ACADEMIC REGULATIONS & COURSE STRUCTURE

For

STRUCTURAL ENGINEERING

(Applicable for batches admitted from 2016-2017)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA - 533 003, Andhra Pradesh, India
### I Semester

<table>
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<tr>
<th>S. No.</th>
<th>Subject</th>
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<tr>
<td>1</td>
<td>Advanced Mathematics</td>
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<td>2</td>
<td>Theory of Elasticity</td>
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<td>3</td>
<td>Matrix Analysis of Structures</td>
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<td>Structural Dynamics</td>
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<td>I. Experimental Stress Analysis</td>
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<td>II. Sub-Structure Design</td>
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<td>III. Structural Optimization</td>
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<td>I. Repair and Rehabilitation of Structures</td>
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<td>II. Analysis and Design of Tall Buildings</td>
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<td>III. Plastic Analysis and Design</td>
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<td>Advanced Structural Engineering Laboratory</td>
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**Total Credits**: 20

### II Semester

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<td>Stability of Structures</td>
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<td>Theory of Plates &amp; Shells</td>
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<td>I. Pre-Stressed Concrete</td>
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<td>II. Mechanics of Composite Materials</td>
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<td>I. Industrial Structures</td>
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<td>II. Bridge Engineering</td>
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<td>III. Earth Retaining Structures</td>
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**Total Credits**: 20
### III Semester

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### IV Semester

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UNIT-I

UNIT-II

UNIT-III

UNIT-IV
Tests of significance – Analysis of variance for regression – Multiple correlation coefficients – Multiple linear regression with two independent variables.

UNIT-V
Linear Programming Problem Formation, Graphical Method, Simplex method, artificial variable method-Big-M method-Two Phase Method.
Non Linear Programming Problem Gradient method, Steepest Ascent Descent Methods.

TEXT BOOKS
2. Introductory Methods of Numerical Analysis – Sastry, S.S.
UNIT-I

UNIT -II
Two dimensional problems in rectangular co-ordinates – Solution by polynomials – Saint Venant’s principle – Determination of displacements – Bending of simple beams – Application of Fourier series for two dimensional problems for gravity loading

UNIT-III
Two dimensional problems in polar co-ordinates - General equations in polar co-ordinates – Stress distribution for problems having symmetrical about an axis - Strain components in polar co-ordinates – Displacements for symmetrical stress distributions - Stresses for plates with circular holes subjected to far field tension – stress concentration factor.

UNIT-IV

UNIT-V
Torsion of prismatical bars – Bars with elliptical cross section – Other elementary solution – Membrane analogy – Torsion of rectangular bars – Solution of torsional problems by energy method.

REFERENCES
1. Theory of Elasticity- Timoshenko & Goodier
2. Elasticity: Theory, Applications and Numeric- Martin H. Sadd
UNIT-I

UNIT-II
Stiffness method – Element and global stiffness equation – coordinate transformation and global assembly – structure stiffness matrix equation – analysis of simple pin jointed trusses – continuous beams – rigid jointed plane frames

UNIT-III

UNIT-IV

UNIT-V
Space trusses and frames - Member stiffness for space truss and space frame– Transformation matrix from Local to Global – Analysis of simple trusses, beams and frames

REFERENCES:
3. Indeterminate Structural analysis- C K Wang
5. Foundation Analysis and design – J.E. Bowls.
UNIT-I

Introduction to Structural Dynamics: Fundamental objective of Dynamic analysis – Types of prescribed loadings – methods of Discretization – Formulation of the Equations of Motion.

UNIT-II

Theory of Vibrations: Introduction – Elements of a Vibratory system
– Degrees of Freedom of continuous systems - Oscillatory motion – Simple Harmonic Motion

UNIT-III


UNIT-IV

Multi Degree of Freedom System: Selection of the Degrees of Freedom
– Evaluation of Structural Property Matrices – Formulation of the MDOF equations of motion

UNIT-V


REFERENCES:
1. Dynamics of Structures by Clough & Penzien.
2. Structural Dynamics A K Chopra
UNIT-I
Introduction and Strain measurement methods – Model & Prototype
– Dimensional analysis-Factors influencing model design – Scale factors and Model material properties – Methods of model design. Definition of strain and its relation to experimental determinations - properties of strain gauge systems – Mechanical, Optical, Acoustic and Pneumatic types.

UNIT-II
Electric resistance strain gages: Introduction – gauge construction
– strain gauge adhesives - mounting methods – gauge sensitivities and gage factor – performance characteristics of wire and foil strain gauges – environmental effects. Analysis of strain gauge data – the three element rectangular rosette – the delta rosette – correction for transverse sensitivity.

UNIT-III

UNIT-IV
Theory of photo elasticity: Introduction – temporary double refraction
– Index ellipsoid and stress ellipsoid – the stress optic law – effects of stressed model in a polariscope for various arrangements - fringe sharpening.

UNIT-V

REFERENCES:
1. Experimental Stress Analysis- Riley and Dally
2. Experimental Stress Analysis - L.S. Srinath
3. Experimental Stress Analysis – Lee
4. Experimental Stress Analysis- Sadhu Singh
UNIT-I
Soil Exploration – Importance, Terminology, planning - Geophysical methods. Borings, location, spacing and depth, methods of boring including drilling, stabilization of boreholes, boring records.

UNIT-II
Soil sampling – Methods of sampling -Types of samples and samplers-cleaning of bore holes, preservation, labeling and shipment of samples - Design considerations of open drive samplers.

UNIT-III
Shallow Foundations –Bearing capacity – General bearing capacity equation, Meyerhof’s, Hansen’s and Vesic’s bearing capacity factors - Bearing capacity of stratified soils - Bearing capacity based on penetration resistance- safe bearing capacity and allowable bearing pressure. (Ref: IS -2131 & IS 6403)

UNIT-IV

UNIT-V
Pile foundations-Classification of piles-factors influencing choice-Load -carrying capacity of single piles in clays and sands using static pile formulae- \( \alpha \) - \( \alpha \) - and \( \lambda \) - methods –Dynamic pile formulae-limitations-Monotonic and cyclic pile load tests – Under reamed piles. Pile groups -Efficiency of pile groups- Different formulae-load carrying capacity of pile groups in clays and sands – settlement of pile groups in clays and sands – Computation of load on each pile in a group.

REFERENCES:
1. Principles of Foundation Engineering by Braja M. Das.
2. Soil Mechanics in Engineering Practice by Terzagi and Peck
3. Foundation Design by Wayne C. Teng, John Wiley & Co.,
5. Analysis and Design of sub structures by Swami Saran
7. Foundation Design and Construction by MJ Tomlinson – Longman Scientific
8. A short course in Foundation Engineering by Simmons and Menzes – ELBS.
STRUCTURAL OPTIMIZATION
(ELECTIVE-I)

UNIT-I
Introduction: Need and scope for optimization – statements of optimization problems-
Objective function and its surface design variables- constraints and constraint surface-
Classification of optimization problems (various functions continuous, discontinuous and
discrete) and function behavior (monotonic and unimodal)

UNIT-II
Classical optimization techniques: Differential calculus method, multi variable optimization by
method of constrained variation and Lagrange multipliers (generalized problem) Khun-Tucker
conditions of optimality -Fully stressed design and optimality criterion based algorithms-
introduction, characteristics of fully stressed design theoretical basis-examples

UNIT-III
Non-Liner programming: Unconstrained minimization- Fibonacci, golden search, Quadratic
and cubic interpolation methods for a one dimensional minimization and univariate method,
Powel’s method, Newton’s method and Davidon Fletcher Powell’s method for multivariable
optimization- Constrained minimization- Cutting plane method- Zoutendjik’s method- penalty
function methods

UNIT-IV
Linear programming: Definitions and theorems- Simplex method-Duality in Linear
programming- Plastic analysis and Minimum weight design and rigid frame

UNIT-V
Introduction to quadratic programming: Geometric programming- and dynamic programming-
Design of beams and frames using dynamic programming technique

REFERENCES
Optimization Concepts and Application in Engineering- Belegundu A.D. and Chandrupatla
T.R

2. Strengthening and stabilization - Techniques - design considerations - Beam shear capacity strengthening - Shear Transfer strengthening - stress reduction techniques - Column strengthening - flexural strengthening - Connection stabilization and strengthening, Crack stabilization.


REFERENCE:
1. Concrete technology - Neville & Brooks
2. Special Structural concrete - Rafat Siddique
3. Concrete repair and maintenance illustrated - Peter H Emmons
4. Concrete technology - M S Shetty
1. Design Criteria Philosophy, Materials – Modern concepts – High Performance Concrete, Fibre Reinforced Concrete, Light weight concrete, Self Compacting Concrete


TEXT BOOKS:


PLASTIC ANALYSIS AND DESIGN
(ELECTIVE-II)

1. Introduction and basic hypothesis: Concepts of stress and strain – relation of steel Moment curvature relation- basic difference between elastic and plastic analysis with examples- Yield condition, idealizations, collapse criteria- Virtual work in the elastic-plastic state-Evaluation of fully plastic moment and shape factors for the various practical sections.

2. Method of Limit Analysis: Introduction to limit analysis of simply supported fixed beams and continuous beams, Effect of partial fixity and end, invariance of collapse loads, basic theorems of limit analysis, rectangular portal frames, gable frames, grids, superposition of mechanisms, drawing statistical bending moment diagrams for checks.

3. Limit design Principles: Basic principles, limit design theorems, application of limit design theorems, trial and error method, method of combining mechanisms, plastic moment distribution method, load replacement method, continuous beams and simple frames designs using above principles.

4. Deflection in Plastic beams and frames: Load deflection relations for simply supported beams, deflection of simple pin based and fixed based portal frames, method of computing deflections.

5. Minimum weight Design: Introduction to minimum Weight and linear Weight functions- Foulkes theorems and its geometrical analogue and absolute minimum weight design.

REFERENCES:
1. Plastic Methods of Structural analysis- B G Neal, Chapman and Rall publications
2. Plastic analysis and Design – C E Messennet, M A Seve
1. Strain measurement - Electrical resistance strain gauges
2. Non destructive testing- Impact Hammer test, UPV test
3. Qualifications tests on Self compaction concrete- L Box test, J Box test, U box test, Slump test
4. Tests on Buckling of columns – Southwell plot
5. Repair and rehabilitation of concrete beams
6. Chemical Analysis of water for suitability in concreting with and without Reinforcement.
7. Chemical Analysis of sand and Aggregate for Suitability in Construction.

NOTE: A minimum of five experiments from the above set have to be conducted.


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


REFERENCES:


3. Calculation of EQ load – 3D modeling of building systems and analysis (theory only) Design and ductile detailing of Beams and columns of frames Concept of strong column weak beams, Design and ductile detailing of shear walls


5. Retrofitting and restoration of buildings subjected to damage due to earthquakes- effects of earthquakes – factors related to building damages due to earthquake- methods of seismic retrofitting- restoration of buildings

REFERENCES


3. Relevant code of practices.
STABILITY OF STRUCTURES


3. In-elastic buckling: Buckling of straight bars – Double modulus theory Tangent modulus theory. Experiments and design formulae:

4. Torsional Buckling: Pure torsion of thin walled bars of open cross section – Non uniform torsion of thin walled bars of open cross section - Torsional buckling – Buckling of Torsion and Flexure.

5. Lateral Buckling of simply supported Beams: Beams of rectangular cross section subjected for pure bending, Buckling of I Section subjected to pure bending.

REFERENCES:

1. Derivation of governing differential equation for plate– in plane bending and transverse bending effects- Rectangular plates: Plates under various loading conditions like concentrated, uniformly distributed load and hydrostatic pressure. Navier and Levy’s type of solutions for various boundary condition.

2. Circular plates: Symmetrically loaded, circular plates under various loading conditions, Annular plates.


5. Beam theory of cylindrical shells: Beam and arch action. Design of diaphragms - Geometry analysis and design of elliptic Paraboloid, Conoidal and Hyperbolic Paraboloid shapes by membrane theory.

REFERENCES:


2. K. Chandra Sekhara

3. A Text Book of Plate Analysis – Bairagi, K, Khanna Publisher, New Delhi.

1. General principles of Pre-stressing- Pre-tensioning and Post tensioning - Pre tensioning and Post tensioning methods- Different systems of Pre-stressing- Analysis of prestress and Bending stresses– Resultant
2. Losses of Pre-stressing- Loss of Pre-stress in pre-tensioned and post tensioned members due to various causes - Elastic shortening of concrete, shrinkage of concrete, creep of concrete, Relaxation of steel, slip in anchorage, differential shrinkage- bending of members and frictional losses- Long term losses
3. Flexural, shear; torsional resistance and design of Prestressed concrete section. Types of flexural failure – code procedures-shear and principal stresses – Prestressed concrete members in torsion – Design of sections for flexure, Axial Tension, Compression and bending, shear, Bond
5. Analysis of end blocks: By Guyon’s method and Magnel’s method, Anchorage zone stresses- Approximate method of design- anchorage zone reinforcement- transfer of pre stresses- pre tensioned members-Composite sections: Introduction-Analysis for stresses- differential shrinkage- general design considerations

REFERENCES:
1. Prestressed Concrete- N. Krishna Raju
2. Prestressed Concrete- S. Ramamrutham
3. Prestressed Concrete- P. Dayaratnam
4. Prestressed Concrete- T.Y.Lin


TEXT BOOKS:


FRACTURE MECHANICS
(ELECTIVE –III)


REFERENCES
2. Elements of Fracture Mechanics – Prasanth Kumar, wiley Eastern Publications
3. Fracture Mechanics: Fundamentals and applications – T. L. Andra son, PhD, CRC publications
INDUSTRIAL STRUCTURES
(ELECTIVE –IV)

1. Planning and functional requirements- classification of industries and industrial structures- planning for layout- requirements regarding lighting ventilation and fire safety- protection against noise and vibrations
2. Industrial buildings- roofs for industrial buildings (Steel) - design of gantry girder- design of corbels and nibs- machine foundations
3. Design of Folded plates- Design considerations- analysis of folded plates- analysis of multibay folded plates- design of diaphragm beam
4. Power plant structures- Bunkers and silos- chimney and cooling towers- Nuclear containment structures
5. Power transmission structures- transmission line towers- tower foundations- testing towers

REFERENCES:
1. Advanced reinforced concrete design - N. Krishnam Raju
2. Handbook on machine foundations- P. Srinivasulu and C.V. Vaidyanathan
3. Tall Chimneys- Design and construction – S.N. Manohar
5. SP 32: 1986, Handbook on functional requirements of Industrial buildings
6. Design of shells- K. Chandrasekhar
BRIDGE ENGINEERING  
(ELECTIVE –IV) 

1. Masonry arch Bridge design details- Rise, radius, and thickness of arch- Arch ring- 
Dimensioning of sub structures- Abutments pier and end connections.(Ref: IRC- SP-13)  
2. Super Structure: Slab bridge- Wheel load on slab- effective width method- slabs supported on 
two edges- cantilever slabs- dispersion length- Design of interior panel of slab- Pigeaud’s 
method- design of longitudinal girders- Guyon-Messonet method- Hendry Jaegar method- 
Courbon’s theory. (Ref: IRC-21), voided slabs, T-Beam bridges.  
3. Plate girder bridges- Elements of plate girder and their design-web-flange- intermediate 
stiffener- vertical stiffeners- bearing stiffener-design problem  
4. Prestressed Concrete and Composite bridges- Preliminary dimensions-flexural and torsional 
parameters- Courbon’s Theory – Distribution coefficients 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 and end block design- short term and long term deflections- Composite 
action of composite brides- shear connectors- composite or transformed section- design 
problem. (Ref: IRC: Section-VI)  
5. Sub structure- Abutments- Stability analysis of abutments- piers- loads on piers – Analysis of 
piers- Design problem(Ref: IRC-13, IRC-21, IRC-78)- Pipe culvert- Flow pattern in pipe 
culvers- culvert alignment-culvert entrance structure- Hydraulic design and structural design of 
pipe culverts- reinforcements in pipes .(Ref: IRC: SP-13) 

REFERENCES: 
1. Design of concrete bridges- Aswini, Vazirani, Ratwani  
2. Essentials of bridge engineering- Jhonson Victor D  
3. Design of bridges- Krishna Raju
EARTH RETAINING STRUCTURES
(ELECTIVE –IV)

1. Earth pressures – Different types and their coefficients- Classical Theories of Earth pressure – Rankine’s and Coulomb’s Theories for Active and Passive earth pressure- Computation of Lateral Earth Pressure in Homogeneous and Layered soils- Graphical solutions for Coulomb’s Theory in active and passive conditions.


REFERENCES

1. Principles of Foundation Engineering by Braja M. Das.
2. Foundation analysis and design – Bowles, JE – McGraw Hill
Analysis and Design using STADD, STRAP, STRUDS, ANSYS

1. Programming for beams subject to different loading (mandatory).
2. Analysis of reinforced concrete multistoried building
3. Analysis of steel transmission line tower
4. Analysis of plane and space truss
5. Analysis of plane and space frame
6. Determination of mode shapes and frequencies of tall buildings using lumped mass (stick model) approximation
7. Wind analysis on tall structure
8. Analysis of pre stressed concrete bridge girder
9. Analysis of Cylindrical shell
10. Modal Analysis of a Cantilever Beam

NOTE: A minimum of eight (including item 1) from the above set have to be conducted.

REFERENCE:

Computer aided design laboratory (Civil Engineering) by Shesha Prakash and Suresh.S