Guru Nanak Dev Engineering College, Ludhiana
Civil Engineering Department

1.1 Study Scheme of Post Graduate Program (Batch 2016 & Onwards)

M.Tech Structural Engineering							
S No	**Subject Code**	**Course Title**	**Type**	**Contact Hours**	**Credits**	**Distribution of Marks**	
				L-T-P		**Ext**	**Int**
First Semester							
1	MTST-16501	Structural Dynamics	Core	4-0-0	4	100	50
2	MTST-16503	Analysis of Plates, Shells and Grids	Core	4-0-0	4	100	50
3	MTST-16505	Advanced Solid Mechanics & Structural Analysis	Core	4-0-0	4	100	50
4	MTST-166xx	Program Elective-I	Program Elective	3-0-0	3	100	50
5	MTST-166xx	Program Elective-II	Program Elective	3-0-0	3	100	50
6	MTST-16507	Laboratory-I	Lab-I	0-0-2	2	50	50
Second Semester							
1	MTST-16502	Bridge Engineering	Core	4-0-0	4	100	50
2	MTST-16504	Research Methodology	Core	4-0-0	4	100	50
3	MTST-16506	Plastic Analysis and Design of Steel Structures	Core	4-0-0	4	100	50
4	MTST-166xx	Program Elective-III	Program Elective	3-0-0	3	100	50
5	MT-xxx	Open Elective – I	Open Elective	3-0-0	3	100	50
6	MTST-16508	Laboratory-II	Lab-II	0-0-2	2	50	50
Third Semester							
1	MT-yyy	Open Elective – II	Open Elective	3-0-0	3	100	50
2	MTST-166xx	Program Elective-IV	Program Elective	3-0-0	3	100	50
3	MTST-16509	Pre-Thesis Seminar	Pre-thesis seminar	0-0-2	1	-	100
4	MTST-16510	Pre-Thesis Project	Pre-thesis project	0-0-3	3	50	50
Fourth Semester							
1	MTST-16511	Thesis/Dissertation	Thesis	0-0-15	15	100	200

List of Program Electives for Structural Engineering

S. No	Course Name	Course Code
1	Nonlinear Analysis and computer aided methods	MTST-16601
2	Finite Element Methods	MTST-16602
3	Non-destructive Testing and Composite Materials	MTST-16603
4	High Rise Buildings	MTST-16604
5	Structural Reliability	MTST-16605
6	Structural Optimisation	MTST-16606
7	Pre-stressed Concrete Structures	MTST-16607
8	Analysis & Design of substructures	MTST-16608
9	Soil-Structure Interaction	MTST-16609
10	Earthquake Resistant Design of Masonry and RC Buildings	MTST-16610
11	Buried Structures	MTST-16611
12	Design of Highway and Airport Pavements	MTST-16612
13	Environmental Impact assessment & Management	MTST-16613
14	Disaster Reduction and Management	MTST-16614
`15	Site Investigations	MTST-16615
16	Advanced Structure Design and detailing	MTST-16616
17	Industrial Structures	MTST-16617
18	Theory of elasticity and plasticity	MTST-16618
19	Structural Stability	MTST-16619
20	Ground Improvement	MTST-16620
21	Numerical Methods in Engineering	MTST-16621

***Department can float any above subject as Open elective as per the requirement of timetable.**

MTST-16501: Structural Dynamics

Course Credits --4

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

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.

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.

Single Degree of Freedom Systems : Free vibrations of single degree of freedom system – un-damped 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.

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.

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.

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-16502 Bridge Engineering

Course Credits --4

Internal Marks: 50 **L T P**
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-16503: Analysis of Plates, Shells and Grids

Course Credits --4

	L	T	P
Internal Marks: 50			
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

Shells

Types of shells, differential equation of shells and its application to different type of shells

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, Anályis 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 – 504 Research Methodology

Course Credits --4

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

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, judgment 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.

References:

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-16505: Advanced Solid Mechanics & Structural Analysis

Course Credits -- 4

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

Analysis of Stress and Strain: Principal stresses and strains, stress components on an arbitrary plane, octahedral shear stress, Cauchy's stress quadric, transformation of strain components with changes in coordinate basis, equilibrium equations and constitutive relations, energy methods.

Bending and torsion of prismatic straight beam: Pure bending, bending due to uniform traverse loading, torsion of beams with solid cross section - Warping function and Prandtl stress function approach, membrane analogy.

Matrix methods of analysis: 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. 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. Analysis of continuous beams, rigid-jointed plane frames and pin-jointed plane frames using physical and element approaches

References:

1. Matrix analysis of framed structures: William Weaver Jr. & James M. Gere (Van Nostrand Reinhold Company Inc.)
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)
4. Advanced Mechanics of Solids: L. S. Srinath (Tata McGraw Hill)
5. Engineering Solid Mechanics: Fundamentals and Applications: A. R. Ragab & S. E. Bayoumi (CRC Press)
6. Elasticity-Theory,Applications and Numerics: M. H. Sadd (Academic Press)

MTST 506: Plastic Analysis and Design of Steel Structures

Course Credits --4

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

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

References:

1. Baker J. and Heyman J., Plastic Design of Frames, Cambridge the University Press, 1969.
2. Neal B.G., The Plastic Methods of Structural Analysis, John Wiley&. Sons. New York, 1977.
3. SP: 6(6) – 1972, Handbook for Structural Engineers 6. Application of Plastic Theory in Design of Steel Structures, Bureau of Indian Standards, New Delhi 110002.

MTST-16507: Laboratory-1

Course Credits --2

	L	T	P
Internal Marks: 100			
External Marks: 50	**0**	**0**	**2**
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, any computer language

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.

MTST-16508 Laboratory-2

Course Credits --2

Internal Marks: 50 **L T P**
External Marks: 50 **0 0 2**
Total Marks: 100

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

2) Properties of fresh concrete -- 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.

MTST-16509: Pre-Thesis Seminar

Course Credits --1

	L	T	P
Internal Marks: 100			
External Marks: --	**0**	**0**	**2**
Total Marks: 100			

This is an unstructured open-ended course where under the overall supervision of a faculty member of his discipline, each student must submit report as a culmination of his endeavor and investigation. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the student's interaction with the teachers.

**The topic of seminar must be related to the thesis work of the student.*

MTST-16510: Pre-Thesis Project

Course Credits --3

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

This is an unstructured course where under the overall supervision of a faculty member of his discipline, each student must submit report as a culmination of his endeavor and investigation related to the topic of his/her discipline. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the student's interaction with the teachers.

**The topic of Project must be related to the thesis work of the student.*

MTST-16602: Finite Element Methods

Course Credits --3

	L	T	P
Internal Marks: 50			
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 Wave-front 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)

MTST-16604 High Rise Buildings

Course Credits --3

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

.Tall Building systems and Concepts: environmental systems. Service systems, construction system, foundation design, architectural- structural interaction.

Tall building criteria and loading gravity load. Earthquake loadings, wind loading and effects, fire and blast, quality control crib Structural safety

Structural design of tall steel buildings: commentary on structural standards, elastic analysis and design. Plastic analysis and design, stability, Design methods based on stiffness, fatigue and fracture, load factor (Limit State) design.

Structural design of tall concrete and masonry buildings: commentary structural standards, plastic analysis-strength of members and correction, non-linear analysis and limit design, stability, stiffness and crack control creep shrinkage and temperature effects. Limit state design , masonry structures.

Frame-shear wall systems: Twist of frame. Analysis of shear wall, frame wall interaction, analysis of coupled shear wall, computation of earthquake load dynamic analysis of tall building.

References:

1. Structural Analysis and design of Tall Buildings by Tara Nath Bungale
2. Advances in tall buildings by Beedle L.S.
3. Analysis of Shear walled buildings
4. Design of multistory reinforced concrete buildings for earthquake motion by J.A. Blume, N.M. Newmark

MTST-16607 Prestressed Concrete Structures

Course Credits --3

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

L	T	P
3	0	0

Limit state design of statically determinate pre-stressed beams- limit state of collapse by flexure, shear, torsion, limit state of serviceability. Anchorage zone stresses for post-tensioned members.

Statically indeterminate structures- analysis and design- continuous beams and frames, Choice of profile, linear transformation, concordancy, omically viable profile

Composite beam with precast pre-stressed beams and cast in situ RC slab-analysis and design. Time dependant effects such as creep, shrinkage etc. On composite construction inclusive of creep relaxation and relaxation creep- partial pre-stressing principles, analysis and design of simple beams, crack and crack width calculations.

Analysis and design of pre-stressed pipes, tanks and spatial structures-slabs, grids, folded plates and shells

References

Prestressed concrete structures – Lundy.

Prestressed concrete – T.Y. Lin.

Prestressed concrete – N. Krishna Raju.

MTST-16610 Earthquake Resistant Design of Masonry and RC Buildings

Course Credits --3

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

Total Marks: 150

Dynamics of Structures and Seismic Response: Equation of motion, dynamic response of single storey structure (SDOF), seismic response of SDOF structure, concept of response spectrum, dynamic response of spectrum representation for elastic systems. Systems with multi degree of freedom (MDOF)**:** periods and mode of vibration, elastic response, restoring force, damping, damping values for buildings.

Earthquake and Ground Motion: Causes of earthquake, nature and occurrences, seismic waves, effects, consequences, measurements, strong ground motion, seismic zones.

Seismo-resistant building architecture: Lateral load resisting systems- moment resisting frame, Building with shear walI or bearing wall system, building with dual system; Building configuration – Problems and solutions; Building characteristics – Mode shape and fundamental period, building frequency and ground period, damping, ductility, seismic weight, hyper-staticity/redundancy, non-structural elements, foundation soil/ liquefaction. Foundations; Quality of construction and materials – quality of concrete, construction joints, general detailing requirements

Design forces for buildings: Equivalent static method, Determination of lateral forces as per IS 1893(Part 1), Modal analysis using response spectrum.

Ductility considerations in earthquake resistant design of RCC buildings: Impact of ductility; Requirements for ductility; Assessment of ductility– Member/element ductility, Structural ductility; Factor affecting ductility; Ductility factors; Ductility considerations as per IS13920.

Earthquake resistant design of RCC building: Determination of lateral forces on an intermediate plane frame using Equivalent static method and Modal analysis using response spectrum; various load combinations as per IS-1893(Part 1); Identification of design forces and moments in the members; Design and detailing of typical flexural member ,typical column, footing and detailing of a exterior joint as per IS13920.

Masonry building: categories, plain and reinforced masonry walls, box action and bands, infill walls, improving seismic behavior of masonry building, load combinations and permissible stress, seismic design of masonry building.

References:

1. Earthquake resistant design of structures by Pankaj Agarwal and Manish Shrikhande, Prentice-Hall of India, 2006
2. Seismic design of reinforced concrete and masonry buildings by T. Paulay and M.J.N. Priestley, John Wiley & Sons, 1991
3. The seismic design handbook, Edited by F. Naeim, Kluwer Academic publishers, 2001.
4. Park & Pauly; Behavior of RC structure

MTST-16612 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

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. Sharma “Principles, Practice and Design of highway Engineering"

2. Khannna & Justo “Highway Engineering"

3. Oglesby “Highway Engineering (3rd Edition)

MTST-16621 Numerical Methods in Engineering

Course Credits --3

	L	T	P
Internal Marks: 50			
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