Guru Nanak dev Engineering College, Ludhiana
(An Autonomous College under UGC Act)
Civil Engineering Department

Course Scheme: M. Tech (Structural Engineering)—Full Time

Schedule of Teaching and study Scheme

Semester	Subjects	Credits	Contact Hours/week			No. of subjects	Distribution of marks		Total Credits
			L	T	P		Ext	Int	
1	Core subjects	4	4	-	-	3	100	50	20
	Program elective	3	3	-	-	1	100	50	
	Open elective	3	3	-	-	1	100	50	
	Laboratory-1	2	--	-	4	1	50	50	
2	Core subjects	4	4	-	-	3	100	50	20
	Program elective	3	3	-	-	1	100	50	
	Open elective	3	3	-	-	1	100	50	
	Laboratory -2	2	--	-	4	1	50	50	
3	Program elective	3	3	-	-	1	100	50	14
	Program elective	3	3	-	-	1	100	50	
	Pre-thesis seminar	4	-	-	4	1	50	50	
	Pre-thesis project	4	-	-	4	1	50	50	
4	Thesis/Dissertation	14	14	-	-	--	100	200	14
Total Marks and credits							**1500**	**1000**	**68**

List of Core Subjects

S. No.	Subject	Subject Code
1	Structural Dynamics	MTST-501
2	Bridge Engineering	MTST-502
3	Theory and Design of Plates, Shells and Grids	MTST-503
4	Research Methodology	MTST-504
5	Advanced Solid Mechanics & Structural Analysis	MTST-505
6	Plastic Analysis and Design of Steel Structures	MTST-506

List of Laboratory/Practical work

S. No.	Subject	Subject Code
1	Laboratory-1	MTST-507
2	Laboratory-2	MTST-508
3	Pre-thesis seminar	MTST-509
4	Pre-thesis project	MTST-510
5	Thesis	MTST-511

List of Program Electives

S. No.	Subject	Subject Code
1	Nonlinear Analysis and computer aided methods	MTST-601
2	Finite Element Methods	MTST-602
3	Non-destructive Testing and Composite Materials	MTST-603
4	High Rise Buildings	MTST-604
5	Structural Reliability	MTST-605
6	Structural Optimisation	MTST-606
7	Pre-stressed Concrete Structures	MTST-607
8	Analysis & Design of substructures	MTST-608
9	Soil-Structure Interaction	MTST-609
10	Earthquake Resistant Design of Masonry and RC Buildings	MTST-610
11	Buried Structures	MTST-611
12	Design of Highway and Airport Pavements	MTST-612
13	Environmental Impact assessment & Management	MTST-613
14	Disaster Reduction and Management	MTST-614
`15	Site Investigations	MTST-615
16	Advanced Structure Design and detailing	MTST-616
17	Industrial Structures	MTST-617
18	Theory of elasticity and plasticity	MTST-618
19	Structural Stability	MTST-619
20	Ground Improvement	MTST-620

List of subjects to be offered as 'Open Electives'

1	Experimental Methods in Engineering	MTCE-621
2	Numerical Methods in Engineering	MTCE-622
3	Instrumentation and model simulation	MTCE-623
4	Advanced Engineering Mathematics	MTCE-624
5	Probabilistic Methods in Engineering	MTCE-625
6	Limit Analysis	MTCE-626

MTST-501: Structural Dynamics

Course Credits --4

Internal Marks: 50   **L   T   P**
External Marks: 100   **4   0   0**
Total Marks: 150

UNIT I:
Theory of vibrations: Introduction - Elements of vibratory system – Types of vibration-Degrees of Freedom-Continuous System - Lumped mass idealization - Oscillatory motion - Simple Harmonic motion – Vibration control in the design of structures.

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.

UNIT III
Single Degree of Freedom Systems : Free vibrations of single degree of freedom system - undamped and damped vibrations - critical damping - Logarithmic decrement ,Formulation and solution of the equation of motion - Free vibration response - Response to Harmonic, Periodic, Impulsive and general dynamic loadings - Duhamel integral.Forced vibration of SDOF systems - Harmonic excitation -Dynamic magnification factor – Phase angle – Bandwidth. Numerical solution of single degree of freedom systems – Central Difference Method – Average acceleration method, Wilson-θ method- Newmark – β method. Earthquake response of linear systems.

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

UNIT VI
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.

REFERENCES:
1. Dynamics of Structures by Clough & Penzien, McGraw Hill, New york
2. Structural Dynamics by Mario Paz, C.B.S Publishers, New Delhi.
3. Dynamics of Structures by Anil K. Chopra, Pearson Education (Singapore), Delhi.
4. Mechanical Vibrations by G.K. Grover
5. Dynamics of Structures by Walter C. Hurty & Moshe F. Rubinsten

MTST-503: Theory and Design of Plates, Shells and Grids

Course Credits --4

Internal Marks: 50   **L   T   P**
External Marks: 100   **4   0   0**
Total Marks: 150

Analysis of Plates
Introduction- Assumptions in the theory of thin isotropic plates. Pure bending of plates, slope and curvature, relations between bending moments and curvature, Particular cases of pure bending.

Symmetrical bending of circular plates-Differential equation-Uniformly loaded circular plates with simply supported and fixed boundary conditions-Annular plate with uniform moments and shear forces along the boundaries

Small deflections of laterally loaded plates-Differential equation-Boundary conditions-Navier solution and Levy's solution for simply supported rectangular plates-

Analysis of Grids
Bending of anisotropic plates - Derivation of governing differential equation – Determination of Rigidities in various cases like R.C. slabs, corrugated sheet – Application to the theory of grid works.

Various methods of analyzing grids for roofs and bridges. Distribution of concentrated loads to various beams of grid floors and bridge decks.

References:
1.   Timoshenko S.P. and Krieger S. W., Theory of Plates and Shells, Tata Mc Graw Hill, 1959.
2.   Theory and Analysis of Plates by P. Szilard, Prentice Hall, 1974.
3.   Bairagi N. K., Plate Analysis, Khanna Publishers, 1986.
4.   T.K.Varadan & K. Bhaskar, Análysis of plates – Theory and problems, Narosa Publishing Co., 1999.
5.   Reddy J N., Theory and Analysis of Plates and Shells, Taylor and Francis, 2007.

MTST-505: Advanced Solid Mechanics & Structural Analysis

Course Credits --4

Internal Marks: 50   L T P
External Marks: 100   4 0 0
Total Marks: 150

Introduction: Matrix methods of analysis and their suitability, static and kinematic indeterminacies as related to two-dimensional and three-dimensional skeletal structures, generalized system of coordinates.

Force method: Development of flexibility matrices for statically determinate and in determinate beams, rigid-jointed plane frames and pin-jointed plane frames. Assembly of global flexibility matrix from element flexibility matrices. Analysis of continuous beams, rigid-jointed plane frames and pin-jointed plane frames using physical and element approaches.

Displacement method: Development of stiffness matrices for statically determinate and in determinate beams, rigid-jointed plane frames and pin-jointed plane frames. Assembly of global stiffness matrix from element stiffness matrices. Analysis of continuous beams, rigid-jointed plane frames and pin-jointed plane frames using physical and element approaches.

BOOKS RECOMMENDED

1. Matrix analysis of framed structures: William Weaver Jr. & James M. Gere
2. Structural analysis - A matrix approach: G S Pandit & S P Gupta (Tata McGraw Hill)
3. Basic structural analysis: C S Reddy (Tata McGraw Hill)

MTST-602: Finite Element Methods

Course Credits --3

Internal Marks: 50	**L**	**T**	**P**
External Marks: 100	**3**	**0**	**0**
Total Marks: 150			

Introduction
Brief History , Role the Computer , General Steps of the Finite Element Method , Applications of the Finite Element Method , Advantages of the Finite Element Method , Computer Programs for the Finite Element , Methods for Solution of Simultaneous Linear Equations , Banded-Symmetric Matrices, Bandwidth, Skyline, and Wavefront Methods

Introduction to the Stiffness Method
Definition of the Stiffness Matrix , Derivation of the Stiffness Matrix for a Spring Element, Assembling the Total Stiffness Matrix by Superposition , Boundary Conditions , Potential Energy Approach to Derive Spring Element Equations

Trusses
Derivation of the Stiffness Matrix for a Bar Element in Local Coordinates , Selecting Approximation Functions for Displacements , Transformation of Vectors in Two Dimensions , Global Stiffness Matrix , Computation of Stress for a Bar in the x-y Plane , Solution of a Plane Truss , Transformation Matrix and Stiffness Matrix for a Bar in Three-Dimensional Space , Use of Symmetry in Structure, Inclined or Skewed Supports, Potential Energy Approach to Derive Bar Element Equations , Comparison of Finite Element Solution to Exact Solution for Bar , Galerkin's Residual Method and Its Use to Derive the One-Dimensional Bar Element Equations

Beams
Beam Stiffness, Assemblage of Beam Stiffness Matrices , Beam Analysis Using the Direct Stiffness Method , Distributed Loading , Comparison of the Finite Element Solution to the Exact Solution for a Beam , Beam Element with Nodal Hinge , Potential Energy Approach to Derive Beam Element Equations , Galerkin's Method for Deriving Beam Element Equations

Frames and Grids
Two-Dimensional Arbitrarily Oriented Beam Element , Rigid Plane Frame Examples , Inclined or Skewed Supports – Frame Element , Grid Equations , Beam Element Arbitrarily Oriented in Space , Concept of Substructure Analysis

Plates with Plane Stress and Plane Strain
Basic Concepts of Plane Stress and Plane Strain, Derivation of the Constant-Strain Triangular Element Stiffness Matrix and Equations , Treatment of Body and Surface Forces , Explicit Expression for the Constant-Strain Triangle Stiffness Matrix

Practical Considerations in Modelling and Result Interpretation
Finite Element Modelling , Equilibrium and Compatibility of Finite Element Results , Convergence of Solution , Interpretation of Stresses , Static Condensation , Flowchart for the Solution of Plane Stress/Strain Problems , Computer Program Assisted Step-by-Step Solution, Other Models, and Results for Plane Stress/Strain Problems

Axisymmetric Elements
Derivation of the Stiffness Matrix, Solution of an Axisymmetric Pressure Vessel, Applications of Axisymmetric Elements

Isoparametric Formulation
Isoparametric Formulation of the Bar Element Stiffness Matrix , Rectangular Plane Stress Element , Isoparametric Formulation of the Plane Element Stiffness Matrix , Gaussian and Newton-Cotes Quadrature , Evaluation of the Stiffness Matrix and Stress Matrix by Gaussian Quadrature , Higher-Order Shape Functions

Three-Dimensional Stress Analysis
Three-Dimensional Stress and Strain, Tetrahedral Element, Isoparametric Formulation

Plate Bending Element
Basic Concept of Plate Bending, Derivation of a Plate Bending Element Stiffness Matrix and Equations, Computer Solution for a Plate Bending Problem

References

1.   A First Course in the Finite Element Method by Logan D. L.; (Cengage Learning)
2.   Elementary Finite Element Method by Desai C.S. ; (Prentice Hall of India)
3.   Introduction to Finite Elements in Engineering by Chandrupatla T.R. & Belegundu A.D.; (Prentice Hall of India)
4.   Finite Element Procedures in Engineering Analysis by Bathe K.J ; (Prentice Hall of India)
5.   Finite Element Analysis: Fundamentals by Gallaghar R.H ; (Prentice Hall Inc.)
6.   Finite Element Analysis in Engineering Design by Rajasekaran S.; (Wheeler Pub.)
7.   Finite Element Analysis - Theory and Programming by Krishnamoorthy C. S.; (Tata McGraw Hill)
8.   The Finite Element Method, Vol I & II by Zienkiewics O.C. & Taylor R.L.; (McGraw Hill)
9.   Finite Element Analysis by Bhavikatti S. S.; (New Age International Publishers)

MTCE-622: Numerical Methods in Engineering

Course Credits --3

Internal Marks: 50   **L   T   P**
External Marks: 100   **3   0   0**
Total Marks: 150

1. Equation: Roots of algebraic transcendental equation, Solution of linear simultaneous Equations by different methods using Elimination, Iteration, Inversion, Gauss-Jordan and Gauss Siedel iteration method – Factorisation method – Ill conditioned matrix. Numerical integration: Newton Cotes closed quadrature – Trapezoidal rule – Simpson's $1/3^{rd}$ rule – $3/8^{th}$ rule method. Homogeneous and Eigen Value problem, Non-linear equations, Interpolation.

2. Finite Difference Technique: Partial differential equation: Laplace, Poisson and wave equation – Explicit and implicit methods. Initial and Boundary value problems of ordinary and partial differential equations, Solution of Various types of plates and other civil engineering related problems

3. Statistical Methods: Method of correlation and Regression analysis for fitting a polynomial equation by least square

4. Initial Value problem: Galerkin's method of least square, Initial Value problem by collocation points, Runge kutta Method

References:
1. James B. Scarborough: Numerical Mathematical Analysis, Oxford and IBH Publishing, 1955.
2. S.S. Sastry : Introductory Methods of Numerical Analysis, PHI Learning (2012).
3. J.B Dixit : Numerical Methods, USP (Laxmi publication),
4. Akai T J: Applied Numerical methods for Engineers, John Wiley & Sons New York, 1994
5. Chapra S.C. and Canale R.P. Numerical methods for Engineers, Tata Mc.Graw Hill Publishing Co. Ltd., New York, 1985
6. Gerald: Applied Numerical Analysis, Pearson Education, New Delhi ,2003
7. Krishnamurthy E V and Sen S. K. :Numerical algorithms, East- West Press Pvt Ltd., New Delhi. 1986
8. Rajasekharan S. Numerical methods in Science and Engineering , Wheeler & Co. Pvt. Ltd., New Delhi. 1986
9. Rao S.S. *Optimisation theory and applications,* Wiley Eastern Ltd., New York. 1979

Course Credits --2

Internal Marks: 100   **L T P**
External Marks: 50   **0 0 4**
Total Marks: 150

1) Algorithm/flow chart for analysis of various structural elements using spread sheets, C++ etc.

2) Algorithm/flow chart for design of various RC structural elements such as beams, slabs, columns, footings using spread sheets, C++ etc.

3) Algorithm/flow chart for design of various MS structural elements beams, columns using spread sheets, C++ etc.

4) To study the effect of joint-stiffness on the behaviour of a flexural member.

5) Analysis of rigid-jointed and pin-jointed frames using software such as STAADpro etc. for these typical design constraints: a) Mass irregularity b) Torsional irregularity c) Re-entrant corners d) Non-parallel systems e) Weak storey f) Soft storey g) Diaphragm Discontinuity h) Out-of-plan offsets i) Vertical geometric irregularity.

6) Analysis of sLaboratory-beam systems, grid-system using software such as STAADpro etc.

7) Analysis of soil-structure interaction problems.

2ND Semester (Jan- Jun 2015)

MTST-502 Bridge Engineering

Course Credits --4

	L	T	P
Internal Marks: 50			
External Marks: 100	4	0	0
Total Marks: 150			

Definitions and components; classification, layout and planning of bridges; introduction to analysis and design of long span bridges like suspension and cable stayed bridges.

Site investigations; preliminary data collection; selection of appropriate bridge type; hydraulic design of bridges; traffic design of bridges.

Analysis and design of superstructure for straight and curved bridge decks-loadings details; specification- reinforced concrete and steel decks, Decks of various types like slab, hollow and voided slab, beam and slam, box girder etc.

Analysis and design of foundations - shallow foundations (open Foundations), deep foundations- well foundations and caisson; design and constructional aspects of foundations.

Latest developments in construction methods for concrete and steel bridges- their impact on the analysis and the design.

Inspection and maintenance and rehabilitation of bridges.

References:
1. Bridge Deck analysis by Pama & Gusens
2. Bridge deck behavior by Edward V. Hambly
3. Essentials of bridge engineering by D. Johnson Vector

MTST 506: Plastic Analysis of Structures

Course Credits --4

Internal Marks: 50

External Marks: 100

Total Marks: 150

L T P

4 0 0

Concept of ductility; Behavior of ductile structures; Definition of collapse and characteristics of bending moment distribution at collapse; Fundamental theorems; Simple plastic theory of bending; Concept of plastic hinges and mechanisms; Hinge formation in indeterminate structures, Redistribution of moments, Assumption made for structures subjected to bending only; Concept of loaded factors and ultimate load as design criteria.

General methods of analysis- load interaction method; analysis by generalized hinge rotation; analysis by combinations of elementary mechanisms; analysis by adjustment of restraints; plastic moment distribution method; Upper and lower bounds.

Minimum weight design-Concept, Assumptions, Design of frame with prismatic members; Elements of linear programming and its application to minimum weight design problems.

Deflections- Assumption; Calculation of deflection at ultimate loads and permissible values.

Concept of shake down analysis and related theorems; applications to simple structural systems.

MTST – 504 Research Methodology

Course Credits --4

Internal Marks: 50
External Marks: 100
Total Marks: 150

L T P
4 0 0

OVERVIEW OF RESEARCH
Nature and Objectives of research, historical, descriptive and experimental, Study and formulation of research problem, Scope of research and formulation of hypotheses; Feasibility, preparation and presentation of research proposal

METHODS OF DATA COLLECTION
Primary data and Secondary Data, methods of primary data collection, classification of secondary data,

SAMPLING METHODS
Probability sampling: simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgement sampling, quota sampling. Sampling distributions

PROCESSING AND ANALYSIS OF DATA
Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses :Parametric (t, z and F) Chi Square, ANOVA. Measures of central tendency and dispersion: mean, median, mode, range, mean deviation and standard deviation. Regression and correlation analysis

DESIGN OF EXPERIMENTS:
Basic principles, study of completely randomized and randomized block designs. Edition and tabulation of results, presentation of results using figures, tables and text, quoting of references and preparing bibliography

Note: Application and use of various essential software for case studies should be covered in the lectures.

Reference Books
Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.
Malhotra, N.K., Marketing Research An Applied Orientation, 4th Edition Pearson Education: New Delhi.
Zikmund, W.G., Business Research Methods, 7th Edition, Thomson South-Western.
Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi.
Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 2nd edition

MTST 612 Design of Highway and Airport Pavements

Course Credits --3

Internal Marks: 50	L T P	
External Marks: 100	3 0 0	
Total Marks: 150		

GENERAL CONSIDERATION: Components of road pavement such as subgrade, Sub base, Base course and wearing course and their functions, Comparison of flexible and rigid pavements highway and air port pavements

PAVEMENTS MATERIALS: Stabilizing base viz., Mechanical, Stabilized with admixture like cements, Bitumen lime and other chemicals.

FACTOR AFFECTING THE PAVEMENTS DESIGN: Traffic factor , Moisture and climate factors, Soil factor, Stress distribution factors, Design method of Flexible pavements, General classification of various methods and their approach Empirical methods using soil classification tests, Theoretical and semi theoretical methods, General observation and limitation of various methods

DESIGN METHOD OF RIGID PAVEMENTS: Analysis of stresses in concrete pavements due to various wheel loads. Cyclic changes in temperature. Changes in moisture and volumetric change in subgrade and base course, Comparison of analysis of stress due to wheel loads on liquid and solids subgrade theorem, Thickness design methods such as P.C. A. design method F.A.A. methods etc., Design of distributed steel reinforcement design of dowels, Design of spacing of joints

PAVEMENT EVALUATION AND STRENTHENING: Method of pavement evaluation including LCN method for airport, Design of various type of overlays for flexible and rigid pavements, Mechanics of pumping and blowing, Factor affecting pumping, preventive measures.

PAVMENTS PERFORMANCE: Pavements performance, Road Mechanic and their applications, The AASHO road test, Evaluation of performance of the flexible and rigid pavements, Analysis of results from flexible and rigid pavements

Reference

1. S.K. Khurana " Principles ,Practice and Design of highway Engineering"

2. Khannna & Justo " Highway Engineering"

3. Oglesby " Highway Engineering (3rd Edition)

MTST-508 Laboratory-2

Course Credits --2

Internal Marks: 50   L   T   P

External Marks: 50   0   0   4

Total Marks: 100

1) Concrete mix design procedures by BIS, ACI guidelines.

2) Fresh properties of concretes -- self compacting concrete (SCC); fiber reinforced concrete (FRC); light weight concrete (LWC); recycled aggregate concrete (RAC).

3) Evaluation of compressive strength, split-tensile strength, flexure strength and load-displacement response for SCC, FRC, LWC and RAC.

4) Evaluation of limiting strain for SCC, FRC, LWC and RAC.

5) Shear strength of concrete beams -- effect of shear-span ratio, concrete grade and percentage tensile steel.

6) Studies on permeability of concrete, abrasion resistance, carbonation etc.