrete core **12 Hrs**
8. Testing of brick masonry wall **12 Hrs**
9. Testing of simply supported R.C.C slab **12 Hrs**
10. Testing of concrete by extracting concrete core **12 Hrs**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- I YEAR- II SEMESTER
STRUCTURAL ENGINEERING**

STRUCTURAL DESIGN LAB (Lab – IV)

Course Outcomes: At the end of the course, students will be able to

1. Design and Detail all the Structural Components of Frame Buildings.
2. Design and Detail complete Multi-Storey Frame Buildings.

Syllabus Content:

Design and detailed drawing of complete structures in R.C.C and steel by individual student using latest relevant IS codes.

List of Experiments:

1. Static and Dynamic analysis of Building structure using software (ETABS / STAADPRO) 12 Hrs
2. Design of RCC and Steel structure using software (ETABS / STAADPRO) 12 Hrs
3. Analysis of folded plates and shells using software. 12 Hrs
4. Preparation of EXCEL sheets for structural design. 12 Hrs

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- II YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

EARTHQUAKE RESISTANCE DESIGN OF BUILDINGS (PE – V)

Prerequisites: Structural Dynamics, Reinforced Concrete Design

Course Objectives: To impart knowledge on the seismology and behavior of buildings during earthquakes.

Course Outcomes: The learner will be able to analyse and design buildings to resist seismic forces.

UNIT - I

Engineering Seismology: Earthquake phenomenon cause of earthquakes-Faults- Plate tectonics-Seismic waves- Terms associated with earthquakes-Magnitude/Intensity of an earthquake-scales-Energy Released-Earthquake measuring instruments-Seismoscope, Seismograph, accelerograph-Characteristics of strong ground motions- Seismic zones of India.

Introduction-Functional Planning-Continuous load path-Overall form-simplicity and symmetry-elongated shapes-stiffness and strength - Seismic design requirements-regular and irregular configurations-basic assumptions.

UNIT - II

Conceptual Design - Horizontal and Vertical Load Resisting Systems - System and Members for Lateral Loads and High Rise / Tall Structures.

Twisting of Buildings – Flexible Building and Rigid Building Systems.

Strength and Stiffness – Ductility – Definition – Ductility Relationships – Choice of construction Materials – Unconfined Concrete & Confined Concrete - Design Earthquake Loads – Basic Load Combinations – Permissible Stresses.

Seismic Methods of Analysis – Static Method – Equivalent Lateral Force Method. Dynamic Analysis – Response Spectrum Method.

UNIT - III

Introduction to Earthquake Resistant Design – Seismic Design Requirements and Methods.

RC Buildings – IS Code based Method.- Vertical Irregularities – Mass Irregularity Torsional Irregularity - Plan Configuration Problem - Design Lateral Force, Base Shear Evaluation – Lateral Distribution of Base Shear – Structural Walls Strategies and the Location of Structural Walls – Sectional Shapes – Behaviour of Unreinforced and Reinforced Masonry Walls – Behaviour of Walls Box Action and Bands – Behaviour of infill Walls - Non Structural Elements – Failure Mechanism of Nonstructural Elements – Effects of Nonstructural Elements on Structural System – Analysis – Prevention of Damage to Nonstructural Elements – Isolation of Non-Structures.

UNIT - IV

Design of Shear walls: Classification according to Behavior, Loads in Shear walls, Design of Rectangular and Flanged Shear walls, Derivation of Formula for Moment of Resistance of Rectangular Shear walls – Behaviour of Coupled Shear Walls.

UNIT - V

Ductility Considerations in Earthquake Resistant Design of RC Buildings: Introduction- Impact of Ductility- Requirements for Ductility- Assessment of Ductility- Factors affecting Ductility- Ductile detailing considerations as per IS 13920. Behavior of beams, columns and joints in RC buildings

during earthquakes-Vulnerability of open ground storey and short columns during earthquake-
Seismic Evaluation and Retrofitting.

Capacity Based Design: Introduction to Capacity Design, Capacity Design for Beams and Columns-
Case studies.

REFERENCES:

1. Earthquake Resistant Design of structures – S. K. Duggal, Oxford University Press
2. Earthquake Resistant Design of structures – Pankaj Agarwal and Manish Shrikhande, Prentice Hall of India Pvt. Ltd.
3. Seismic Design of Reinforced Concrete and Masonry Building – T. Paulay and M.J.N. Priestly, John Wiley & Sons
4. Masonry and Timber structures including earthquake Resistant Design –Anand S.Arya, Nem chand & Bros
5. Earthquake –Resistant Design of Masonry Building –Miha Tomazevic, Imperial college Press.
6. Design of Reinforced Concrete Structures by N. Subramanian, Oxford University Press.
7. Earthquake Tips – Learning Earthquake Design and Construction C.V.R. Murty

REFERENCE CODES:

1. IS: 1893 (Part-1) -2016. "Criteria for Earthquake Resistant – Design of structures." B.I.S., New Delhi.
2. IS: 4326-1993, "Earthquake Resistant Design and Construction of Building", Code of Practice B.I.S., New Delhi.
3. IS: 13920-2016, "Ductile detailing of concrete structures subjected to seismic force" – Guidelines, B.I.S., New Delhi.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- II YEAR- I SEMESTER
STRUCTURAL ENGINEERING**

INDUSTRIAL STRUCTURES (PE – V)

Prerequisites: Design of Steel Structures & Structural Analysis

Course Objectives: To impart knowledge about different types of industrial structures their analysis and design for different conditions as per codal provision.

Course Outcomes: The learner will be able to plan different types of industrial structures such as cold formed members, RC bunkers, Silos, Chimneys. Cylindrical shells and design them.

UNIT -I

Planning of Industrial Structures – types of industrial structures – different components of industrial structures – Bracings of Industrial Buildings – Design of Steel Industrial Buildings.

UNIT-II

Thin Walled / Cold Formed Steel Members: Definitions – Local Buckling of Thin-Elements-Post Buckling of Thin-Elements – Light Gauge Steel Columns and Compression Members – Form-Factor for Columns and Compression Members – Behaviour of Stiffened Elements Under Uniform Compression – Multiple Stiffened Compression Elements –Effective Length of Light Gauge Steel Compression Members – Light Gauge Steel Tension Members.

UNIT-III

RC Bunkers & Silos: Introduction – Janssen's Theory – Airy's Theory – Design of Square, Rectangular and Circular Bunkers; Design of Silos.

UNIT-IV

RC Chimneys: Introduction – Wind Pressure – Stresses in Chimney Shaft Due to Self-Weight and Wind – Stresses in Horizontal Reinforcement Due to Wind Shear – Stresses Due to Temperature Difference – Combined Effect of Self Load, Wind and Temperature – Temperature Stresses in Horizontal Reinforcement Problems.

UNIT-V

Design Principles of Cylindrical Shells & Design Problems.

REFERENCES:

1. Advanced Reinforced Concrete Design, By N. Krishna Raju (CBS Publishers & Distributors) 2005
2. Design of Steel Structures, By Ram Chandra and Virendra Gehlot vol-II, 2007.
3. Design of Steel Structures, By Duggal - Tata McGraw-Hill publishers – 2010

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH.- II YEAR- I SEMESTER
STRUCTURAL ENGINEERING

BRIDGE ENGINEERING (PE – V)

Course Objectives: The objective of the course is to introduce the concepts in bridge design. the analysis of bridge decks and sub structure are also dealt with.

Course Outcomes: At the end of the course, students will be able to understand

1. The method of design of concrete bridges
2. Design of solid slab and continuous bridges
3. Basic principles and design of prestressed bridges
4. Analysis of bridge decks
5. Design loads of abutments and piers.

UNIT-I

Concrete Bridges: Introduction-Types of Bridges-Economic span length-Types of loading-Dead load-live load-Impact Effect-Centrifugal force-wind loads-Lateral Loads-Longitudinal forces-Seismic loads-Frictional resistance of expansion bearings-Secondary Stresses-Temperature Effect-Erection Forces and effects-Width of roadway and footway-General Design Requirements.

UNIT-II

Solid slab, Girder Bridges & Continuous Bridges: Introduction-Method of Design. Girder Bridges - Introduction-Method of Design-Courbon's Theory. Continuous Bridges - Introduction- Span lengths-Analysis of Continuous Bridges-Decking of Girders with constant Moment of Inertia-Continuous bridges with variable Moment of Inertia-Method of Analysis -Girders with Parabolic Soffit-Method of plotting Influence lines-Girders with Straight Haunches-Design steps for Continuous Bridges.

UNIT-III

Pre-Stressed Concrete Bridges: Basic principals- Method of Pre-stressing-Pretensioning and Post-tensioning- Comparison- Freyssinet Method-Magnel-Blanet System-Lee-Mc call system-Basic Assumptions-Losses in Prestress-Equation based on Initial and final stress conditions-Cable Zone-Design of selections-Condition of first crack- Ultimate load design-Shear-Vertical Prestressing-Diagonal Tension in I-section-End Block-Magnel's method-Empirical Method-General Design requirements-Mild steel reinforcement in prestressed concrete member-Concrete cover and spacing of pre-stressing steel-Slender beams-Composite Section-Propped-Design of Propped Composite Section-Unpropped composite section-Two-stage Prestressing-Shrinking stresses-General Design requirements for Road Bridges.

UNIT-IV

Analysis of Bridge Decks: Harmonic analysis and folded plate theory-Grillage analogy- Finite strip method and FEM.

UNIT-V

Sub-structure of bridges: Substructure- Beds block-Piers- Pier Dimensions- Design loads for piers- Abutments- Design loads for Abutments.

REFERENCES

1. Design of Concrete Bridges by M.G. Aswani, V.N. Vazirani and M.M. Ratwani.
2. Bridge Deck Behaviour by E.C. Hambly.
3. Concrete Bridge Design and Practice by V.K.Raina.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Structural Engineering)**

ENGLISH FOR RESEARCH PAPER WRITING (Audit Course - I & II)

Prerequisite: None

Course objectives: Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

UNIT-I:

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT-II:

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT-III:

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT-IV:

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

UNIT-V:

skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

TEXT BOOKS/ REFERENCES:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Structural Engineering)**

DISASTER MANAGEMENT (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to

- learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches,
- planning and programming in different countries, particularly their home country or the countries they work in

UNIT-I:

Introduction:

Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

Disaster Prone Areas in India:

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT-II:

Repercussions of Disasters and Hazards:

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT-III:

Disaster Preparedness and Management:

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-IV:

Risk Assessment Disaster Risk:

Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT-V:

Disaster Mitigation:

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

TEXT BOOKS/ REFERENCES:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company.
2. Sahni, Pardeep Et. Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Structural Engineering)

SANSKRIT FOR TECHNICAL KNOWLEDGE (Audit Course - I & II)

Prerequisite: None

Course Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes: Students will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

UNIT-I:

Alphabets in Sanskrit,

UNIT-II:

Past/Present/Future Tense, Simple Sentences

UNIT-III:

Order, Introduction of roots,

UNIT-IV:

Technical information about Sanskrit Literature

UNIT-V:

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TEXT BOOKS/ REFERENCES:

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Structural Engineering)

VALUE EDUCATION (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Course outcomes: Students will be able to

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

UNIT-I:

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

UNIT-II:

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT-III:

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness.

UNIT-IV:

Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT-V:

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation, Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

TEXT BOOKS/ REFERENCES:

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

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CONSTITUTION OF INDIA (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes: Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

UNIT-I:

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working), **Philosophy of the Indian Constitution:** Preamble, Salient Features.

UNIT-II:

Contours of Constitutional Rights & Duties: Fundamental Rights Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III:

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions.

UNIT-IV:

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT-V:

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

TEXT BOOKS/ REFERENCES:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Structural Engineering)

PEDAGOGY STUDIES (Audit Course - I & II)

Prerequisite: None

Course Objectives: Students will be able to:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes: Students will be able to understand:

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT-I:

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

UNIT-II:

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT-III:

Evidence on the effectiveness of pedagogical practices, Methodology for the indepth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the scho curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-IV:

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes

UNIT-V:

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

TEXT BOOKS/ REFERENCES:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? *International Journal Educational Development*, 33 (3): 272–282.
5. Alexander RJ (2001) *Culture and pedagogy: International comparisons in primary education*. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Structural Engineering)**

STRESS MANAGEMENT BY YOGA (Audit Course - I & II)

Prerequisite: None

Course Objectives:

- To achieve overall health of body and mind
- To overcome stress

Course Outcomes: Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

UNIT-I:

Definitions of Eight parts of yog. (Ashtanga)

UNIT-II:

Yam and Niyam.

UNIT-III:

Do`s and Don`ts in life.

- i) Ahinsa, satya, astheya, bramhacharya and aparigraha
- ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT-IV:

Asan and Pranayam

UNIT-V:

- i) Various yog poses and their benefits for mind & body
- ii) Regularization of breathing techniques and its effects-Types of pranayam

TEXT BOOKS/ REFERENCES:

1. 'Yogic Asanas for Group Training-Part-I': Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech. (Structural Engineering)

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS
(Audit Course - I & II)

Prerequisite: None

Course Objectives:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes: Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students

UNIT-I:

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)

UNIT-II:

Neetisatakam-Holistic development of personality

- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

UNIT-III:

Approach to day to day work and duties.

- Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

UNIT-IV:

Statements of basic knowledge.

- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad Bhagwad Geeta:

UNIT-V:

- Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

TEXT BOOKS/ REFERENCES:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.