5.2 M.Tech. in Civil Engineering with Structural Engineering Courses

Academic Scheme And Syllabus
Year 2015-16

Scheme for M.Tech. (Civil) with Structural Engineering Courses (Semester – I) Academic year 2015-16

Sr. No.	Course	Code	Course Plan for Each Week (Hrs)			Credits	Evaluation (Marks)						Total
			Lectures	Laboratory	Tutorial		Test 1	Test 2	End Semester		End Semester Weightage (%)	In Semester Evaluation	
									Marks	Duration			
1	Advanced Solid Mechanics	MTST101	3	--	2	4	20	20	100	4	60	25	125
2	Structural Dynamics	MTST102	3	--	2	4	20	20	100	4	60	25	125
3	Non-linear Analysis	MTST103	3	--	2	4	20	20	100	4	60	25	125
4	Advanced Structural Analysis	MTST104	3	--	2	4	20	20	100	4	60	25	125
5	Elective-I	MTST105 to MTST 120	3	--	2	4	20	20	100	4	60	25	125
6	Seminar -I	MTST121	--	--	4	2	--	--	--	--	--	125	125
Total			**15**	**--**	**14**	**22**	**100**	**100**	**---**		**300**	**250**	**750**

NOTE - Test 1, Test 2 and end semester weightage marks will be added and shown as the theory marks in the mark sheet. Duration of Test 1, Test 2 is of 1 hour. For passing, Student must secure minimum 50% marks in each course with all heads of passing taken together and minimum 50% marks in the end semester examination.

Elective – I Courses

Sr. No.	Code	Elective

1.	MTST105	Numerical Methods
2.	MTST106	Analysis of Composite Structures
3.	MTST107	Advanced Foundation Engineering
4.	MTST108	Structural Optimization

Scheme for M.Tech. (Civil) with Structural Engineering Courses (Semester – II) Academic year 2015-16

Sr. No.	Course	Code	Course Plan for Each Week (Hrs)			Credits	Evaluation (Marks)						Total
			Lectures	Laboratory	Tutorial		Test 1	Test 2	End Semester		End Semester Weightage (%)	In Semester Evaluation	
									Marks	Duration			
1	Finite Element Analysis	MTST151	3	--	2	4	20	20	100	4	60	25	125
2	Theory of Plates	MTST152	3	--	2	4	20	20	100	4	60	25	125
3	Bridge Engineering	MTST153	3	--	2	4	20	20	100	4	60	25	125
4	Earthquake Engineering	MTST154	3	--	2	4	20	20	100	4	60	25	125
5	Elective - II	MTST155 to MTST 170	3	--	2	4	20	20	100	4	60	25	125
6	Seminar –II	MTST171	--	--	4	2	--	--	--	--	--	125	125
Total			**15**	**--**	**14**	**22**	**100**	**100**	**---**	**--**	**300**	**250**	**750**

NOTE - Test 1, Test 2 and end semester weightage marks will be added and shown as the theory marks in the mark sheet. Duration of Test 1, Test 2 is of 1 hour. For passing, Student must secure minimum 50% marks in each course with all heads of passing taken together and minimum 50% marks in the end semester examination.

Elective – II Courses

Sr. No.	Code	Elective
1.	MTST155	Design of Pre-stressed Concrete Structures
2.	MTST156	Advanced Design of Concrete Structures
3.	MTST157	Reliability Based Civil Engg. Design
3.	MTST158	Theory of Shells

Scheme for M.Tech. (Civil) with Structural Engineering Courses (Semester – III) Academic year 2015-16

Sr. No.	Course	Code	Course Plan for Each Week (Hrs)			Credits	Evaluation (Marks)						Total
			Lectures	Laboratory	Tutorial		Test 1	Test 2	End Semester	End Semester Weightage (%)	Report	Seminar	
1	Seminar on Literature Review	MTST176	--	--	2	04	--	--	--	--	50*	50*	100
2	Dissertation Stage-I Seminar	MTST177	--	_	2	04	--	_	--	_	50*	50*	100
Total			**--**	**--**	**4**	**08**	**--**	**--**	**---**	**--**	**100**	**100**	**200**

For passing, Student must secure minimum 50% marks in each course with all head of passing taken together

* Examined by supervisor and at least one internal examiner and on observer from another department.

Scheme for M.Tech. (Civil) with Structural Engineering Courses (Semester – IV) Academic year 2015-16

Sr. No.	Course	Code	Course Plan for Each Week (Hrs)			Credits	Evaluation (Marks)						Total
			Lectures	Laboratory	Tutorial		Test 1	Test 2	End Semester	End Semester Weightage (%)	Report	Seminar	

1	Dissertation Stage-II Seminar (Pre-Synopsis)	MTST178	--	--	4	04	--	--	--	--	50*	50*	100
2	Dissertation & Viva-Voce	MTST179	--	_	4	08	--	_	--	_	100**	100**	200
Total			**--**	**--**	**8**	**12**	**--**	**--**	**---**	**--**	**100**	**200**	**300**

For passing, Student must secure minimum 50% marks in each course with all heads of passing taken together

* Examined by supervisor and at least one internal examiner and on observer from another department.

** Examined by supervisor and one approved external examiner

SEMESTER-I	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST101	**COURSE: Advanced Solid Mechanics**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

*60% weightage for end semester exam

Course Objective	This course will expand on the basic principals established in Solid Mechanics. Methods of three-dimensional stress and strain analysis will be extended to allow the student to obtain solutions using analytical and/or numerical methods. These will include the analyses of principal stresses and strains, three dimensional Mohrs circles, strain gauge experimentation and failure criteria. In addition, this unit will focus on plastic deformation of solids, including the analysis of residual stresses
Course Outcome	At the completion of this course students should be able to - • Understand advanced stress/strain correlations • Model an engineering structure without detailed instruction • Establish links between theoretical and practical applications; identify problems and formulate solution strategies

Course content:

Sr.No.	**Description**	**No. of Lectures**
1	**Revision:** Stress transformation and strain transformation at a point in an elastic body, 3-D Problems, rigid body translation and rotation of an element in space. Generalized Hook's law, separation of elastic strain rigid body displacement for a general displacement field u,v,w. Principal stresses and strains.	08
2	**Two dimensional problems in elasticity:** Plain stress and Plain strain problems. Differential equations of equilibrium and compatibility equations. Boundary conditions, stress functions.	05
3	**Problems in rectangular coordinates:** Polynomial solutions, cantilever loaded at the end, simply supported beam under uniformly distributed load, linear loading.	04
4	**Two dimensional problems in polar coordinates:** Stress distribution symmetrical about an axis, pure bending of curved bars, displacement for symmetrically loaded cases, bending of curved bars by forces at end. Effect of an circular hole in a plate under in-plane loading.	10

	Concentrated load at a point of a straight boundary. Stresses in circular disk. Forces acting on the end of wedge.	
5	**Three dimensional problems in elasticity:** Differential equation of equilibrium in 3D, condition of compatibility determination of displacement, principle of superposition, uniqueness theorem, problems of rods under axial stress bar under its own weight pure bending of prismatic rods, torsion of prismatic bars of elliptical rectangular triangular and other sections. Membrane analogy-torsion of narrow rectangular bars .torsion of hallow shafts and thin tube.	10
6	**Bending of prismatic bars as a problem of elasticity in 3D:** Bending of cantilever stress functions circular and rectangular section non-symmetrical cross section shear center for different cross section of bars calculation of deflection.	05
7	**Energy theorems**: Application of complimentary energy theorems to the problems of elasticity. **Introduction to plasticity:** Criterion of yielding strain hardening rules of plastic flow different stress-strain relation .total strain theory, theorem of limit analysis, elasto-plastic bending and torsion of bars.	06

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

Text Books:-

1. C.K.Wang (December 1963) , "Applied Elasticity", MCGRAW-HILL INC.,US, ISBN 0070681252, 537 pages
2. Timoshenko (1970), " Theory of Elasticity" ,McGraw-Hill Publishing Company, ISBN 0070858055,608 pages
3. Shames I. H(1964), "Mechanics of Deformable Solids", Prentice Hall India
4. Srinath L. S(2009),"Advanced mechanics of solids" ,Tata McGraw-Hill Education, **ISBN 0070139881, 504 pages**

Reference Books:-

1. J. Chakrabarti (2006), " Theory of plasticity", Elsevier/Butterworth-Heinemann, ISBN 0750666382, 882 pages
2. Timoshenko S (2004), "Strength of Materials Vol – I & II",CBS Publishers & Distributors, ISBN 8123910304 ,298 pages
3. Boresi A. P (2002) ," Advanced mechanics of materials" ,John Wiley & Sons, ISBN 0471438812,681 pages

SEMESTER-I	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST102	**COURSE: Structural Dynamics**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

*60% weightage for end semester exam

Course Objectives:

The course objectives are to make the student understand:

- What is dynamic load how it is different than static load and different types of dynamic loads
- Free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system courseed to different dynamic loads
- Dynamic degrees of freedom, Calculation frequencies and mode shapes for lumped mass MDOF systems, analysis of MDOF systems courseed to dynamic loads using modal analysis
- Analysis of systems with distributed mass
- Random vibrations, probabilistic theory, random process and related parameters
- Stochastic Response analysis of Linear SDOF Systems

Course Outcomes:

- The students are expected to understand the difference between static and dynamic analysis, types of dynamic loads,
- Students will be able to evaluate the response of SDOF and MDOF systems to different types of dynamic loads including ground motions.
- Students will be able to understand basics of Random vibrations and its apply this concept to analyse Linear SDOF systems

Course content:

Sr.No.	**Description**	No. of Lectures
1	**Introduction:** Introduction to structural dynamics, definition of basic problem in dynamics, static v/s dynamic loads, different types of dynamic loads.	02
2	**Single degree of Freedom (SDOF) systems:** Undamped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement. Forced vibration, response to harmonic forces, periodic loading, dynamic load factors, response of structure courseed to general dynamic load, Duhamel's integral, numerical evaluation of dynamics response of SDOF systems courseed to different types of dynamic loads. Use of Fourier Series for periodic forces, introduction to vibration isolation.	16

	Distributed mass system idealized as SDOF system, use of Rayleigh's method, response of SDOF system courseed to ground motion. **Introduction to frequency domain analysis**, response of structure in frequency domain courseed to general periodic and non-periodic / impulsive forces of short duration, use of complex frequency response function.	
3	**Generiilized Single-Degree of Freedom System:** Generalized properties, assemblages of rigid bodies, systems with distributed mass and elasticity, expressions for generalized system properties.	03
4	**Lumped mass multi degree of freedom (MDOF) system:** Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods, energy methods and use of Lagrange's method in writing equations of motions. Decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, and application to beams and multi storey frames with rigid girders courseed to lateral dynamic loads.	10
5	**Structure with distributed mass system:** Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams courseed to the action of specified dynamic loads.	04
6	**Random Vibrations:** Probability theory: Single random variable, important averages of single random variable, two random variables, important averages of two variables, principal axis of joint probability density function, Rayleigh's probability density function. Random processes, stationary and ergodic processes, autocorrelation function, power spectral density function, relationship between power spectral and autocorrelation functions, power spectral density and autocorrelation functions for derivatives of processes, superposition of stationary processes, stationary Gaussian processes, stationary white noise, probability distribution for maxima and extreme values.	08
7	**Stochastic Response of Linear SDOF Systems:** Transfer functions, relationship between input and output autocorrelation functions, relationship between input and output power spectral density functions, response characteristics for narrowband systems	05

Text Books:-

1. Dynamics of Structures by Clough & Penzien, McGraw-Hill, Computers & Structures, CBS Publishers, 2015
2. Dynamics of Structures: Theory & Applications to Earthquake Engineering by Anil K Chopra, Prentice Hall of India

Reference Books:-

1. Structural Dynamics by Mario Paz, Springer India, CBS Publishers, 2004
2. Introduction to Structural Dynamics by John M Biggs, CBS Publishers,2014
3. Basic Structural Dynamics by James C Anderson & Farzad Naeim, John Wiley & Sons
4. Fundamentals of Structural Dynamics by Roy R Craig & Andrew J Kurdia, Wiley
5. Mechanical Vibrations by Den P Hartog, McGraw-Hill
6. Dynamics of Structures by Jagmohan L Humar, 3rd Edition, CRC Press,
7. Wind Effects on Structures by Simiu E & Scanlan R H, Wiley
8. Wing Loading of Structures by John D Holmes, Spon Press
9. Structural Vibration: Analysis & Damping by Beards C F, Arnold
10. Vibrations & Control System by Beards C F, Ellis Horwood
11. Passive Energy Dissipation Systems in Structural Engineering by Soong T T & Dargush G F, Wiley
12. Introduction to Structural Motion Control by Connor J J, Prentice Hall, NJ
13. Active Structural Control by Soong T T, Wiley, NY & Longman Scientific & Technical, England
14. Liquid Sloshing Dynamics by Ibrahim, Cambridge University Press
15. Structural Damping: Applications in Seismic Response Modification by Zach Liang, George C Lee, Gary F Dargush & Jianwei Song, CRC Press
16. MATLAB: An Introduction with Applications by Amos Gilat, Wiley India

Sr. No.	Examination	Module
1	T-1	Module 1 to3
2	T-2	Module 4 and 5
3	Final Examination	Module 1 to 7

SEMESTER-I	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST103	**COURSE: Non Linear Analysis**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

*60% weightage for end semester exam

Course Objectives:
This course provides students an understanding of different types of non linearities in structures. The main objectives of the course are

- To introduce the students to the concepts of plastic analysis of steel structures including continuous beams, single/multiple span rigid jointed portal frames and single bay gable frames
- To introduce the students to the concepts of elastic stability of structures.

Course Outcome:
At the end of the course the students shall be able to

- Find the shape factor, determine the collapse load of single and multiple span beams, pin jointed frames, single/multiple span rigid jointed portal frames and single bay gable frames.
- Find the fully plastic moment of a section under the effect of axial force and shear force.
- Determine buckling loads of prismatic, non-prismatic members, beam-columns, single span portal frames.
- Analyse thin walled open cross sections for torsional buckling, combined buckling due to torsion and flexure and analyse the beams for lateral buckling.

Course content:

Sr.No.	**Description**	**No. of Lectures**
1	**Plastic Analysis:** Concepts of plastic analysis of steel structures, stress strain relations. Shape factor- Plastic modulus, plastic hinge, fully plastic moment, moment curvature relations.Use of statistical and mechanism methods for calculation of collapse load, Lower and upper bound theorems, various types of failure mechanisms.Determination of collapse load – Single and multiple span beams carrying various types of loads.	10
2	Collapse load analysis of pin jointed frame s, single/multiple span rigid	04

	jointed portal frames and single bay gable frames.	
3	Effect of axial force and shear force on the fully plastic moment of a section.Design of beams and single span rigid jointed frames courseed to a system of proportionate loading as per Indian code provisions.	08
4	**Elastic stability:** Geometric Non linearity –Basic Concepts.Elastic buckling of bars, Euler's formula, buckling of continuous beams, buckling of non-prismatic members, effect of shear force on buckling of bars, use of energy method and finite difference method.	08
5	Analysis of beam-columns with various end conditions, use of trigonometric series.Buckling of single span portal frames.	04
6	Torsional buckling: Pure torsion of thin walled open cross section, warping and warping rigidity, Torsional buckling of columns, combined buckling by torsion and flexure.	06
7	Lateral torsional buckling of beams, lateral buckling of beams in pure bending, lateral torsional buckling of cantilever and S.S. beams.Indian codal provisions regarding buckling of steel members-columns &beams.	08

Text Books:-

1. Loard Baker & Jacques Heyman (1980), "Plastic Design of Steel frames", Cambridge University Press, ISBN-0521297788, 238 pages
2. Michael. R, Horne & B. G. Neal (2014), "Plastic Theory of Structures", Elsevier, ISBN-9781483188454, 188 pages
3. Alexander Chajes (1974), "Principles of Structural Stability Theory", Prentice Hall, ISBN-9780137099641, 336 pages
4. NGR Iyengar (2007), "Elastic Stability of Structural Elements", Macmillan, 440 pages
5. M. L. Gambhir (2004), "Stability Analysis & Design of Structures", Springer Science & Business Media, 535 pages

Reference Books:-

1. Lynn. S. Beedle (1997), "Plastic Design of Steel Frames", John Wiley & Sons, Australia Limited, ISBN-978047109862
2. Stephen Timoshenko & James. M. Gere, " Theory of Elastic Stability", Tata McGrawhill
3. Chai H Yoo & Subg Lee (2011), "Stability of Structures: Principles & Applications", Elsevieer, 536 pages
4. George Simites & Dewey H Hodges (2006), "Fundamentals of Structural Stability", Butterworth-Heineman, 480 pages

Sr. No.	Examination	Module
1	T-1	Module 1 to3
2	T-2	Module 4 and 5

3	Final Examination	Module 1 to 7

SEMESTER-I	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST104	**COURSE: Advanced Structural Analysis**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

* 60% weightage for end semester exam

Course Objectives:

- To review the basic concepts of Structural Analysis
- To learn the force method of analysis of indeterminate stuctures
- To understand displacement method of analysis of indeterminate stuctures
- To understand the derievation of one dimensional beam element for computational analysis
- To understand the concept of geometric stiffness

Course Outcomes:

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

- Use the force method for analysis of indeterminate structures
- Use the displacement method for analysis of indeterminate structures
- To derieve the one dimensional beam element for computational analysis
- To applythe concept of geometric stiffness to buckling analysis.
- To apply structural modeling principles to reduce computational effort.

Course content:

Sr.No.	**Description**	No of lectures
1	**Review of the concepts :** Basic concepts of structural analysis; Basis for principle of virtual work.	6
2	**Principle of virtual forces:** Standard and matrix formulation; Force method for analysing skeletal structures.	8
3	**Principle of virtual displacements:** Standard and matrix formulation; Displacement method for analysing skeletal structures; Extension of displacement method to the generalised stiffness method. Basic concepts associated with computer implementation of stiffness method	8 6
4	**One-dimensional beam element:** Basis for cross-sectional level formulation of flexibility and stiffness	4

5	Flexibility approach for determining element flexibility; Stiffness approach for determining element stiffness; Special consideration of shear effects in stiffness approach; Consideration of torsional effects for thin-walled member -- incl. torsion bending; Special considerations for finite joints (both rigid and flexible); Consideration of local load (incl. temperature) effects	12
6	**Formulation of geometric stiffness due to axial force:** Linearised buckling analysis.	2
7	**Simplifications to reduce computational effort in analysis:** Sub-structure analysis (static condensation); Symmetry considerations in structures.	2

List of Tutorials:
1. Deflections in structures
2. Force method of analysis
3. Displacement method of Analysis
4. Geometric stiffness
5. Matrix method of analysis

Term work:
Assignments including problems based on the above syllabus shall be submitted as term work.
The distribution of term work marks will be as follows:
Reports of experiments performed and assignments : 30 marks
Attendance Quiz : 20 marks

Text Books:-

1. Aslam Kassimali (2012), "Matrix Analysis of Structures", Cenage Learning
2. Lecture notes M.B. Kanchi,
3. Pandit Gupte (2001), "Matrix structural Analysis", Tata McGraw-Hill Education, ISBN 0070667358, 602 pages
4. T.M (1994), "Structural Analysis by Matrix Approach"

Reference Books:-

1. Gere Weaver (1980), "Matrix Structural Analysis", Van Nostrand Reinhold Company, ISBN 0442257732, 492 pages

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

SEMESTER-I	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST105	**COURSE: Elective – I:Numerical Methods**		
Period per week (each of 60 minutes)	Lecture	03	
	Practical	---	
	Tutorial	02	
Scheme of evaluation		**Hours**	**Marks**
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

*60% Weightage for end semester

Course Objectives:

- To master basic Programming fundamentals, Fundamentals of numerical methodsDetermine errors present in numerical solutions to engineering problems.
- Utilize programming logic, structure and syntax to develop multifunctional algorithms to solve engineering problems
- Identify and classify the numerical problem to be solved.
- Choose the most appropriate numerical method for its solution based on characteristics of the problem
- Understand the characteristics of the method to correctly interpret the results.

Course Outcomes:

At the end of this course, students will be able to solve engineering problems using scientific programming techniques.

- Root finding; solutions for nonlinear algebraic equations
- Solving sets of linear equations
- Interpolation and curve fitting models
- Numerical Differentiation and Integration
- Understand fundamentals of numerical methods..

Course content

Module	Topics	No. of Lectures
1.	Programming fundamentals, Fundamentals of numerical methods, Error analysis;	03 05

2	Curve fitting, Interpolation and extrapolation	05
3	Differentiation and integration	04 03
4	Solution of nonlinear algebraic and transcendental equations	08
5	Elements of matrix algebra	06
6	Solution of systems of linear equations, Eigen value problems, differential equations.	05 04
7	Computer oriented algorithms; Numerical solution of different problems.	05

Reference Books:-

1. J.H. Wilkinson(1965), "The Algebraic Eigenvalue Problem", Oxford University Press, ISBN 0198534183,608 pages
2. K.E. Atkinson (1989)," An Introduction to Numerical Analysis", J. Wiley and Sons, ISBN 0471624896, 712 pages
3. G.E. Golub and C.F. Van Loan (1989), "Matrix Computations", Johns Hopkins University Press, ISBN 1421407949, 756 pages.

Sr. No.	Examination	Module
1	T – I	1 , 2
2	T – II	3, 4
3	Final exam	5, 6, 7

SEMESTER-I	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST106	**COURSE: Elective – I Analysis of Composite Structures**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

* 60% weightage for end semester exam

Course Objectives:

- To introduce the general set of composite materials
- To show the advantages of composites over metals
- To explain the fabrication processes
- To analyze the structural mechanics of composite materials.
- To explain the deformation and failure of composite materials under the influence of different loads.
- To know the effect of hygrothermal environment on composite materials.

Course Outcomes:

- The use of composite materials in real structures.
- Composite material: classification, characterization, fabrication techniques.
- Structural mechanics of composite materials: Calculation of strength and stresses.
- Delamination, knowledge about interlaminar stresses.
- Environmental effect on composite materials.

Course content

Sr.No.	**Description**	**No.of Letctures**
1	Polymer matrix composites in structures. Fibers and polymeric matrix materials. Fabrication processes.	10
2	Introduction to anisotropic elasticity. Unidirectional composites.	06
3	Micromechanics Interfaces and interphases in polymer composites. Laminates and lamination theory.	08

4	Delamination in composites. Interlaminar stresses and free edge effects. Stress and failure analysis of laminated composites.	08
5	Hygrothermal and environmental effects.	04
6	Experimental characterization of composites.	04
7	Introduction to metal matrix, ceramic matrix and carbon-carbon composites. Intelligent composites, design approach.	08

Text Books:-

1. Jones R. M. (1975), "Mechanics of Composite Materials", McGraw Hill Kogakusha, Tokyo, ISBN 0070853479, 355 pages
2. Agarwal B. D. and Broutman L. J. (1990), "Analysis and Performance of Fibre composites", John Wiley & Sons, New York., ISBN 0471625728, 741 pages
3. Kaw A. K, " Mechanics of Composite Materials", CRC Press
4. Mukhopadhyay M (2005), "Mechanics of Composite Materials & Structures", Universities Press

Reference Books:-

1. Christensen R. M. (1991), "Mechanics of Composite Materials" Krieger Publishing Company, ISBN 0894645013, 348 pages
2. Calcote L. R. (1969), "The analysis of Laminated Composite Structures", Van Nostrand Reinhold Co., New York, ISBN 0442156286, 222 pages
3. Holmes M. and Just D. J. (1985), "GRP in structural Engineering", Applied Science Publishers, London. ISBN 0853342326, 298 pages
4. Gibson R. F. (17-Oct-2011), "Principles of Composite Material Mechanics", CRC Press, ISBN 1439850054, 683 pages
5. Reddy J. N., "Analysis of Composite Laminated Plates", McGraw Hill.

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

SEMESTER-I	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST107	**COURSE: Elective – I Advanced Foundation Engineering**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

*60% weightage for end semester exam

Course Objectives:

The design of foundation requires the consideration of many essential factors with regard to soil data, geology of the site, land use patterns, ground conditions and the type of structure to be built. A detailed understanding of the field situation is also very important apart from theoretical knowledge of the course. This course seeks to provide an overview of the essential features of foundation design. The different aspects of foundation engineering ranging from soil exploration to the design of different types of foundation, including the ground improvement measures to be taken for poor soil conditions have been covered in this course.

Course Outcomes:

- An ability to apply knowledge of mathematics, science and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to identify, formulate and solve engineering problems
- An ability to use the techniques, skills and modern engineering tools

Course content:

Sr.No.	**Description**	**No.of Lectures**
1	**Review of fundamentals of soil mechanics:** Soil, soil formation , soil profiles , weight volume relationship, soil classification, Indian standard method of soil classification, concept of total stress, effective stress and pore water pressure. One dimensional consolidation, Terzaghi's theory, derivation of equation. Determination of a_v, m_v, c_c, c_v from laboratory test , determination of p_c by various methods, field consolidation curve, secondary consolidation, quassi- pre consolidation , three-dimensional consolidation, practical applications.	**10**
2	**Shear strength** Coulomb's law of shear strength , Mohr's Coulomb's criteria of failure, shear strength and shear strain behavior of sandy and clayey soils under undrained , drained and consolidated drained conditions, concept of progressive failure , critical void ratio, practical applications. Estimation of stresses in soils, Boussinesque and Westergard theories, Newmark Chart, practical applications	**08**
3	**Sub-surface ground geotechnical investigations** Direct methods of explorations, influence of type of soils, type of foundations, etc. on the programme of exploration, lateral extent and depth of exploration, bore log details, profiles of soil in various directions, indirect methods, and practical applications.	**06**

4	**Bearing capacity ofshallow foundations**: Type of shallow foundations, gross load and net load , gross and net ultimate bearing capacity, safe bearing capacity, and allowable bearing pressure, modes of failure, criteria of failure , Terzhagi, Meyerhof, bearing capacity in shear, compressibility (including critical rigidity index) criteria, factor of safety. Bearing capacity of clay and sand in settlement, settlement analysis for clay, normally and over consolidated soils, settlement analysis of sand, Schemertmann method, and practical applications.	**09**
5	**Pile foundations**: Axially loaded piles, necessity of piles, types of piles, static and dynamic resistance of piles, pile load carrying capacity using dynamic pile formulae and their limitations, pile load carrying capacity using Terzhaghi, Meyerhof,Berznatsv, Vesic, Indian standard 2911 (part -1 & part-2) method, settlement of pile in clay, group of piles, load carrying capacity for sand and clay soils, group efficiency, group settlements, practical applications.	**09**
6	**Ground improvements**: Various methods, sand drains, stone columns, stabilization, grouting, reinforced earth, geotextiles, diaphragm walls,	**04**
7	**Caissons & cofferdams.**	**02**

Reference Books:-

1. Taylor D.W. (2013), “Fundamentals of Soil Mechanics”, Asia publications Bombay, ISBN 1258768925, 714 pages
2. Karl terzaghi, (1996),” Soil Mechanics in Engineering Practice”, John Wiley & Sons, ISBN 0471086584, 549 Pages
3. Joseph E Bowles, (1997),” Foundation Analysis and Design”, McGraw-Hill, ISBN 0071188444, 1175 Pages
4. Dr. Alam Singh, “Soil Mechanics and Foundation Engineering Vol. 1, & 2”, Standard Book House
5. Dr. Alam Singh, “Geotechnical Application”, Standard Book House.

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

SEMESTER-II	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST108	**COURSE: Elective – I Structural Optimization**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

* 60% weightage for end semester exam

Course Objective	The objective of this course is to introduce the concepts of design optimization and review major conventional and modern optimization methods used in structural optimization applications.
Course Outcome	After completion of course students will be ready with : to find the best solutions from which a designer or a decision maker can derive a maximum benefit from the available resources.

Course content:

Sr.No.	**Description**	**No.of Lectures**
1	**Introduction to optimization:** Historical development, engineering applications of optimizations	03
2	**Classical optimization technique:** Single variable optimization. Multivariable optimization with no constraints, multivariable optimization with equality and quality constraints	04
3	**Linear programming:** Simple method- simplex algorithm **Non-linear programming:** One dimensional methods-elimination methods- unrestricted search-exoustive search- Fibonacci method-golden section method – interpolation method –quadratic & cubic interpolation method-direct root method	12
4	**Non-linear programming:** Unconstrained optimization technique –direct search methods –random search, univariable and pattern search methods-descent methods-gradient of a function-steepost descent method –fletcher –reeves conjugate gradient method, quasi newton methods, dividon Fletcher powells variable metric method **Non linear programming:** Constrained optimization techniques –direct method – method of physible direction- indirect method- transformation techniques – basic approach in the penalty function method – interior and exterior penalty	18

	function methods	
5	Introduction to dynamic programming	03
6	Introduction to CPM and PERT	03
7	Applications of the above methods to some structural problems	05

Reference Books:-

1. Rao S. S. (2009), "Optimization – Theory and Applications", John Wiley & Sons, ISBN 0470183527, 813 pages
2. Gass S.I (2003), "Linear Programming", McGraw Hill Book.Co, ISBN 0486432847, 532 pages
3. Srinath L.S (2001),"PERT and CPM - Principles and Applications", Affiliated East-West Press (Pvt.) Ltd, ISBN 8185336202.
4. Wagner H.M, (1975), "Principles of Operation Research", Prentice Hall of India, ISBN 0137095929, 1039 pages

Sr. No.	Examination	Module
1	T-1	Module 1 to2
2	T-2	Module 3to4
3	Final Examination	Module 1 to 7

Seminar – I
MTST121

M.Tech. in Civil Engineering with Structural Engineering Courses

Academic Scheme And Syllabus
Year 2015-16

SEM II

SEMESTER-II	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST151	**COURSE: Finite Element Analysis**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

* 60% weightage for end semester exam

Course Objectives:

- To understand variational method of analysis
- To learn about concepts of elements and their properties
- To understand iso-parametric elements and their uses.
- To understand finite element methods and its application for solution of structural mechanics problems.

Course Outcomes:

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

- Understand variational formulation of finite element method.
- Understand the different elements used in finite element modelling.
- Understand iso-parametric elements and their uses
- Solve the structural mechanics problems using finite element approach

Course content:

Sr.No.	**Description**	**No. of Lectures**
1	**Review of Variational methods:** Calculus of variation- Variational Principles of Solid Mechanics. Principle of Minimum Potential Energy, Principle of Complementary Energy-Hamilton's Principle. **Variational Formulation of Finite Element Method (FEM)**	06
2	**The Basic component:** Concept of an Element –Various element Shapes- Displacement Models –Formulation of Finite Element Method using Principle of Virtual Displacement s- Derivation of element stiffnesses and Loads for Pin-jointed Bar element, Beam Element, Triangular plate Element (inplane forces), Rectangular Plate Element (inplane forces), Quadrilateral Plate Element (inplane forces), Triangular and Rectangular Plate Elements in Bending	12
3	**Isoparametric Elements** : Local vs Natural Co-ordinate system, Line, Triangular, Quadrilateral and Tetrahedral Elements – Interpolation Displacement Models Formulation of Isoparametric Finite Element matrices in Local and Global Co-ordinate system	05

4	**Implementation of FEM**: Discretization of the Structure – Calculation of Element stiffness, Mass and Equivalent Nodal Loads, Assemblage of Structure Matrices, Boundary Conditions- Solution of the Overall Problem. Calculations of Element Stresses, Computer Program Organisation	06
5	**Formulation and Solution of Problems in Structural Mechanics using the above methods.**	03
6	**Introduction to Non-Linear Analysis**: Geometric Non-Linearity-Geometric Stiffness of an Axial Element. Stability of Bar- Spring System. General Formulation of Geometrically Non Linear Problem. Geometric Stiffness of Beam-Column and Triangular Elements. Non-Linear Material Behavior. Non- Linear Spring- Elasto Plastic Analysis by FEM- Elasto Plastic Analysis of a truss- Two Dimensional Element Formulations- General Formulation of a physically Non-Linear Problem.	10
7	**Introduction to Dynamic Analysis by FEM**: Formulation of Inertial Properties- Lumped Mass vs Consistent Mass Matrices –Condensation and Assembly of Mass Matrices- Formulation of Damping Properties- Free Vibration, Steady – State and Transient Response Analysis for Simple Problems.	06

Text Books:-

1. Rajshekaran S. (2008), "Finite Element Analysis", Wheeler publishing, ISBN 8121923149, 630 pages
2. Krishnamoorthy C.S, (1994), "Finite Element Analysis", Tata McGraw Hill, ISBN 0074622102, 710pages
3. William B. Bickford, (1990),"First Course in The Finite Element Method", ISBN 0256079730, 649 pages

Reference Books:-

1. O. C. Zienkiewicz, K. Morgan (2000), "Finite Elements and Approximation", Dover publications, ISBN 0486453014, 352 Pages
2. J.N. Reddy, (2008), "Non linear Finite Element Analysis", Oxford University Press, ISBN 0195692039,
3. Cook R.D., Malkus D.S. and Plesha ,(2001), " Concepts and Applications of Finite Element Analysis", John Wiley & Sons (Asia) Pvt Ltd. ISBN 0471356050, 736 pages
4. Weaver W and Johnston P.R., "Finite Element for Structural Analysis", Prentice Hall

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

SEMESTER-II	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST152	**COURSE: Theory of Plates**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

*60% weightage for end semester exam

Course Objective	The objective of this course is to enable students to acquire the analytical and numerical methods needed for the solution of different types of plates and thin slabs.
Course Outcome	After successfully completing the course, the student will be able to - 1) Express various types of loadings on a plate in terms of Fourier series. 2) Apply the Navier and Levy solutions for rectangular plates with different boundary conditions and loading. 3) Obtain solutions for circular plates. 4) Use finite difference methods to obtain plate deflections and moments, and also apply available finite-element programs to plate problems.

Course content:

Sr.No.	**Description**	**No. of Lectures**
1	**Introduction:** Introduction to theory of plates with small and large deflections, distinction between plate and shell action.	04
2	**Pure bending of thin plates:** Curvature at a point, circle of curvature, moment curvature relationships, relationship between twisting moment and twist of surface.	06
3	**Classical plate theory:** Classical Small-Deflection Theory of Thin Plates,Plate Equation in Cartesian Coordinate System,Boundary Conditions of Kirchhoff's Plate Theory	06
4	**Symmetrical bending of thin circular plates with small deflections under axi-symmetrical transverse loads:** Differential Equation of Circular Plates, Circular plates different support	08

	conditions, plates with overhangs, plates with coaxial circular opening. Circular plates courseed to different loads.	
5	**Small deflection theory for laterally loaded thin rectangular plates:** Rigorous Solution of Plate Equation, Rectangular plates courseed to transverse load, Transverse shears and bending moments, corner effects.	08
6	**Series solutions of governing differential equation:** Various support conditions, Navier's and Levi's solution for uniformly distributed , uniformly varying load and concentrated loads,	08
7	**Numerical technique for solution of plate equations:** Use of numerical techniques for the solution of plates, concept of influence surface; study of simply supported plate with continuous edge moments.	08

Text Books:-

1. Timoshenko, (1989), ''Theory of Plates and Shells", McGraw-Hill, 580 pages
2. Varadan T.K and Bhaskar K, "Analysis of Plates Theory and Problems", Narosa Publishing House, ISBN 8173192561, 198 pages
3. N.K. Bairagi(1984)," Plate Analysis", Khanna Publishers, 310 pages
4. Bhavikatti (2015), "Thoery of Plates & Shells", New Age International

Reference Books:-

1. R.Szilard(1974), "Theory and Analysis of Plates, "John Wiley & Sons, ISBN 0471429899, 1024 pages

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

SEMESTER-II	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST153	**COURSE: Bridge Engineering**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

* 60% weightage for end semester exam

Course Objectives:

- To understand Bridge types
- To learn IRC Loading criteria
- To understand fundamentals of Bridge design
- To understand construction systems and Planning of Bridges
- To understand the principles of long span bridge design

Course Outcomes:

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

- Understand the different loadings on Bridges
- Understand the components of different types of Bridges
- Understand the behavior and suitability of various bridge types
- Design the various components of bridges

Course content:

Sr.No.	**Description**	**No. of lectures**
1	**Introduction:** Classification and components of bridges, historical perspective, layout and planning, investigations for bridges, choice of type of the bridges, conceptual bridge design, bridge aesthetics. bridge appurtenances.	6
2	**Loads on bridges:** Loading standards for highway and railway bridges (IRC, IRS)	7
3	**Analysis and design of RC and PSC bridge decks:** Slab culvert bridges, slab-and-beam bridges, load distribution in slabs and beams, bow-string girder bridges, behaviour of skew bridge decks	7
4	Behaviour, analysis and design of RC and PSC box-girder bridge decks.	6
5	Behaviour, analysis and design of steel bridge decks: girder bridges, truss bridges, arch bridges, composite construction	8
6	Design of bearings, substructure and foundations – piers and abutments of different	6

List of Assignments

1. Design of a Slab Bridge
2. Design of a RC Girder Bridge
3. Problems on IRC loading Criteria
4. Bridge Furniture
5. Bridge bearings and expansion joints

Term work:

Assignments including problems based on the above syllabus shall be submitted as term work.
The distribution of term work marks will be as follows:

Assignments : 30 marks
Attendance Quiz : 20 marks

	types, shallow and deep foundations – design and constructional aspects	
7	Modern methods of construction of concrete, steel and composite bridges, their impact on analysis and design Introduction to analysis and design of long span bridges: suspension and cable stayed bridges.	8

Text Books:-

1. Raju N. K (1988), "Design of Bridges", Oxford and IBH Publishing, ISBN 8120417410.
2. Victor D. J (2007), "Essentials of Bridge Engineering" , Oxford & IDH, ISBN 8120417178, 495 pages.
3. T.R Jagdeesh & M.A Jayaram,(2009), " Design of Bridge Structures", Prentice Hall India Private Ltd. New Delhi, 360 pages

Reference Books:-

1. Ponnuswamy S (2008), "Bridge engineering", Tata McGraw-Hill Education, ISBN 0070656959, 747 pages
2. Raina V.K(1994), " ConcreteBridge Practice", Tata McGraw Hill, ISBN 0074623621, 756 pages

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

SEMESTER-II	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST154	**COURSE: Earthquake Engineering**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--

	Total	**125**
	Credits	**04**

* 60% weightage for end semester exam

Course Objectives:

The coursework objectives are to make the students to understand:

- The importance of the earthquake engineering.
- The basics of Structural Dynamics: different types of dynamic loads, concept of damping, analysis of SDOF system courseed to different types of dynamic loads,
- How to calculate frequencies and mode shapes for the MDOF system, analysis of MDOF system courseed to different types of dynamic loads.
- Basics of earthquake engineering: causes of earthquake, types of earthquakes, seismic waves, structure of earth, and measurement of earthquake.
- Concept of Response Spectrum: ground motion parameters, response spectrum, characteristics of response spectrum, and methods of construction of response spectrum.
- Analysis of the structure courseed earthquake ground motion. Codal provisions of IS 1893-2002 and calculation of earthquake loads as per this codes are taught.
- Importance of ductility in earthquake resistant design of structure and codal provision of IS 13920 are taught.
- Practical knowledge by conducting some basic experiments in structural dynamics and also during the tutorial classes assignments based on the above topics were given.

Course Outcome:

- The stdents are expected to understand the difference between static and dynamic analysis, types of dynamic loads, concept damping,
- The students will be able to evaluate the response of structures to different types of dynamic loads including ground motions.
- The students are expected to understand earthquake phenomenon, concept of response spectrum, application of structural dynamics in evaluation of structural response to earthquake ground motion, and Codal provisions.
- The students will be able to carry out Seismic analysis of structure.

Course content:

Sr.No.	**Description**	**No .of Lectures**
1	**Review of Structural dynamics**: Definitions of basic problems in dynamics, undamped vibration of SDOF system, natural frequency and periods of vibration, damping in structure,response to periodic loads, response to general dynamic load, response of structure course to ground motion, use of Fourier series for periodic forces, MDOF system, determination of frequencies and mode shapes, orthogonality principle,	12

	Forced vibration of MDOF system, modal analysis, applications to multistoried rigid frames course to lateral dynamic loads including ground motion	
2	**Seismological background:** Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, intensity and magnitude of earthquake, measurement of ground motion, seismogram, earthquake frequency, local site effects, seismotectonics and Seismicity of India.	06
3	**Characterization of ground motion:** Earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra. peak structural response from the response spectrum, response spectrum characteristics, construction site specific response spectra.	06
4	**Deterministic earthquake response:** Types of earthquake excitation, lumped SDOF elastic systems. translational excitation, lumped MDOF elastic systems, systems with distributed mass and elasticity, translational excitation, time history analysis, multistoried buildings with symmetric plans, multi storied buildings with un symmetric plans, torsional response of symmetric plan building, distributed - parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a single mode, SRSS and CQC combination of modal responses. **Earthquake response of inelastic buildings:** Allowable ductility and ductility demand, building with weak or soft first storey	10
5	**Earthquake dynamics of base isolated buildings:** Isolation systems, base isolation of one storey buildings, effectiveness of base isolation, application of base isolation	04
6	**I. S. code method of seismic analysis:** Seismic co-efficient method and its limitation, response spectrum method, IS 1893-2002 provisions for seismic analysis of buildings and water towers, seismic evaluation and retrofitting, types of structural system used in building to resist earthquake loads.	06
7	Review of damages during past earthquakes and remedial measures, seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints as per IS 13920	04

Text Books:-

1. Dynamics of Structures by Anil K Chopra, Prentice Hall of India
2. Structural Dynamics of Earthquake Engineering: Theory & Application using MATHEMATICA & MATLAB by S Rajasekaran, Woodhead Publishing Ltd.

3. Earthquake Resistance Design & Risk Reduction by David Dowrick, Wiley India
4. Seismic Analysis of Structures by T K Dutta, John Wiley & Sons (Asia) Pvt.Ltd
5. I.S. Codes No. 1893, 4326, 13920 (All latest codes)

Reference Books:-

1. Fundamentals of Earthquake Engineering by N M Newmarks & E Rosenblueth, Prentice Hall
2. Earthquake Spectra & Design by N M Newmarks & W J Hall, Earthquake Engineering Research Institute, Berkeley, California
3. Dynamics of Structures by Clough & Penzien, McGraw-Hill, Computers & Structures
4. Fundamentals of Earthquake Engineering by Amr S Elnashai & Luigi Di Sarno, Wiley India
5. Fundamentals of Earthquake Resistant Construction by Ellis L Krinitzsky, James P Gould & Peter H Edinger, Wiley India
6. Elementary Seismology by C R Richter, W.H. Freeman & Company, San Francisco
7. Design of Earthquake Resistant Structures by E Rosenblueth, Pentech Press, London
8. Design of Seismic Isolated Structures: From Theory to Practice by Farzad Naeim & James M Kelly, John Wiley & Son
9. Mechanics of Rubber Bearings for Seismic and Vibration Isolation by James M Kelly & Dimitrios A Konstantinidis, Wiley
10. Seismic Engineering by Jacques Betbeder-Matibet, Wiley
11. Seismic Design of Reinforced Concrete & Masonary Buildings by T. Paulay & M J N Priestley, Wiley India
12. Plate Tectonics: An Insider's History of The Modern Theory of The Earth by Naomi Oreskes, Westview Press
13. "Proceedings on World Conference on Earthquake Engineering" 1956-2000.

Sr. No.	Examination	Module
1	T – I	1 , 2
2	T – II	3, 4
3	Final exam	5, 6, 7

SEMESTER-II	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**	
CODE: MTST155	**COURSE: Elective – II Design of Pre-stressed Concrete Structures**	
Period per week (Each of 60 minutes)	Lecture	03
	Laboratory	--

	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

*60% weightage for end semester exam

Course Objectives:

To understand the mechanical behavior, analysis and design of prestressed concrete elements.

Course Outcome:

The course will enable the students to

1) Evaluate short and long term losses in prestressed concrete members.
2) Design of flexural members (slabs and beams).
3) Check the flexural members for vertical shear and deflection.
4) Analyze the stresses in anchorage zones.
5) Analysis for flexural stresses of Composite beam.

Use the code IS-1343.

Course content

Sr.No.	Description	No.of Lectures
1	Introduction to basic concepts and general principles of pre-stressed concrete, materials used in prestressed concrete and methods and techniques of prestressing, prestressing systems.	02
2	Analysis of prestressed concrete sections for flexure considering loading stages, computational of sectional properties, critical sections under working loads for pretensioned and post tensioned members, load balancing method of analysis of prestressed concrete beams, losses in prestress, application to simply supported beams and slabs	11
3	Design philosophy of prestressed concrete sections, permissible stresses in concrete and steel, design approaches using working stress method as per IS 1143 – 1980, limit state of collapse – flexure and shear as applied to prestressed concrete beams, kern points, choice and efficiency of sections, cable profile and layouts, cable zone, deflection of prestressed concrete sections.	11
4	End zone stresses in prestresses concrete members, pretension transfer bond, transmission length, end block of post tensioned members.	06
5	Design of simply supported pre-tensioned and post tensioned slabs and beams. Design of bridge girders courseed to IRC loadings	06
6	Analysis and design of composite prestressed concrete structures	04
7	Introduction to application of prestressing to continuous beams, linear transformation and concordancy of cables	08

Text Books:-

1. N. Krishna Raju (2006), "Prestressed Concrete", Tata McGraw-Hill Education, ISBN 0070634440, 784 pages.
2. T. Y. Lin, (1981), "Design of Prestressed Concrete Structures", John Wiley Publishers, ISBN 0471018988,646 pages

Reference Books:-

1. Y. Guyon (1953), "Prestressed Concrete", Contractors Record Ltd, 543 pages.

Sr. No.	Examination	Module
1	T – I	1 , 2
2	T – II	3, 4
3	Final exam	5, 6, 7

Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Duration (Hrs)	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**04**

*60% weightage for end semester exam

Course Objective	This course will enable students to: 1. To introduce to students the codes of practices in loading and design of reinforced concrete structures. 2. To extend students' knowledge and proficiency in reinforced concrete structural design and analysis. 3. To develop students with the teamwork experience and prepare them for the effective use of the latest industry standard formulas, tables, design aids and computer software in the design of reinforced concrete building structures.
Course Outcome	After completion of course students will be ready with : Advanced methods for analysis and design of RC structures. Design criteria for complex structures, especially civil reinforced concrete structures. Design according to different National and International Guidelines

Course content:

Sr.No.	Description	No. of Lectures
1	**Ultimate Load analysis of concrete structures:** Stress strain characteristics of concrete and reinforcing steel, review of elastic theory and ultimate strength theory, whitneys rectangular stress block, analysis and design of singly and doubly rectangular and tee sections.	04
2	**Concept of limit design** : Introduction to the concept of limit design. Moment curvature relationship of reinforced concrete sections , rotation capacity of sections , ultimate load analysis by Cambridge and bakers method. Application to continuous beams and simple rectangular portal frames. Yield line analysis of slabs, virtual work and equilibrium method. Application to orthotropically reinforced rectangular slabs with various bourndry conditions under uniformly distributed loads.	10
3	**Reinforced concrete design by limit state method:** Review of limit state method as per IS 456:2000. Limit state collapse in flexure , direct compression , compression with bending , shear and torsion , limit state of serviceability for deflection and cracking , applications to beam-slab system of typical residential, office, industrial floors and rectangular portal frames and gable ended frames.	08

4	**Design of different slab systems:** Analysis and Design of Two-way Slab System without Beams (Flat Plate and Flat Slabs), Two Way Joist Slabs & Two-way Slabs with Beams	06
5	**Large span roofs:** Folded plate roofs- whitneys method, Simpsons method and design based on IS codes Circular cylindrical shell roofs- beam theory of cylindrical shells, single and multiple base with various edge conditions.	08
6	**Silos and bunkers:** Lateral pressure as per Janssen's and Airy's theorys, design consideration for square, rectangular and circular shapes, design of hoppers and supporting structures.	06
7	**SpecialTopics:** ShearWalls,ShearFriction,Corbels,LedgeBeams,StrutandTieModels ,DeepBeams	06

Reference Books:-

1. V. Ramkrishnan & P. D. Arthur (1964), "Ultimate Strength Design for Structural Concrete", Wheeler Publishing Co, Pitman, 264 pages.
2. G. S. Ramaswamy, (2005), " Design and Construction of Concrete Shell Roofs ",CBS Publishers & Distributors, ISBN 8123909905
3. Karve S.R. and Shah V. C (1994), "Design of Reinforced Cement Concrete Structures using Limit State Approach", Structures Publishers, ASIN B007I29ARC
4. Krishna Raju (1986), Advanced Reinforced Concrete Design, CBS Publishers

Sr. No.	Examination	Module
1	T-1	Module 1 to3
2	T-2	Module 4 and 5
3	Final Examination	Module 1 to 7

SEMESTER-II	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST157	**COURSE : Elective – II Reliability Based Civil Engineering Design**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Hours	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**03**

*60% weightage for end semester exam

Course Objective	The main objective of the course is to introduce the students to - • Random variables, probability and statistics, Monte Carlo simulation, Variation reduction techniques • Concept of failure of a structure • Reliability based design , Application of reliability analysis to structural members and structural systems
Course Outcome	At the end of the course, the students shall be able to – • Determine probability distributions, correlation between random variables • Use Monte Carlo simulation, variation reduction techniques and find different reliability indices • Perform Reliability based design and Apply reliability based analysis to structural members and structural systems

Course content:

Sr.No.	**Description**	
1	**Revision:** General introduction to structural safety and reliability and reliability. Concept of uncertainty in reliability-based analysis and design. Course outline.	**06**
2	• Random variables. • Probability axioms and probability functions. • Conditional probability. • Common probability distributions. • Correlation between random variables. • Random vectors and functions of random variables	06
3	• . Monte Carlo simulation, Variation reduction techniques.	06
4	• Concept of failure of a structure.	06

	• Reduced variable space and basic definition of reliability index. • First order second moment index. • Hasofer-Lind reliability index. • Rackwitz-Fiessler reliability index.	
5	• Reliability-based design code and its development. • Load and resistance factor design format. • Calibration of partial safety factors. • Uncertainty models for load and resistance.	06
6	• Second order reliability method. • Bayesian approach. • Response surface approach. • Time-varying reliability. • Summary.	06
7	Application of reliability analysis to structural members and structural systems	06

Reference Books:-

1. Ang, A.H.S. & Tang, W.H. (1975), "Probability Concepts in Engineering Planning and Design: Volume 1 - Basic Principles", Wiley, New York, ISBN 3857480939
2. Benjamin, J.R. & Cornel, C.A. (1970), "Probability, Statistics and Decision for Civil Engineers", McGraw-Hill, New York, 684 pages
3. Ellingwood, B. et al.(1980), "Development of a Probability Based Load Criterion for American National Standard A58", US Department of Commerce, Special Publication NBS-577.
4. Ranganathan R. (1990), "Reliability Analysis and Design of Structures", McGraw-Hill, New Delhi, ISBN 0074603140, 354 pages

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

SEMESTER-II	**CLASS: M.Tech. (Civil) with Structural Engineering Courses**		
CODE: MTST158	**COURSE: Elective – Theory of Shells**		
Period per week (Each of 60 minutes)	Lecture	03	
	Laboratory	--	
	Tutorial	02	
Scheme of evaluation		Hours	Marks
	In Semester Tests	01	20 X 02
	End Semester Exam*	04	100
	Termwork	--	25
	Seminar	--	--
	Total		**125**
	Credits		**03**

* 60% weightage for end semester exam

Course Objective	The objective of this course is to enable students to acquire the analytical and numerical methods needed for the solution of different types of shells .
Course Outcome	After completing this course you will understand the force flow in shell structures and be able to manually calculate stresses, deformations and buckling loads of elementary shell shapes. They will understand the scientific approach to deriving and solving the governing differential equations and will be able to make, interpret and check analyses of shell structures.

Course content:

Sr.No.	**Description**	**Hrs**
1	**Introduction to structural behavior of thin shells, membrane and bending actions.**	04
2	**Mathematical representation of a shell surface:** Principal curvatures, Gauss curvature. Classification of Shells	06
3	**Membrane theory of thin shells:** Stress resultants, application to cylindrical shell under symmetric loads and surfaces of revolution under axi-symmetric loads	06
4	**Bending theory of open circular cylindrical shells:** With special emphasis to approximate theories of Finsterwalder and Schorer theories: Introduction to DKJ Flugge and other exact theories: Different boundary conditions for single and multiple shells.	08
5	**Bending theory of closed cylindrical shell:** Stiffness coefficients at free edges along radial and rotational directions; Bending theory of spherical shells. Geckeler's approximations, Stiffness coefficients.	08
6	**Moment theory of shells of revolution:** Introduction, Governing equations, Shells of revolutions under axisymmetrical loads, Approximate method for solutions of governing equations.	08
7	**Approximate theories of shell analysis and their application:**	08

	Introduction , the semi membrane theory of cylindrical shells, The Donnel-Mushtari-Vlasov theory of thin shells, Theory of shallow shells, Edge effects.	

Reference Books:-

1. Stephen Timoshenko, S. Woinowsky-Krieger (2003), "Theory of Plates and Shells", Textbook Publishers, ISBN 0758184093, 580 Pages
2. R. Chandrashekara, (1987), "Analysis of Thin Concrete Shells", McGraw Hill Book Co, ISBN 0074515683, 288 Pages
3. Ramaswamy G.S., (1984), "Design and Construction of Concrete Shell Roofs", Krieger Pub Co; ISBN 0898740010, 745 Pages
4. N.K. Bairagi, (1990), "Shell Analysis", Khanna Publishers, Delhi ,
5. V.V. Novozhilov, (1970), "Thin Shells", Kluwer Academic Publisher, ISBN 900164550X, 429 Pages
6. Bhavikatti (2015), "Thoery of Plates & Shells", New Age International

Sr. No.	Examination	Module
1	T-1	Module 1 to 2
2	T-2	Module 3 to 4
3	Final Examination	Module 1 to 7

Seminar – II
MTST171

SEM-III

MTST176 Seminar on Literature Review

The project work extends through the third and fourth semester. The project work is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic and submit a thesis for evaluation? The work at this stage may involve review of literature, laboratory experimental work, development of software, development of model, case study, field data collection and analysis etc. On completion of the work the student shall prepare a report and will give a Seminar on the report.

MTST177 Dissertation Seminars Stage I

Student shall finalize a theme, related to construction engineering and/or management area for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report.

SEM – IV

MTST178 Dissertation Seminars Stage II

Student shall study the problem of dissertation in the light of outcome of Stage I and Stage II seminars. On completion of data collection, analysis, and inferencing the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis to the University.

MTST179 Dissertation and Viva Voce

On finalization of the dissertation student shall submit the dissertation report to the University. The student shall have to appear for a Viva-voce examination for the dissertation.