SRM UNIVERSITY
(Under section 3 of UGC Act 1956)

M.Tech. (Full Time) - Structural Engineering
Curriculum & Syllabus
2013 – 2014

FACULTY OF ENGINEERING AND TECHNOLOGY
SRM UNIVERSITY
SRM NAGAR, KATTANKULATHUR – 603 203

COURSE CODE	COURSE NAME				
SEMESTER I		**L**	**T**	**P**	**C**
ST2001	Matrix Computer Method of Structural Analysis	3	2	0	4
ST2002	Structural dynamics	3	2	0	4
ST2003	Theory of elasticity and plasticity	3	2	0	4
MA 2002	Applied Mathematics	3	0	0	3
STXXXX	Program Elective I	3	0	0	3
	TOTAL	**15**	**6**	**0**	**18**
	Total contact hours- 21				
SEMESTER II		**L**	**T**	**P**	**C**
ST2004	Advanced reinforced concrete structures	3	0	2	4
ST2005	Advanced steel structures	3	2	0	4
ST2006	Finite element method with computer application	3	0	2	4
STXXXX	Program elective II	3	0	0	3
STXXXX	Program elective III	3	0	0	3
	TOTAL	**15**	**2**	**4**	**18**
	Total contact hours-21				
SEMESTER III		**L**	**T**	**P**	**C**
	Interdisciplinary elective	3	0	0	3
STXXXX	Program elective IV	3	0	0	3
STXXXX	Program elective V	3	0	0	3
STXXXX	Program elective VI	3	0	0	3
ST2048	Industrial Training	0	0	1	1
ST2049	Project work Phase I	0	0	12	6
	TOTAL	**12**	**0**	**13**	**19**
	Total contact hours-25				
SEMESTER IV		**L**	**T**	**P**	**C**
ST2050	Project work Phase II	0	0	32	16
	TOTAL	**0**	**0**	**32**	**16**
	Total contact hours-32				

Total Credits to be earned for the award of M.Tech degree = 71

CONTACT HOUR/CREDIT:

L: Lecture Hours per week **T: Tutorial Hours per week**
P: Practical Hours per week **C: Credit**

PROGRAM ELECTIVES

Course Code	Name of the course	L	T	P	C
ST2101	Soil Structure Interaction	3	0	0	3
ST2102	Aseismic Design of Structures	3	0	0	3
ST2103	Computer Aided Design	3	0	0	3
ST2104	Concrete Technology & Special Concretes	3	0	0	3
ST2105	Design of Bridges	3	0	0	3
ST2106	Design of Reinforced Concrete Foundations	3	0	0	3
ST2107	Design of Shell and Folded Plate Structures	3	0	0	3
ST2108	Design of Steel-Concrete Composite Structures	3	0	0	3
ST2109	Advanced Analysis and Design for Wind Earthquake and other Dynamic Loads	3	0	0	3
ST2110	Design of Tall Buildings	3	0	0	3
ST2111	Disaster Resistant Structures	3	0	0	3
ST2112	Offshore Structures	3	0	0	3
ST2113	Maintenance and Rehabilitation of Structures	3	0	0	3
ST2114	Prestressed Concrete Structures	3	0	0	3
ST2115	Optimization in Structural Design	3	0	0	3
ST2116	Stability of Structures	3	0	0	3
ST2117	Theory of Plates	3	0	0	3
ST2118	Infrastructure Engineering for sanitary structures	3	0	0	3
ST2119	Theory of Shells	3	0	0	3
ST2120	Dam Safety	3	0	0	3
ST2121	Bridge Maintenance Management	3	0	0	3
ST2122	Ground Improvement Techniques	3	0	0	3
ST2123	Seismic Retrofit of Buildings	3	0	0	3
ST2124	Fluid Structure Interaction (Mathematical Approach)	3	0	0	3
ST2125	Engineering Fracture Mechanics	3	0	0	3
ST2126	Analysis and design of structural sandwich panels	3	0	0	3
ST2127	Experimental Techniques and Instrumentation	3	0	0	3

SYLLABUS FOR CORE COURSES

Course Code	MATRIX COMPUTER METHOD OF STRUCTURAL ANALYSIS	L	T	P	C
ST2001		3	2	0	4
	Total Contact Hours - 75				

PURPOSE

To introduce matrix force and displacement methods for two and three dimensional structures including programming aspects.

INSTRUCTIONAL OBJECTIVES

1.	To introduce fundamental characteristics of elements and system by evaluation of its flexibility and stiffness matrices
2.	To impart knowledge about analysis of system through direct and element approach of flexibility method
3.	Analysis of structures by direct and element approach of stiffness method is to be included
4.	Programming techniques for simple problems and use of standard programmes to be practiced
5.	Awareness to the use of advanced techniques of matrix methods are to be created

UNIT I- FUNDAMENTAL CONCEPTS (9 hours)

Force and displacement measurement - Generalised or independent measurements - constrained or dependent measurements - concept of flexibility and stiffness using systems of springs - Reciprocal relationships between stiffness and flexibility - stiffness and flexibility in constrained measurements - (rank of matrix)

UNIT II-FLEXIBILITY METHOD (9 hours)

Direct method applied to beams and frames - Relationship between element and system - Strain Energy in terms of flexibility coefficients - Approach to equivalent joint load concept through Betti's Law - Problems in beams, frames, trusses - including effect of temperature and support sinking.

UNIT III-STIFFNESS METHOD (9 hours)

Direct stiffness method to beams, frames and simple trusses - Strain energy in terms of stiffness coefficients - Relationship between element and systems - Static condensation techniques - Problems in beams, frames including secondary effects. Analysis of 3D structures - Grid and pin jointed trusses.

UNIT IV-PROGRAMMING (9 hours)

Programming of solution techniques for simultaneous equation solution - Matrix operation - Simple program development for element stiffness matrix - assemblage - Complete structure of a stiffness analysis program with subroutines - Use of GTSTRUDL / STAAD / SAP to solve problems in trusses, beams and frames.

UNIT V-ADVANCED TOPICS (9 hours)

Sub structuring techniques - Force and displacements - band width - reduction - tridiagnolisation technique - Band solvers - Frontal - solvers - Re analysis technique - Transfer matrix method - use of symmetry and antisymmetry.

TUTORIALS - 30 hours

REFERENCES

1. Jack C. McCormac, " *Structural Analysis: Using Classical and Matrix Methods*", John Wiley, Fourth Edition, 2007.
2. Rajasekaran.S., Sankarasubramanian.G, "*Computational Structural Mechanics"*, Prentice Hall of India Pvt Ltd, New Delhi - 110 001, First Edition, 2001
3. William McGuire, Richard H. Gallagher and Ronald D. Ziemian *"Matrix Structural Analysis, With MASTAN2"*, John Wiley, Second Edition, 2000
4. Beaufit F.W et al. *"Computer Methods of Structural Analysis"*, Prentice Hall, 1970
5. John L.Meek, *"Matrix Structural Analysis"*, Mc Graw Hill Book Company, 1971
6. Bathe K.J. and Wilson E.L, *"Numerical Methods in Finite Element Analysis"*, Prentice Hall, Engle Wood Cliffs, New Jersey, USA, 1976
7. Rubinstien, M.F. *"Matrix Computer Analysis of Structures"*, Prentice Hall, 1966

Course Code	STRUCTURAL DYNAMICS	L	T	P	C
ST2002		3	2	0	4
	Total Contact Hours - 75				

PURPOSE

"No load is static except the dead weight of the structures" - goes the saying. Hence all structures subject to earth quake, wind, blast, impact loading etc shall be analysed & designed for dynamic loads.

INSTRUCTIONAL OBJECTIVES

1.	To introduce general theory of vibration and solve problems of single degree of freedom (SDOF) systems
2.	To solve dynamic problems in multi-degree of freedom (MDOF) systems
3.	To introduce dynamic analysis of continuous systems
4.	To apply structural dynamic principles to the analysis of structures for seismic and wind loading
5.	To introduce blast loading

UNIT I-SINGLE DEGREE OF FREEDOM SYSTEMS (9 hours)

Differential equation of motion - D'Alembert's principle - Free vibration and forced vibration response - damped and undamped - evaluation of damping constants - vibration of machine foundation - vibration isolation- vibration measuring instruments. Response to general loading - pulse excitation - Duhamel Integral - Numerical methods - Newmark method.

UNIT II-MULTI-DEGREE OF FREEDOM AND CONTINUOUS SYSTEMS (9 hours)

Two and three degree systems - solution of eigen value problem - Stodola method - orthogonality conditions - Modal superposition method. Vibration analysis of continuous systems - simply supported beams - Effect of shear and rotary inertia - Timoshenko beam - Effect of axial loads.

UNIT III-ANALYSIS FOR SEISMIC FORCES (9 hours)

Concept of response spectrum - estimation of design forces of multistory buildings using Bureau of Indian Standards (BIS) codes - earthquake analysis of base isolated buildings.

UNIT IV-ANALYSIS FOR WIND FORCES (9 hours)

Wind effects on structures - static and dynamic - analysis for wind loads using BIS codes - quasi static method and gust factor method.

UNIT V-BLAST LOADING **(9 hours)**

Blast loading - over ground and underground structures - design parameters - relevant BIS codes.

TUTORIALS -30 hours

REFERENCES

1. Anil.K.Chopra, *"Dynamics of Structures"* (Theory and Applications to Earthquake Engineering), Prentice Hall of India Private Limited. New Delhi, Second Edition, 2007
2. Mukhopadhyay, M., *"Structural Dynamics"*, Ane Books, India, 2006
3. Paz, M., *"Structural Dynamics - Theory and Computations"*, Kluwer Acedamic Publishers, U.S.A, 2004
4. Clough & Penzein *"Dynamics of Structures"*, McGrawHill 1995
5. Short course on Seismic Design of Reinforced Concrete Buildings, CEP, IIT, Kanpur, Dec.1995

Course Code	THEORY OF ELASTICITY AND PLASTICITY	L	T	P	C
ST2003		3	2	0	4
	Total Contact Hours - 75				

PURPOSE

The behaviour of materials and structures on application of load is understood by following the load deformation characteristics to understand the above phenomenon this topic is considered.

INSTRUCTIONAL OBJECTIVES

1.	To develop systematic - knowledge of stress strain concept
2.	To familiarize with the fundamentals of two dimensional problems
3.	To develop the knowledge about torsion for shapes like ellipse triangular and rectangular
4.	To introduce the energy theorem and the energy methods
5.	Introduction to the problems in plasticity

UNIT I-STRESS AND STRAIN **(9 hours)**

Analysis of stress and stain - stress strain relationship - state of strain at a point - compatibility equations - generalized Hooke's Law -plane stress and plane strain.

UNIT II-TWO DIMENSIONAL PROBLEMS **(9 hours)**

Airy's stress function - polynomials - biharmonic equations - general solution of problems by displacement (warping function) force (Prandtl's stress function)

Two dimensional problems in carterian co-ordinates

- Bending of Cantilever loaded at end
- Bending of beam by uniform load

UNIT III-TORSION (9 hours)

General solution of problems - Torsion of prismatic bars by displacement (warping function) force (Prandtls stress function) torsion of shafts of circular and non circular cross sectional shapes only (Elliptic and Rectangular) - Torsion of thin rectangular sections and hollow thin walled sections.

UNIT IV-ENERGY METHOD (9 hours)

Principle of virtual work - Strain energy in axial load, flexure, shear and torsion - Rayleigh Ritz Methods - Castigliano's theorem-Complementary strain energy.

UNIT V-PLASTICITY (9 hours)

Introduction to problems in plasticity-Physical assumption - Criterian of yielding - Rankines theory - St. Venant's theory - Flow rule (Plastic stress - strain relationship - Elastic Plastic problems of beams in bending - plastic torsion - sand heap analogy.

TUTORIALS -30 hours

REFERENCES

1. Richard.G.Budynas, *"Advanced Strength and Applied Stress Analysis"* Mc Graw-Hill, New Delhi, Second Edition, 2011
2. Chakrabarty, *"Theory of Plasticity"*, Tata McGraw Hill Book Co., New Delhi, Third Edition, 2006
3. Mendelson.A., *"Plasticity - Theory and Applications"*, Krieger Pub Co., Florida, U.S.A,Second edition,1983.
4. Chwo.P.C. and Pagano.N.J. *"Elasticity Tensor, Dyadic and Engineering Applications"*, D.Van Nastrand and Co., Inco. 1990
5. Wang *"Applied Elasticity"*, Mc Graw Hill, New Delhi, 1990
6. Timoshenko.S. and Goodier .J.N. *"Theory of Elasticity"* Tata Mc Graw Hill Education., India, Third Edition, 2010.
7. Sadhusingh *"Theory of Elasticity"* Khanna Publishers, New Delhi, Fourth Edition, 2012.

		L	T	P	C
MA2002	**APPLIED MATHEMATICS**	**3**	**0**	**0**	**3**
	Total contact hours - 45				
	Pre-requisite				
	Nil				

PURPOSE

To develop analytical capability and to impart knowledge in Mathematical and Statistical methods and their applications in Engineering and Technology and to apply these concepts in engineering problems they would come across

INSTRUCTIONAL OBJECTIVES

1.	At the end of the course, students should be able to understand statistical concepts, transforms techniques, mathematical concepts, integral equations and calculus of variations and apply the concepts in solving the problems occurring in Engineering and technology fields

UNIT I-TRANSFORM METHODS (9 hours)

Laplace transform methods for one-dimensional wave equation - Displacements in a long string - Longitudinal vibration of an elastic bar - Fourier transforms methods for one-dimensional heat conduction problems in infinite and semi-infinite rod.

UNIT II-ELLIPTIC EQUATIONS (9 hours)

Laplace equation - Properties of harmonic functions - Fourier transform methods for Laplace equation.

UNIT III-CALCULUS OF VARIATIONS (9 hours)

Variation and its properties - Euler's equation - Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables - Some applications - Direct methods - Ritz and Kantorovich methods.

UNIT IV-INTEGRAL EQUATIONS (9 hours)

Fredholm and Volterra integral equations - Relation between differential and integral equations - Green's function -Fredholm equation with separable kernel - Iterative method for solving equations of second kind.

UNIT V-RANDOM VARIABLES AND ESTIMATION THEORY (9 hours)

Probability - Probability distributions - moments, M.G.F-Two dimensional random variables correlation, regression multiple and partial correlation and regression. - Curve fitting - Principle of least squares - Fitting of straight line and parabola.Estimation theory basic concepts (Review) - Estimation of parameters - Maximum likelihood estimates - method of moments.

REFERENCES

1. Sankara Rao, K., "Introduction to Partial Differential Equations", PHI, New Delhi, 1995.Unit - I Chapter 6 Section 6.13, 6.13.2, Chapter 7 Section 7.11, Unit - II Chapter 2 Section 2.4, Chapter 7 Section 7.13,
2. Sneddon, I.N., "Elements of Partial Differential Equations", Mc Graw Hill, 1986
3. Elsgolts, L., "Differential Equations and Calculus of Variations", Mir Publishers, Moscow, 1966
4. Gupta, S.C., & Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, Reprint 1999
5. Venkataraman M.K., "Higher Engineering Maths for Engg. And Sciences", National Publishing Company, Chennai.

Course Code	ADVANCED REINFORCED CONCRETE STRUCTURES	L	T	P	C
ST2004		3	0	2	4
	Total Contact Hours - 75				

PURPOSE

To get exposed to the design of structures and structural elements using various codes of practice.

INSTRUCTIONAL OBJECTIVES

1.	To understand the basic concepts of reinforced concrete members
2.	To develop an idea about the design of special R.C. elements
3.	To familiarize with design and detailing of flat slabs and flat plates
4.	Limit analysis of concrete beams and cast in site frames
5.	To introduce the detailing and strengthening of existing structure
6.	To test RC Beams in laboratory

UNIT I-INTRODUCTION (9 hours)

Review of Basic Concepts - Behaviour and Design of Reinforced Concrete members considering flexure, Torsion, combined with flexure and flexural shear, axial compression deflection and crackwidth as per IS-456-2000 - Comparative study with BS 8110 and ACI - 318.

UNIT II-DESIGN OF SPECIAL R.C. ELEMENTS (9 hours)

Behaviour and Design of Slender Columns - Design of R.C.Walls - Ordinatry and Shear walls - Design of Corbels - Deep beams and grid floors.

UNIT III-FLAT SLABS AND FLAT PLATES (9 hours)

Design of flat slabs and flat plate - According to ACI method - Design of shear - Reinforcement and Edge (Spandrel) beams - yield line theory & Hiller borg method of design of slabs.

UNIT IV-DESIGN OF SPECIAL R.C. ELEMENTS (9 hours)

Limit Analysis of Concrete beams - moment - rotation curves - moment redistribution in continuous beams - Baker's method of plastic design - Design of cast in - situ frames.

UNIT V-DESIGN AND DETAILING OF STRUCTURES (9 hours)

Detailing for ductility - Fire Resistance of buildings - Field control of concrete - Strengthening of existing structures - Design and detailing of structures according to different codes.

TESTING (30 hours)

Tests on Hardened Concrete-In-situ strength determination by Rebound Hammer and UPV tester - Testing of RC beams in flexure.

REFERENCES

1. Varghese.P.C., *"Advanced Reinforced Concrete Design"*, Prentice Hall of India, Second Edition, 2009
2. Pillai.S.V and Menon.D, *"Reinforced Concrete Design"*, Tata McGraw Hill Book Co., first Edition, 2002
3. Purushothaman.P. *"Reinforced Concrete Structural Elements"*, Behaviour, Analysis and Design. Tata Mc Graw Hill 1986
4. Park.R & Paulay.T, *"Reinforced Concrete Structures"*, John Wiley and Sons, 1975

Course Code	ADVANCED STEEL STRUCTURES	L	T	P	C
ST2005		3	2	0	4
	Total Contact Hours - 75				

PURPOSE	
Structural steel design is as important as concrete design. The speed of construction in the case of steel structure is quite fast compared with concrete. Hence for industrial buildings steel is preferred to RCC.	
INSTRUCTIONAL OBJECTIVES	
1.	General principle in the design of steel structures
2.	Various types of connections
3.	Steel transmission line towers
4.	Plastic method of structural analysis
5.	Analysis and design of industrial structures

UNIT I-GENERAL (9 hours)

Beams subjected to biaxial bending - Built-up Purlins - Various types and design - Design of Wind girders-Beam-columns - With various support conditions-Design of foundations-with lateral forces.

UNIT II-CONNECTIONS (9 hours)

Bearing type joints - unstiffened and stiffened seat connections - moment resisting connection of brackets-bolted and welded-semi-rigid connections.

UNIT III-TOWERS (9 hours)

Basic structural configurations - free standing and guyed towers - loads on towers - wind loads - foundation design - design criteria for different configurations and transmission line towers.

UNIT IV-PLASTIC ANALYSIS (9 hours)

Theory of plastic bending - Plastic hinge concept - Mechanism method - Application to continuous beams and portal frames-Plastic moment distribution - Analysis of Gable frames - instantaneous centre of rotation - Connections.

UNIT V-INDUSTRIAL BUILDINGS (9 hours)

Industrial buildings-braced and unbraced - Gable frames with gantry-Rigid industrial frames-Fire resistant design-Fatigue resistant design.

TUTORIALS -30 hours

REFERENCES

1. N.Subramanian, *"Design of Steel Structures: Theory and Practice"*, Oxford university Press, U.S.A, Third Edition, 2011

2. Duggal.S.K, *"Design of Steel Structures"*, McGraw Hill New Delhi, 2010
3. Dayaratnam P. *"Design of Steel Structures,"* S. Chand Limited, New Delhi. 2008
4. John E. Lothers, *"Structural Design in Steel"*, Prentice Hall, 1999
5. Neal. B.G., *"Plastic Method of Structural Analysis"*, Taylor & Francis, Third Edition, 1985
6. Edwin.H.Gaylord, Charles.N.Gaylord, James. E. Stallmeyer, *"Steel Structures"*, McGraw Hill, New Delhi, 1980.
7. Ramchandra, *"Design of Steel Structures"*, Vol I & II Standard Book House, Delhi, 1975
8. Arya.S and Ajmani.J.L, *"Design of Steel Structures"*, Nem Chand & Bros, Roorkee

Course Code	FINITE ELEMENT METHOD WITH COMPUTER APPLICATION	L	T	P	C
ST2006		3	0	2	4
	Total Contact Hours - 75				

PURPOSE

To know various element formulations, use them for analysis including programming.

INSTRUCTIONAL OBJECTIVES

1.	To introduce various methods of formulation
2.	To formulate one, two and three dimensional element properties
3.	To impart knowledge of application of method to field problems
4.	To apply finite element method to dynamic and stability problems
5.	To introduce structural analysis software

UNIT I-INTRODUCTION (9 hours)

Boundary value problems - Concept of piecewise approximation - Variational Methods - Rayleigh Ritz method - Methods of weighted residual - Collocation, sub domain, Galerkin, least square methods - Finite Difference Method - Concept of Finite element method - Displacement model, stress model and hybrid models - principle of minimum potential energy - Principle of minimum complimentary potential energy - Hellinger - Reissner's principle - Steps in Finite Element Analysis.

UNIT II-BAR AND TRIANGULAR ELEMENT PROPERTIES (2D)

(9 hours)

Displacement field - compatibility and convergence criteria - Bar elements - Analysis of framed structures - 2D and 3D truss and Beam elements - Analysis of plane strain / plane stress conditions - CST, LST and QST elements.

UNIT III-RECTANGULAR ELEMENT PROPERTIES (2D) (9 hours)

Lagrangian, serendipity and Hermitian family elements - Rectangular and quadrilateral element - degenerated elements - sub-Iso-super parametric elements - numerical integration techniques - Isoparametric elements - axisymmetric elements.

UNIT IV-ELEMENT PROPERTIES (3D) (9 hours)

3D brick elements - eight and twenty nodded elements - plate bending elements - thin plates - Mindlin's plate theory - thick plate elements.

UNIT V-APPLICATION TO FIELD PROBLEM (9 hours)

Application of finite elements analysis - Torsion.

PRACTICALS (30 hours)

Introduction of structural Analysis software Programming in Excel for model analysis-Modelling using STAAD and SAP and dynamic analysis-RCC and Steel design-Finite element modeling.

REFERENCES

1. Krishnamoorthy C.S., *"Finite Elements Analysis - Theory and Programming"*, Tata McGraw Hill publishing company limited, New Delhi, 2008
2. O. C. Zienkiewicz, R. L. Taylor, J.Z. Zhu., *"The Finite Element Method: Its Basis and Fundamentals: Its Basis and Fundamentals"*, Butterworth-Heinemann, Sixth Edition, 2005
3. C. S. Krishnamoorthy, S. Rajeev, Arunachalam Rajaraman., *" Computer Aided Design: Software And Analytical Tools"*, U.K, 2005
4. Rajesekaran .S., *"Finite Element Methods in Engineering Design"*, Wheeler Publishers, Allahabad, 1999
5. Chandrapatla R.T. and Belagundu, A.D., *"Introduction to Finite Elements in Engineering"*, Second Edition, Prentice Hall of India, 1997
6. Bathe K.J, *"Finite Element Procedures in Engineering Analysis"*, PHI, New Delhi, 1990

7. Robert Davis Cook, David S. Malkus, Michael E. Plesha., *"Concepts and Applications of Finite Element Analysis"*, John Wiley, , New York, Third Edition 1989
8. Zienkiewicz.O.C and R.L Taylor, *"The Finite Element Method"*, Vol.1, Basic Formulation and linear problems, Mc Graw Hill Limited, U.K. 1989
9. Hans R. Schwarz, *"Finite Element Methods"*, Academic Press, 1988
10. Bruce Irons and Shrire.N., *"Finite Element Primer"*, Ellis Howood Limited, 1983
11. Ernest Hinton, D. R. J. Owen, *"Finite Element Programming"*, ACADEMIC Press INC, London, Fifth Edition, 1979
12. Gallagher R.H, *"Finite Element Analysis - Fundamentals"*, Prentice Hall Inc. 1975

ST2048	INDUSTRIAL TRAINING (Training to be undergone after II semester)	0	0	1	1
	3 week practical training in industry				
	Prerequisite				
	Nil				

PURPOSE	
To provide practical exposure in Civil Engineering related organizations.	
INSTRUCTIONAL OBJECTIVES	
1.	Students have to undergo three – week practical training in Civil Engineering related organizations so that they become aware of the practical applications of theoretical concepts studied in the class rooms.

Students have to undergo three-week practical training in Civil Engineering related organizations of their choice but with the approval of the department. At the end of the training student will submit a report as per the prescribed format to the department.

Assessment process

This course is mandatory and a student has to pass the course to become eligible for the award of degree. The student shall make a presentation before a committee constituted by the department which will assess the student based on the report submitted and the presentation made. Marks will be awarded out of 100 and appropriate grades assigned as per the regulations.

		L	T	P	C
ST2049	**PROJECT WORK PHASE I (III semester)**	**0**	**0**	**12**	**6**
ST2050	**PROJECT WORK PHASE II (IV semester)**	**0**	**0**	**32**	**16**
PURPOSE					
To undertake research in an area related to the program of study					
INSTRUCTIONAL OBJECTIVE					
The student shall be capable of identifying a problem related to the program of study and carry out wholesome research on it leading to findings which will facilitate development of a new/improved product, process for the benefit of the society.					

M.Tech projects should be socially relevant and research oriented ones. Each student is expected to do an individual project. The project work is carried out in two phases – Phase I in III semester and Phase II in IV semester. Phase II of the project work shall be in continuation of Phase I only. At the completion of a project the student will submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project. The method of assessment for both Phase I and Phase II is shown in the following table:

Assessment	Tool	Weightage
In- semester	I review	10%
	II review	15%
	III review	35%
End semester	Final viva voce examination	40%

Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of paper for presentation / publication in a conference / journal and produced the proof of acknowledgement of receipt of paper from the organizers / publishers.

SYLLABUS FOR PROGRAM ELECTIVES

Course Code	SOIL STRUCTURE INTERACTION	L	T	P	C
ST2101		3	0	0	3
	Total Contact Hours - 45				

PURPOSE	
To get exposed to the behavioural aspects of structures when it is founded on different soils with different characteristics.	
INSTRUCTIONAL OBJECTIVES	
1.	To develop an idea about soil-foundation interaction
2.	To understand the solid models
3.	Numerical analysis of finite plates
4.	To familiarize with elastic analysis of pile
5.	Load - deflection predication for laterally loaded piles

UNIT I-SOIL-FOUNDATION INTERACTION (9 hours)

Introduction to soil-Foundation interaction problems, soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.

UNIT II-BEAM ON ELASTIC FOUNDATION-SOIL MODELS (9 hours)

Infinite beam, Two parameters, Isotropic elastic half space, Analysis of breams of finite length, Classification of finite beams in relation to their stiffness.

UNIT III-PLATE ON ELASTIC MEDIUM (9 hours)

Infinite plate, Winkler, Two parameters, isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates, simple solutions.

UNIT IV-ELASTIC ANALYSIS OF PILE (9 hours)

Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

UNIT V-LATERALLY LOADED PILE (9 hours)

Load deflection prediction for laterally loaded piles, subgrade reaction and elastic analysis, Interaction analysis, Pile raft system, Solutions, through influence charts.

REFERENCES

1. Selva durai, A.P.S, *"Elastic Analysis of Soil Foundation Interaction"*, Elsevier, 1979
2. Poulos, H.G., and Davis, E. H., *"Pile Foundation Analysis and Design"*, John Wiley, 1980
3. Scott, R.F., *"Foundation Analysis"*, Prentice Hall, 1981
4. *"Structure Soil Interaction-State of Art Report"*, Institution of Structural Engineers. 1978 336.2R-88: Suggested Analysis and Design Procedures for Combined Footings and Mats (Reapproved 2002)

Course Code	ASEISMIC DESIGN OF STRUCTURES	L	T	P	C
ST2102		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To impart the knowledge about the fundamentals of load calculation, systems, design and detailing aspects of structures subject to earthquake loading including recent techniques.

INSTRUCTIONAL OBJECTIVES

1.	To develop systematic knowledge of earthquake and its causes
2.	To understand the basic concepts related to structural design for earthquake loads
3.	To develop an idea about various structural systems adopted
4.	To familiarize with design and detailing of various types of systems
5.	To introduce fundamentals of repair and rehabilitation techniques

UNIT I- INTRODUCTION (9 hours)

Introduction to engineering seismology - various theories - measurement scales - vibration measuring instruments - Past earthquakes in India and world - Response spectrum - significance - construction & use.

UNIT II-STRUCTURAL MATERIALS AND SYSTEMS (09 hours)

Performance of structural materials under cyclic loads - masonry - steel - concrete - soil.Various structural systems in steel and concrete for horizontal load transfer - their behavior and limitations - braced frames - rigid frames - shear walls - wall-frame systems.

UNIT III-STRUCTURAL PLANNING AND ANALYSIS (9 hours)

Seismic design philosophy - Design spectrum - ductility based analysis - capacity design concepts - pushover analysis concepts - energy based design Layout and planning of buildings in seismic zones - regular and irregular buildings - centre of rigidity and centre of mass - torsion. Computing storey shear - drift - using provisions of Bureau of Indian Standards (BIS) codes.

UNIT IV-DESIGN AND DUCTILE DETAILING (9 hours)

Load combinations - Ductility based design - Detailing for seismic performance - Provisions of IS: 13920 for RCC structural elements, frames, shear walls - design of shear walls.

UNIT V-SEISMIC RETROFITTING AND ISOLATION (9 hours)

Damage Assessment techniques - safety analysis and rating - Reliability assessment - Retrofitting techniques - materials. Base Isolation techniques - Active and passive control devices.

REFERENCES

1. Paulay, T. and Priestly, M.N.J., *"Aseismic Design of Reinforced Concrete and Masonry Building"*, John Wiley and Sons, 1987
2. Agarwal, P., and Shrikhande, M., *"Earthquake Resistant Design of Structures"* Prentice Hall of India, New Delhi, 2007
3. Anil.K.Chopra, *"Dynamics of Structures (Theory and Applications to Earthquake Engineering)"*, 3rd Edition, Prentice Hall of India Private Limited. New Delhi, 2009
4. Short course on Seismic Design of Reinforced Concrete Buildings, CEP, IIT, Kanpur, Dec.1995
5. Course Notes, *"Structural Design for Dynamic Loads*", SRM Engineering College, 2002
6. Allen.R.T., and Edwards.S.C, *"Repair of Concrete Structures"*, second edition Blackie Academic & Professional, an imprint of Chapman hall, U.K. 1993
7. Lecture Notes, *"Health Monitoring of Structures - A Proactive Strategy"*, ISTE Sponsored course held at SRMEC, Jan 2003
8. Guidelines for - *"Improving Earthquake Resistance of Housing"*, Building Materials and Technology Promotion Council, Ministry Of

Urban Development and Poverty Alleviation, Department of Urban Employment and Poverty Alleviation, Government of India, New Delhi, 1999 – 2000.

Course Code	COMPUTER AIDED DESIGN	L	T	P	C
ST2103		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To familiarize with various principles of computer aided design including application of artificial intelligence and optimization.

INSTRUCTIONAL OBJECTIVES

1.	Basics of drafting are introduced
2.	To introduce different methods of matrix Structural Analysis, finite element method
3.	Use of software for design and detailing
4.	Application of optimal design principles
5.	To introduce fundamentals of AI and expert system

UNIT I-COMPUTER GRAPHICS (9 hours)

Graphic primitives - Transformations - Basics of 2-D drafting - Modeling of curves and surfaces - Solid modeling- Graphic standards - Drafting software packages and usages.

UNIT II-STRUCTURAL ANALYSIS (9 hours)

Compute Methods of Structural Analysis - Finite Element Programming - Analysis through application packages.

UNIT III-STRUCTURAL DESIGN (9 hours)

Computer Aided Design of steel and RC Structural elements - Detailed drawing - Bill of materials.

UNIT IV-OPTIMIZATION (9 hours)

Linear Programming - Simplex algorithm - post-optimality analysis - Project scheduling – CPM and PERT application genetic algorithm and applications.

UNIT V-ARTIFICIAL INTELLIGENCE (9 hours)

Introduction - Heuristic search - knowledge based expert systems - Architecture and application of KBES - Expert system shells - Principles of neural network.

REFERENCES

1. Harrison.H.B., *"Structural Analysis and Design"* Vol. I & II, Pergamon Press, 1991 E. Hinton and Owen.D.R.J., Finite Element Programming, Academic Press 1977
2. Billy E. Gillet, *"Introduction to Operation Research"*, A Computer Oriented Algorithmic Approach, Tata McGraw 1982
3. Krishnamoorthy.C.S and Rajeev.S., *"Computer Aided Design"*, Narosa Publishing House New Delhi , 1991
4. Richard Forsyth (Ed.), *"Expert System Principles and Case Studies"*, - Chapman and Hall,1965

Course Code	CONCRETE TECHNOLOGY & SPECIAL CONCRETES	L	T	P	C
ST2104		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To get exposed to behavioural aspects of concrete and to get exposed to different types of concretes and their characteristics and applications.

INSTRUCTIONAL OBJECTIVES

1.	To familiarize with the fundamentals of concrete
2.	To study the different concreting methods
3.	To understand the basic concepts of special concretes, types, properties and their applications
4.	To understand the basics of development in concrete material
5.	To study the application of different concretes

UNIT I-CHARACTERISTCS OF CONCRETE AND MIX DESIGN **(9 hours)**

Properties of fresh and hardened concrete - strength, elastic properties, creep and shrinkage - variability of concrete strength - quality control - Principles of concrete mix design, methods of concrete mix design - High Strength Concrete Mix Design - Super - Plasticizers - Principles involved in mix design of high performance concrete with fly ash or GGBS replacements.

UNIT II-CONCRETING METHODS **(9 hours)**

Process of manufacturing of concrete-methods of transportation-placing and curing - extreme weather concreting - special concreting methods - vacuum dewatering - under water technology-special form work-Ready mix Concrete.

UNIT III-POLYMER AND FIBER CONCRETES (9 hours)

Polymer concrete-Types, Properties and Applications - Blended cement concretes-Fibre-reinforced Concrete-Different types of metallic and non-metallic fibres - Types, Properties and Applications, Slurry-infiltrated fibre reinforced concrete.

UNIT IV-FERROCEMENT, LOW AND HIGH DENSITY CONCRETES (9 hours)

Ferrocement and its applications, Light Weight concrete - High Density concrete - Roller compacted concrete - Types, Properties and Applications.

UNIT V-OTHER CONCRETES (9 hours)

Bacterial concrete - Born again concrete (Recycled Aggregate concrete)-Electric concrete (Smart concrete) description - applications. High performance concrete-Production and applications-Self compacting concrete - Reactive powder concrete - Description, Properties and Applications.

REFERENCES

1. Fintel, *"Hand book of Concrete Enssi Vannostrand"*, CBS Publishers & Distributors, 2004
2. Metha P.K. and Monterio P.J.M. *"Concrete-Structures"*, Properties and Materials, 3rd Edition, McGraw Hill Professional, 2006.
3. M.S. Shetty, *"Concrete Technology"* S.Chand and Company Ltd, Delhi, 2000.
4. Neville.A.M. *"Properties of Concrete"*, Pitman Publishing Limited, London, 1990
5. Aitkens, *"High Performance Concrete"*, McGraw Hill, 1999
6. Rudhani G., *"Light Weight Concrete"* Academic Kiado, publishing home of Hungarian Academy of Sciences, 1963.

Course Code	DESIGN OF BRIDGES	L	T	P	C

ST2105		3	0	0	3
	Total Contact Hours - 45				

PURPOSE	
To get exposed to the design aspects of various types of Bridges.	
INSTRUCTIONAL OBJECTIVES	
1.	IRC specifications for road bridges and general design considerations
2.	Design of slab culverts, the beam and slab bridges
3.	Principles of continuous bridges and composite bridges
4.	Design of prestressed concrete bridges
5.	Design of bearings and substructures

UNIT I- INTRODUCTION AND INVESTIGATION FOR BRIDGES
(9 hours)

Components of bridge - Classification - Need for investigation - Bidge site - Data collection - design discharge - linear waterway - economical span - scour depth - traffic projection - choice of bridge type.

UNIT II-LOADS ON BRIDGES (9 hours)

Indian Road Congress (IRC) bridge codes - dimensions - dead and live loads - impact effect - wind and seismic forces - longitudinal and centrifugal forces - hydraulic forces - earth pressure - temperature effect and secondary stresses.

UNIT III-SLAB AND T - BEAM BRIDGES (9 hours)

Design of slab bridges - skew slab culverts - box culverts. T - beam bridges - Pigeaud curves - Courbon's theory - Hendry Jaegar method - analysis and design of T - beam bridges.

UNIT IV-LONG SPAN BRIDGES (9 hours)

Hollow girder bridges - balanced cantilever bridges - continuous girder bridges - rigid frame bridges - arch bridges - bow string girder bridges. Prestressed concrete bridges - composite prestressed concrete super structures - erection of precast girders - continuous construction - recent trends.

UNIT V-BEARINGS AND SUBSTRUCTURE (9 hours)

Design of bearings for slab, girder, skew bridges - Design of piers - abutments - trestles, Joints - expansion joints.

REFERENCES

1. Johnson Victor D., *"Essentials of Bridge Engineering"*, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2006.
2. Krishna Raju.N. *"Design of Bridges"*, fourth editionOxford & IBM Publishing Co, Bombay,2009.
3. Raina.V.K. *"Concrete Bridge Practice"*, Tata McGraw Hill Publishing Co., New Delhi - 1991
4. Taylor F.W, Thomson S.E. and Smulski.E. *"Reinforced Concrete Bridges"*, John Wiley & Sons, New York 1955
5. Conference Proceedings, *'Advances and Innovations in Bridge Engineering'*, IIT, Madras and Indian Institute of Bridge Engineers, Tamilnadu, Allied Publisher, New Delhi, 1999

Course Code	DESIGN OF REINFORCED CONCRETE FOUNDATIONS	L	T	P	C
ST2106		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To get exposed to the design aspects of foundation structural elements like footings of various types, pile caps, shell foundation etc.

INSTRUCTIONAL OBJECTIVES

1.	To study Structural aspects of footings
2.	To study design of rafts and piles
3.	To know design of piles
4.	To study analysis of flexible beams on elastic foundations
5.	To know the Structural design of steel towers-machine foundations

UNIT I- INTRODUCTION (9 hours)

Review of limit state design of reinforced concrete. Structural design of isolated footings, column pedestals, column footings, combined footings, strap footings, strip footings under several columns.

UNIT II-STRUCTURAL DESIGN OF RAFT FOUNDATION (9 hours)

Design flat slab rafts-mat foundations-beam and slab rafts-combined piled raft foundations-(CPRF)-circular and annular rafts.

UNIT III-STRUCTURAL DESIGN OF PILES (9 hours)

Structural design of different types of piles-under reamed pile foundations-Design of pile cap-Pile foundation-Design of large dia socketed piles-in filled virendeel frame foundations-steel column bases.

UNIT IV-ANALYSIS OF BEAMS (9 hours)

Analysis of flexible beams on elastic foundations-ACI method for analysis of beams and grids on elastic foundations-Analysis of flexible plates on elastic foundations-shells for foundations-Hyperbolic paraboloid(Hyper)shell foundations-Design of conical shell foundation.

UNIT V-FOUNDATION FOR TOWERS (9 hours)

Design of foundation for towers-steel towers-machine foundations-general design principles-structural design of foundation to Rotary machine, reciprocating machine and impact machine.

REFERENCES

1. P.C. Varghese, *"Design of Reinforced Concrete Foundations"*-Prentic-Hall of India Pvt Ltd,2009.
2. P.C. Varghese, *"Foundation Engineering"* - Prentic-Hall of India Pvt Ltd.
3. Kurien.N.P, *"Design of foundation systems-Principles and Practices"*, 3rd Edition, Alpha Science International, 2005.
4. Bowles.J.E, *"Foundation Analysis & Design"*, Fifth edition, Mcgraw Hill-New Delhi (1997)

Course Code	DESIGN OF SHELL AND FOLDED PLATE STRUCTURES	L	T	P	C
ST2107		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To get exposure to the design of special structures involving shells and folded plates.

INSTRUCTIONAL OBJECTIVES

1.	To distinguish between the shell structures and folded plate structures
2.	To know Importance of membrane theory and its limitation
3.	To study different types surface generation using linear elements
4.	To know design aspects of shells-developable and non developable shells
5.	To know design of folded plate roofs

UNIT I- INTRODUCTION (9 hours)

Structural behaviour of thin shells and folded plates - membrane theory of shells - classification of shells - Translational and rotational shells - Ruled surfaces - methods of generating the surface of different shells like hyperboloid, elliptic paraboloid - conical.

UNIT II-DESIGN OF SHELLS WITH DOUBLE CURVATURE

(9 hours)

Design of the following types of shells - Spherical shell - Conical shell - Parabolic and Ellipsoid - Cooling towers.

UNIT III-DESIGN OF CYLINDRICAL SHELLS (09 hours)

Design of cylindrical shell with edge beam using theory for long shells.

UNIT IV-DESIGN OF HYPERBOLIC PARABOLOID (9 hours)

Surface definition - determination of forces - forces with the edge members.

UNIT V-DESIGN OF FOLDED PLATE ROOFS (9 hours)

Assumptions in the analysis of folded plates - Design of folded plates - Theory of bending of thin plates with lateral loads and in plane loads - Scheme for de-shuttering.

REFERENCES

1. Ramaswamy G.S. - *"Design and Constructions of Concrete Shell Roofs"* - CBS Publishers and Distributors - New Delhi - 1986
2. Chatterjee.B.K. - *"Theory and Design of Concrete Shell"*, - Chapman & Hall, Newyork-third edition, 1988
3. Bandhopadhyay J.N. *"Thin shell Structures"* - Classical and Modern Analysis" New Age International Publishers - New Delhi. 1986.

Course Code	DESIGN OF STEEL-CONCRETE COMPOSITE STRUCTURES	L	T	P	C
ST2108		3	0	0	3

	Total Contact Hours - 45				
PURPOSE					
To bring about an exposure to composite structural members and carry out the design of connections and girder bridges.					
INSTRUCTIONAL OBJECTIVES					
1.	To understand the concept of steel - concrete composite member				
2.	To understand the behaviour of composite beams, columns				
3.	To design composite girder bridges and understand the seismic behaviour of composite structures				
4.	To know the design of connections				
5.	To study specific case studies				

UNIT I- INTRODUCTION (9 hours)

Introduction to Steel - Concrete Composite Construction - Theory of Composite Structures -Introduction to Steel - Concrete - Steel - Sandwitch Construction - Behaviour of composite beams and columns .

UNIT II-DESIGN OF COMPOSITE MEMBERS (9 hours)

Design of Composite beams – Design of Composite Columns - Design of Composite Trusses.

UNIT III-DESIGN OF CONNECTIONS (9 hours)

Types of Connections - Design of Connections in Composite structures - Shear Connections - Design of Connections in composite trusses.

UNIT IV-COMPOSITE GIRDER BRIDGES (9 hours)

Behaviour of girder bridges - Design concepts.

UNIT V-CASE STUDIES (9 hours)

Case Studies on steel - concrete composite construction structures in buildings - Seismic behaviour of composite structures and design methods.

REFERENCES

1. *"Teaching Resource Material for Structural Steel Design"*, Volume 2/3 jointly prepared by 1. I.I.T., MS 2. Anna University 3. SERC, MS 4. "Institute for Steel Development and growth", Calcutta
2. Owens .G.W. & Knowels.P. *"Steel Designs Manual"*, (sixth Edition) Steel Concrete Institute (UK) Oxford Black; well Scientific Publications, 2003

3. Johnson.R.P. *"Composite Structures of Steel and Concrete"*. Vol-I, # Oxford Black; well Scientific Publications (Third Edition) U.K. 2004

Course Code	ADVANCED ANALYSIS AND DESIGN FOR WIND EARTHQUAKE AND OTHER DYNAMIC LOADS	L	T	P	C
ST2109		3	0	0	3
	Total Contact Hours – 45				

PURPOSE	
To create a comprehensive knowledge on the analysis and design of structures subjected to wind, blast and seismic loading.	
INSTRUCTIONAL OBJECTIVES	
1.	To study the behaviour of R.C.C. under the action of impact and cyclic loads
2.	To study the effect of wind of loading on structures, their analysis and design
3.	To bring about exposure to blast loads their effect on structure, analysis and design
4.	To study the characteristics of seismic loading and to design structures subjected to seismic loads
5.	To study the design of structures against impact loads

UNIT I-INTRODUCTION (9 hours)

Behaviour of concrete, steel, masonry and soil under impact and cyclic loads - review of structural dynamics with reference to SDOF, MDOF and continuous systems - ductility and its importance - factors affecting design against dynamic loads.

UNIT II-INTRODUCTION TO WIND LOADING (9 hours)

Spectral studies, gust factor, wind velocity, methods of measurements-variation of speed with height - Wind tunnel studies - types of tunnel-modeling requirements - interpretation of results - aero elastic models.

UNIT III-WIND EFFECTS (9 hours)

Wind on structures - rigid structures - static and dynamic effects - tall buildings - chimneys.

UNIT IV-INTRODUCTION TO SEISMIC LOADING (9 hours)

Elements of engineering seismology - theory of vibrations - response spectra - Structural configuration - seismic performance - irregular buildings - soil

performance - modern concepts - base isolation - adoptive system - case studies performance of regular buildings - 3-D computer analysis of building systems - study of analysis results - and interpretation-Ductile detailing as per BIS codes.

UNIT V-DESIGN AGAINST BLAST AND IMPACT (9 hours)

Characteristics of internal and external blast - impact and impulse loads - pressure distribution on buildings above ground due to external blast - underground explosion - design of buildings for blast and impact as per BIS codes of practice.

REFERENCES

- Bungale S. Taranath, *"Structural Analysis and Design of Tall Buildings"*, CRC Press, CRC Press, 2010.
2. Peter Sachs, *"Wind Forces in Engineering"*, Pergamon Press, new York 1978
3. Lawson, T.V., *"Wind Effects on Building"*, Vol I and II, Applied Science Publishers, London 1980
4. Bela Goschy, *"Design of Buildings to withstand abnormal Loading"*, Butterworths, 1990
5. Kolousek. Et al *"Wind effects on Civil Engineering Structures"*, Elseveir Publications, 1984
6. Cook, N.J., *"The designers guide to Wind Loading of Building Structures"*, 1990
7. Course Notes, *"Seismic Design of Reinforced Concrete Structures"*, I.I.T Kanpur, 2000
8. Dowling, C.H., *"Blast Vibration Monitoring and Control"*, Prentice Hall Inc., Englewood Cliffs, 1985

Course Code	DESIGN OF TALL BUILDINGS	L	T	P	C
ST2110		3	0	0	3
	Total Contact Hours - 45				
PURPOSE					

To impart the overall knowledge about the material, elements and systems with planning, analysis and design involved in Tall Buildings.	
INSTRUCTIONAL OBJECTIVES	
1.	To introduce various systems of tall buildings
2.	To know about different types of loads, materials and design philosophy
3.	Various structural systems with their behaviour are introduced
4.	To impart knowledge about static, dynamic and stability analysis of various systems
5.	To know about recent topics of research of tall buildings

UNIT I-INTRODUCTION (9 hours)

Design Philosophy - History - advantages and disadvantages - Vertical city concepts - essential amenities - fire safety - water supply - drainage and garbage disposal - service systems - structural and foundation systems. Factors affecting height, growth and form - Human comfort criteria.

UNIT II-LOADS AND MATERIALS (9 hours)

Gravity loading - Dead and Live load - calculation - Impact and construction loads. Wind loading - static and dynamic approach - Analytical and wind tunnel experimental method. Earthquake loading - Equivalent lateral force, Modal analysis - combination of loading in various design philosophies. Materials for tall buildings - High strength concrete - Light weight concrete - Fibre reinforced concrete Composite Materials.

UNIT III-STRUCTURAL SYSTEMS (9 hours)

Behavior of High Rise structures - Different system for load distribution in steel and concrete - Vertical and horizontal load resistant systems - Rigid frames - braced frames - infilled frames - shear walls - wall frames - tubular systems - outrigger braced systems - Mega systems.

UNIT IV-ANALYSIS AND DESIGN (9 hours)

Analysis and Design principles of various horizontal load transfer systems - approximate methods - Modelling for accurate analysis - 3D analysis - Member forces - displacements. Analysis for various secondary effects - Creep, shrinkage and temperature. Stability Analysis - Overall buckling analysis of frames, wall frames, approximate methods, second order effects of gravity loading, P - effect and various methods of analysis - influence of foundation instability, out of plumb effects - Elastic Deformations. Dynamic Analysis - Principles of design of tall braced frames for earthquake and blast resistant design.

UNIT V-ADVANCED TOPICS **(9 hours)**

Structural systems for future generation buildings - Expert systems for consultations - Economics - Research needs in tall building materials, systems and designs.

REFERENCES

1. Schuller.W.G., *"High Rise Building Structures"*, John Wiley & sons, 1977
2. Lynn.S. Beedle, *"Advances in Tall Buildings"*, CBS Publishers and Distributors, New Delhi, 1996
3. LinT.Y. and Burry D.Stotes, " *Structural Concepts and Systems for Architects and Engineers "*, John Wiley, 1994.
4. Gupta.Y.P.,(Editor), *"Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities*", New Age International Limited, New Delhi,1995.
5. Lecture Notes on *"Tall Buildings"* - Short Term Course organized by Civil Engineering Department, SRM Engg college, Kattankulathur. June 2002
6. Smith .B.S. and Coull .A., *"Tall Building Structure"*, 'Analysis and Design', John Wiley & Sons, Inc., 1991
7. Taranath .B.S., *"Structural Analysis and Design of Tall Buildings"*, Mc Graw Hill Co. 1988

Course Code	DISASTER RESISTANT STRUCTURES	L	T	P	C
ST2111		3	0	0	4
	Total Contact Hours - 45				
PURPOSE					
To get an exposure to types of disaster and understand the concept behind the					

design of disaster resistant structures.	
INSTRUCTIONAL OBJECTIVES	
1.	To understand the design philosophy for loads, earthquake and wind
2.	To study the materials to be used, and design to be made for disaster resistant structures
3.	To study damage assessment and retrofitting
4.	To understand materials design and detailing for life line structures
5.	To know techniques of damage assessment

UNIT I-BEHAVIOUR OF LIFE LINE STRUCTURES (9 hours)

Design philosophy to resist flood, cyclone, and earthquake and fire disasters-National and International Codes of practice - By-laws of urban and semi-urban areas - Past history and lessons from disasters - Approach to traditional and Modern Structures - Concept of life period based Design - case studies.

UNIT II-COMMUNITY STRUCTURES (9 hours)

Safety analysis and rating - Reliability assessment repairs and Retrofitting techniques of Community Structures - Protection of Nuclear Structures - Dams, bridges and buildings.

UNIT III-REHABILITATION AND RETROFITTING (9 hours)

Testing and evaluation - Classification according to safety level - methods and materials for strengthening for different disasters - qualification test.

UNIT IV-MATERIALS, DESIGN AND DETAILING (9 hours)

Modern Materials for disasters reduction - Detailing aspects of structures subject to probable disasters - Construction techniques - Analysis methodology - Techniques for optimal performance - Provisions for artificial disasters - blast and impact.

UNIT V-TECHNIQUES OF DAMAGE ASSESSMENT (9 hours)

Damage surveys - Maintenance and modification to improve hazard resistance - application GIS in disaster management - foundation improvement techniques.

REFERENCES

1. Raiker, R.N. *"Learning from failures, Deficiencies in Design, Construction and Service"*, R&D Center, Raiker Bhavan, 1987
2. Allen.R.T., and Edwards.S.C., *"Repairs of Concrete Structure"*, #CCCCCC;ie and Sons, U.K.1987

3. Moskvin.V *"Concrete and Reinforced Concrete"* - Deterioration and protection - MIR Publishers - Moscow 1983
4. Lecture notes on the course *"Disasters Management"* - conducted by Anna University, 2000

Course Code	OFFSHORE STRUCTURES	L	T	P	C
ST2112		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To get exposed to special features of offshore structures like geometry, forces encountered, structural modeling for design purpose together with their design.

INSTRUCTIONAL OBJECTIVES

1.	To develop the knowledge of wave generalized process and wave theories
2.	To understand the forces on offshore structure
3.	To develop an idea about foundation and structural modeling
4.	To familiarize with foundation analysis and dynamics of offshore structures
5.	Design of offshore structures with failure probability

UNIT I-WAVE THEORIES (9 hours)

Wave generation process, small and finite amplitude wave theories.

UNIT II-FORCES ON OFFSHORE STRUCTURES (9 hours)

Wind forces, wind forces on vertical, inclined cylinders, structures - current forces and use of Morrison equation.

UNIT III-OFFSHORE SOIL AND STRUCTURE MODELLING (9 hours)

Different type of offshore structures, foundation modeling, structural modeling.

UNIT IV-ANALYSIS OF OFFSHORE STRUCTURES (9 hours)

Static methods of analysis, foundation analysis and dynamics of offshore structures.

UNIT V-DESIGN OF OFFSHORE STRUCTURES (9 hours)

Design of platforms, helipads, jacket tower and mooring cables and pipelines - Corrosion and Fatigue Failure.

REFERENCES

1. Chakrabarti, S.K., *"Hydrodynamics of Offshore Structures"*, Computational mechanics, Publications, 1987
2. Thamas H Dawson, *"Offshore Structural Engineering"*, Prentice Hall Inc. Englewood, Cliffs, N.J. 1983
3. API Recommended Practice for Planning, "*Designing and Constructing Fixed Offshore Platform*", American Petroleum Institute Publication, RP2A, Dallas, Texas, 1983
4. Wiegel .R.L, *"Oceanographical Engineering"*, Prentice Hall Inc. Englewood, Cliffs, N.J. 1964
5. Brebia, C.A Walker.S., *"Dynamic Analysis of Offshore Structures"*, New - Nes Butterworths, U.K 1979
6. Reddy DV and Arockiasamy M., *"Offshore Structures"*, Vol.1, Krieger Publication Company, Malabar, Florida, 1991

Course Code	MAINTENANCE AND REHABILITATION OF STRUCTURES	L	T	P	C
ST2113		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To provide a comprehensive knowledge on the diagnosis, assessment and material application relating to maintenance and rehabilitation of structures.

INSTRUCTIONAL OBJECTIVES

1.	To assess the diagnosis and extent of distress
2.	To arrive at the repair techniques
3.	To choose the appropriate material and its application
4.	To study strengthening and demolition of structural components
5.	To know about maintenance of structures

UNIT I-GENERAL ASPECTS (9 hours)

Performance of construction materials and components in actual structure for strength, permeability, thermal properties and cracking effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, Effects of cover thickness.

UNIT II-MAINTENANCE AND DIAGNOSIS OF FAILURE (9 hours)

Definitions: Maintenance, Repair and rehabilitation, Facets of Maintenance, Importance of Maintenance, Various aspects of inspection - Assessment procedure for evaluating a damaged structure. Diagnosis of construction failures.

UNIT III-DAMAGES AND THEIR REMEDIES (9 hours)

Corrosion damage of reinforced concrete, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, cathodic protection, rust eliminators. Causes of deterioration of concrete, steel, masonry and timber structures, surface deterioration, efflorescence, causes, preventive measures such as coatings for embedded steel and set concrete.

UNIT IV-MATERIALS AND TECHNIQUES OF REPAIR (9 hours)

Special concrete and mortar, concrete chemicals, expansive cement, polymer concrete sulphur infiltrated concrete, Ferro cement, fiber reinforced concrete. Methods of repair in concrete, steel, masonry and timber structures. Gunite and shotcrete, epoxy injection.

UNIT V-STRENGTHENING AND DEMOLITION ASPECT (9 hours)

Strengthening of existing structures - repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering, wear, fire, leakage, marine exposure, use of non destructive testing techniques for evaluation, load testing of structure - Demolition of structures using engineered and non engineered techniques - case studies.

REFERENCES

1. Shetty .M.S., *"Concrete, Technology"*, Theory and Practice, S.Chand and Company, New Delhi 2010
2. Raiker .R.N. *"Learning from Failures, Deficiencies in Design, Construction and Service"*, - R&D Centre (SDCPL), Raikar Bhavan, Bombay 1987
3. *"Repair & Rehabilitation" "Compilation from The Indian Concrete Journal"*, - ACC - RCD Publication 2001
4. *"Health Monitoring of Structures"* - A Proactive strategy - proceedings of the ISTE sponsored short course, organized by the Department of Civil Engineering, S.R.M. Engineering College, S.R.M. Nagar, January 2003
5. Revision compbell, Allen and Itarold Roper, *"Concrete Structures Materials Maintenance and Repair"* Longman Scientific and Technical UK 1991

6. Allen .R.T. and Edwards .S.C., *"Repair of Concrete Structures"*, Blakie and Sons, UK 1987

Course Code	PRESTRESSED CONCRETE STRUCTURES	L	T	P	C
ST2114		**3**	**0**	**0**	**3**
	Total Contact Hours - 45				

PURPOSE

To provide comprehensive understanding on the design of prestressed concrete structures including indeterminate structures.

INSTRUCTIONAL OBJECTIVES

1.	To study the analysis of PSC flexural members
2.	To carry out the complete design of tension members
3.	To study analysis and design of compression member
4.	To study analysis and design of composite beam member
5.	To study analysis and design of indeterminate structures

UNIT I-ANALYSIS OF PSC FLEXURAL MEMBERS (9 hours)

Basic Concepts, Stresses at transfer and service loads, ultimate strength in flexure - code provisions in - deflection (short - long term) in (IS, BS, ACI).

UNIT II-DESIGN OF TENSION MEMBERS (9 hours)

Design for shear, bond and torsion Design of End blocks - Design of Tension Members - Design of prestressed concrete cylindrical water tanks - Design of prestressed concrete pipes.

UNIT III-DESIGN OF COMPRESSION MEMBERS (9 hours)

Compression members with and without flexure - its application in design of piles.

UNIT IV-COMPOSITE BEAMS (9 hours)

Composite construction with precast PSC beams and cast-in-situ R.C. Slab - Analysis and Design - Ultimate Strength - their applications - Special Structures like folded plates, prestressed cylindrical shells, spherical shells, partial prestressing - Principles, analysis and design concepts, crackwidth.

UNIT V-STATICALLY INDETERMINATE STRUCTURES (9 hours)

Analysis and design - continuous beams - Concept of linear transformation - concordant cable profile and cap cables.

REFERENCES

1. Krishna Raju.N *"Prestressed Concrete"*, 4th Edition, Tata McGraw Hill Publishing Co. New Delhi 2006
2. Sinha .N.C & S.K. Roy, *"Fundamentals of Prestressed Concrete*", S.Chand & Co., 1985
3. Rajagopalan.N. *"Prestressed Concrete"*, 2th Edition, Alpha Science International, Limited, 2005
4. Lin .T.Y. *"Design of Prestressed Concrete Structures"*, John Wiley and Sons - Inc - 1981
5. Leonhardt.F. *"Prestressed Concrete Design and Construction"*, - Second Edition Wilhelm Ernst & Sohn, Berlin, 1964
6. Guyon .V. *"Limit State Design of Prestressed Concrete"*, - Vol - 1 & 2, Applied Science Publishers, London 1995
7. Dayaratnam.P., *"Prestressed Concrete"*, Tata McGraw Hill Publishing Co. New Delhi 2000.

Course Code	OPTIMIZATION IN STRUCTURAL DESIGN	L	T	P	C
ST2115		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To study optimization techniques and their application to structural design.

INSTRUCTIONAL OBJECTIVES

1.	To study the elements of optimization techniques like linear, quadratic, dynamic and geometric programming
2.	To study the underlying concepts of structural design like minimum weight and minimum cost design
3.	To bring about an understanding of application of optimization techniques structural design problems
4.	To know about computer application to optimization
5.	To understand game theory

UNIT I-INTRODUCTION (9 hours)

Basic concepts of minimum weight, minimum cost design, Objective function, constraints, classical methods.

UNIT II-OPTIMIZATION TECHNIQUES AND ALGORITHMS (9 hours)

Linear, Integer, Quadratic, Dynamic and Geometric programming methods for optimal design of structural elements.

UNIT III-COMPUTER SEARCH METHODS (9 hours)

Linear programming methods for plastic design of frames, Computer search methods for univariate and multivariate Minimization.

UNIT IV-OPTIMIZATION THEOREMS (9 hours)

Optimization by structural theorems, Maxwell, Mitchell and Heyman's theorems for trusses and frames, Fully stressed design with deflection constraints, optimality criterion methods.

UNIT V-GAME THEORY (9 hours)

Strategies and their properties - pure and mixed strategies, two person zero games, Minimax Maximin, saddle point, value of game - Rule of Dominance - Graphical solution.

REFERENCES

1. Uri Krisch, *"Optimum Structural Design"*, McGraw Hill Book Co, 1981
2. Richard Bronson, *"Operation Research"*, Schaum's Outline series, MacGraw Hill Book Co, Singapore, 1983
3. Pun, *"Introduction to Optimization in Practice"*, John Wiley Eastern Limited, New Delhi, 1997
4. Haugen, *"Probabilistic Approaches to Design"*, John Wiley Eastern Limited, New Delhi, 1997
5. Fox, R.C., *"Optimization methods for Engineering Design"*, Addison Wesley, 1997
6. Rao, S.S., *"Optimization Theory and applications"*, Wiley Eastern Limited, New Delhi, 2004
7. Spunt, *"Optimum structural Design"*, Civil Engineering and Engineering mechanics Services, Prentice hall, New Jersey, 1986

Course Code	STABILITY OF STRUCTURES	L	T	P	C
ST2116		3	0	0	3
	Total Contact Hours - 45				
PURPOSE					
To get exposed to the concept of stability, stability analysis and its application to a few problems.					
INSTRUCTIONAL OBJECTIVES					
1.	Concept and characteristics of stability problems				
2.	Buckling of columns with remotes end conditions				

3.	Importance of tersianal and lateral buckling
4.	Buckling of rectangular and circular plates
5.	Approximate methods and application for finite difference methods

UNIT I-INTRODUCTION (9 hours)

Concept of stability - Approaches to stability analysis - characteristics of stability problems.

UNIT II-STABILITY OF STRUCTURES (9 hours)

Buckling of columns with various end conditions columns under eccentric loading - In elastic buckling of columns - beam columns.

UNIT III-TORSIONAL AND LATERAL BUCKLING (9 hours)

Torsional buckling - Lateral buckling of beams - pure bending of simply supported beam and cantilever - beams with udl and concentrated load.

UNIT IV-BUCKLING OF PLATES (9 hours)

Governing differential equation - Navier's solution for rectangular plates, circular plates with clamped and free edge conditions - supporting concentrated central load, edge moment and uniform load.

UNIT V-THIN SHELLS OF REVOLUTION (9 hours)

Geometry of Shells-Shell of revolution, membrane equilibrium with axial symmetry, membrane theory of anti-symmetrically loaded shells.

REFERENCES

1. Chajes, *"A Principles of Structures Stability Theory"*, Prentice Hall, 1974
2. Allen.H.G., and Bulson.P.S., *"Background to Buckling"*, McGraw Hill Book Company, 1980
3. Brush and Almorth, *"Buckling of Bars, Plates and Shells"*, McGraw Hill book Company, 1975
4. Seely, F.B. and Smith, J.O. *"Advanced Mechanics of Materials"*, 2nd Edition, John Wiley and Sons, Inc., New York. 1952
5. Timoshenko.S. and Woinowsby - Krieger.S. *"Theory of Plates and Shells"*, 2nd Ed. Mc Graw - Hill Book Co., New York 1959
6. Ashwini Kumar, *"Stability Theory of Structures"*, Tata Mc Graw Hill Co., New Delhi, 1985

Course Code	Theory of Plates	L	T	P	C
ST2117		3	0	0	3
	Total Contact Hours - 45				

PURPOSE	
To study the behaviour of thin plates and different load conditions and the analysis techniques including analysis for large deflection of plates.	
INSTRUCTIONAL OBJECTIVES	
1.	To analyse the plates under lateral load
2.	To understand the analytical solution for rectangular plates using classical and numerical methods
3.	To study large deflection theory and understand the concepts of design
4.	To understand about thick plates
5.	To study engineering design approach to plates

UNIT I-LATERALLY LOADED PLATES (9 hours)

Theory of bending of thin plates with lateral loads-Governing differential equation and various boundary conditions - in Cartesian and Polar coordination.

UNIT II-RECTILINEAR PLATES (9 hours)

Classical solution for rectangular plates with different types of loads and boundary conditions - Navier's and Levy's solution methods - continuous plates (introduction only).

UNIT III-CIRCULAR PLATES (9 hours)

Symmetrical bending of circular plates, plates on elastic foundation.

UNIT IV-NUMERICAL AND APPROXIMATE METHODS (9 hours)

Finite Difference Methods - improved finite difference Methods - Energy Methods - Variational Methods - Galerkin's Methods - Matrix displacement Methods - Lattice analogy - Finite Element Method (Introduction only) - application to plates.

UNIT V-ADVANCED TOPICS (9 hours)

Large - Deflection Theory - influence surface for plates - Skew plates - orthotropic plate bending theory and bending of thick plates - Mindlin's Theory - Layered plates Engineering approach to design of plates and continuously supported floor slabs - Application of flat plate theory to design of flat slabs.

REFERENCES

1. Szilard, R *"Theory and Analysis of Plates, Classical and Numerical Methods"*, Wiley, 2004.
2. Timoshenko, S and Krieger, S.W. *"Theory of Plates and Shells"*, Textbook Publishers, 2003.

Course Code	INFRASTRUCTURE ENGINEERING FOR SANITARY STRUCTURES	L	T	P	C
ST2118		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To get exposed to the special requirements to be considered in the design of environmental structures and their detailed design incorporating codal requirements.

INSTRUCTIONAL OBJECTIVES

1.	Structural design of steel, cast iron piping sewage tanks
2.	Design of water retaining structures
3.	Importance of special structure
4.	Repair and rehabilitation methods for masonry concrete and steel structure
5.	Design of steel, lattice structures used in water and sewerage works

UNIT I-DESIGN OF PIPES (9 hours)

Structural Design of Concrete, Prestressed Concrete, Steel and cast iron piping mains, Sewage tanks design.

UNIT II-ANALYSIS AND DESIGN OF WATER TANKS (9 hours)

I. S. Codes for Design of Water retaining Structures - Design of concrete roofing system Cylindrical, Spherical, Conical Shapes using membrane theory. Design of Circular, Rectangular, Spherical and Intze types of tanks using concrete. Design of prestressed concrete cylindrical tanks.

UNIT III-SPECIAL STRUCTURES (9 hours)

Design of Special purpose structures - underground reservoirs and swimming pools, intake towers, structural design including foundation of water retaining structures such as settling tanks, clarifloculators, aeration tanks, Imhoff tanks.

UNIT IV-REPAIR AND REHABILITATION OF STRUCTURES (9 hours)

Diagonising the cause and damage, identification of different types of structural and non structural cracks - repair and rehabilitation methods for masonry, concrete and steel structures.

UNIT V-SEWERAGE WORKS (9 hours)

Design of Steel, Lattice Structures used in water and sewerage works - Protection methods of both RC and Steel structures.

REFERENCES

1. Dayanatnam.P. *"Reinforced Concrete"*, Wheeler and Co, New Delhi. 1999
2. Krishna Raju.N. *"Prestressed Concrete"*, Tata Mc Graw Hill Publishing Co. New Delhi, 2000
3. Ramaswamy.G.S. *"Design and Construction of Concrete Shell roofs"*, CBS publishers - New Delhi - 2005

Course Code	THEORY OF SHELLS	L	T	P	C
ST2119		3	0	0	3
	Total Contact Hours - 45				
PURPOSE					
To study the classification of shells, their behaviour and analysis using classical and modern methods.					
INSTRUCTIONAL OBJECTIVES					
1.	To study shell theories - membrane theory and bending theory				
2.	To get exposed to variational methods of analysis				
3.	To get exposed to computer based analysis of shells				
4.	To know about various shells and theories				

5.	To understand design of shells

UNIT I-CLASSIFICATION OF SHELLS AND SHELL THEORIES (9 hours)

Singly curved and doubly curved shells - developable and non-developable - other special types Classification of shell theories - non-linear shell theory - Indian Code Recommendations - Recommendations of ACI committee 334.

UNIT II-MEMBRANE THEORY OF THIN SHELLS (9 hours)

General- pseudo stress resultants - equation of equilibrium characteristic lines Conical, circular domes-Hyperbolic paraboloids - elliptic and rotational paraboloid shells - conoids.

UNIT III-BENDING THEORY OF THIN SHELLS (9 hours)

General - differential equations of equilibrium in terms of displacements. Bending analysis of translational shells - circular cylindrical shells - Hyperbolic paraboloids bounded by straight lines.

UNIT IV-VARIATIONAL METHODS OF ANALYSIS (9 hours)

Gelarkin's method - Hyperbolic paraboloids bounded by straight lines - rotational paraboloids-conoids.

UNIT V-COMPUTER BASED ANALYSIS OF SHELLS (9 hours)

shallow rectangular shell element - doubly curved shell element using polynomials - isoparametric elements - bilinear degenerated shell element - eight noded shell element.

REFERENCES

1. Timoshenko, S. and Krieger, S.W., *"Theory of Plates and Shells"*, McGraw Hill Book Co., New York, 1990
2. Flugge, *"Stresses in shells"*, 2nd edition, Springer - Verlag, Berlin,1962
3. Bilington, D.P., *"Thin Shell Concrete Structures"*, 2 nd edition, McGraw Hill Book Co., New York, 1990
4. Ugural, I.L, *"Theory and Practice of Shell Structures"*, Wilhelm Ernst and john, Berlin, 1968
5. Bandyopadhyay, J.N., *"Thin Shell Structures"*, Classical and modern analyses, New age International Publishers, 1988
6. Ramaswamy, G.S., *"Design Construction Concrete Shell Roofs"*, R.E. Krieger, University of California , 1984

Course Code	DAM SAFETY	L	T	P	C
ST2120		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To provide comprehensive knowledge to the students doing research, about the Analysis and Design of dams and dam safety to apply them in the above field.

INSTRUCTIONAL OBJECTIVES

1.	To know about the classification dams and Selection of dams
2.	To know the Analysis of dams for stability for various forces including Earth quake
3.	To know about the design of dams
4.	To study about the dam safety
5.	To know about the computer analysis of dams by FEM and the various packages used for the analysis

UNIT I-DAMS IN GENERAL (9 hours)

Definition uses and history of dam Construction, Modern dams. Various kinds of dams, problems in dam construction. Classification of dams by their uses and by hydraulic designs, rigid and non rigid dams, factors governing the selection of dams selecting of dam site.

UNIT II-ANALYSIS, DESIGN AND CONSTRUCTION OF GRAVITY DAMS (9 hours)

Introduction. Typical cross section, forces acting, Earth quake forces, Wight of dam, Combination of forces for design. Modes of failures and criteria for the structural stability of gravity dams. Gravity method or two dimensional stability Analysis, Construction of gravity dams, construction of galleries in gravity dams, shear keys, water stops, foundation treatment for gravity dams.

UNIT III-SPILLWAYS, ENERGY DISSIPATERS (9 hours)

Definition. Location, Subsidiary or emergency spillway or beaching section. Design Consideration for the main spillway, controlled and Uncontrolled spillways, Design of crest of spillways Energy dissipation below overflow spillways, Energy dissipation below other types of spillways, stilling basin.

UNIT IV-REQUIREMENTS OF TESTS FOR DAM SAFETY (9 hours)

Introduction Requirements for checking the safety of a dam. Earthen dam evaluation-Dams with Heterogeneous construction materials-Concrete dam evaluation - Non-destructive testing-Laboratory studies-Requirement of

repair materials, repair techniques of damages due to cracks, Cavitations and for Abrasion Erosion.

UNIT V-COMPUTER ANALSIS OF DAMS (9 hours)

Identification of computer program-Methods of Analysis, Finite element method-Analysis of dam-Static Analysis-Dynamic Analysis-Results and interpretation-Eligibility of the packages used in the dam Analysis.

REFERENCES

1. William P. Creager, D Justin and Hinds, *"Engineering for dams vol.1"*, Hesperides Press, 2006.
2. Notes on the training course on structural, Hydrological and foundation Engineering aspects concerning Dam safety by Prof. A. A. Santhakumar & Dr. S. Rajarathnam organized by the Dam Safety Directorate, PWD, Chennai - 5 at the college of Engineering, Guindy, Anna University, Chennai - 600 025

Course Code	**BRIDGE MAINTENANCE MANAGEMENT**	**L**	**T**	**P**	**C**
ST2121		**3**	**0**	**0**	**3**
	Total Contact Hours - 45				
PURPOSE					
To introduce the concepts of monitoring, testing and maintaining bridge structures in their life span.					
INSTRUCTIONAL OBJECTIVES					
1.	To introduce the philosophy underlying bridge maintenance management				
2.	To study the salient features of bridge deterioration,				
3.	To study testing assessment and monitoring of bridge structures				
4.	To know the causes of bridge deterioration				

5.	To know the stress monitoring in bridge structures

UNIT I-INTRODUCTION (9 hours)

Bridge maintenance management - The system - Inspection - Inspection equipments - planning - condition rating.

UNIT II-ASSESSMENT AND EVALUATION (9 hours)

Basic consideration - structural safety - analysis method - Reliability concepts.

UNIT III-NON DESTRUCTIVE TESTING (9 hours)

Concrete Elements - Corrosion analysis equipments - Resistivity measurements - Rebarlocators - Ultrosonic testing - Rebound hammer - carbonation test - permeability testing - internal fracture tester - impulse rador - infrared thermography - Endoscopy - Impact echo - Radiography - coring - steel elements - masonry elements.

UNIT IV-BRIDGE DETERIORATION (9 hours)

Basic Theory - Discount rate - Traffic disruption - Future development - maintenance strategy - performance profiles - whole life assessment.

UNIT V-STRESSS MEASUREMENTS AND BRIDGE MONITORING (9 hours)

In - situ residual stresses - stress relief principle - Indirect stress management - Live load stresses - Monitoring - scour sensing - load cells - displacement transducers - Traffic monitoring.

REFERENCES

1. Ryall M J, *"Bridge Management"*, Butterworth Heinemann, Oxford, 2009
2. Proc. First International Conference on Bridge Management (1990) Elsevier, London
3. Proc. Second International Conference on Bridge Management(1993) Thomas Telford, London
4. Proc. Third International Conference on Bridge Management (1996) F & N Spon, London
5. Proc. Fourth International Conference on Bridge Management(2000) Thomas Telford, London

Course Code	GROUND IMPROVEMENT TECHNIQUES	L	T	P	C
ST2122		3	0	0	3

	Total Contact Hours - 45				
PURPOSE					
To acquire an in-depth knowledge on the ground improvement techniques aimed at improving the bearing capacity of soils.					
INSTRUCTIONAL OBJECTIVES					
1.	Effect of dewatering on ground characteristics				
2.	Sand drains				
3.	Stone column and soil nailing				
4.	Earth reinforcement				
5.	Soil grouting				

UNIT I-DEWATERING (9 hours)

Introduction-scope and necessity of ground improvement in geotechnical engineering, basic concepts and philosophy-Drainage - Ground Water lowering by well points, deep wells, vacuum and electro-osmotic methods. Stabilisation by thermal and freezing techniques.

UNIT II-COMPACTRION AND SAND DRAINS (9 hours)

In-situ compaction of granular and cohesive soils, surface compaction, deep compaction, compaction sand piles - concept, design, factors influencing compaction. consolidation - preloading with sand drains, fabric drains etc theories of sand drains - design and relative merits.

UNIT III-STONE COLUMN, LIME PILES AND SOIL NAILING (9 hours)

Stone column, lime piles - functions - methods of installation - design, estimation of load carrying capacity and settlement, Root piles, soil nailing - Applications.

UNIT IV-EARTH REINFORCEMENT (9 hours)

Earth reinforcement - Principles and basic mechanism of reinforces earth, simple design, Geotextiles and their applications, filtration, drainage, separation, erosion control - case studies.

UNIT V-GROUTING (9 hours)

Grouting - types of grout - suspension and solution grouts - basic requirements of grout - grouting equipment - injection methods - gout

monitoring. Electro - chemical stabilization - stabilization with cement and lime etc. stabilization of expansive clays.

REFERENCES

1. Moseley M. D., *"Ground Treatment"*, Black willie Academic and professional, 1998.
2. Davies, M.C., and Schlosser, F., *"Ground Improvement Geo Systems"*, American Society of Civil Engineers, 1997.
3. Jewell, R.A., *"Soil Reinforcement with Geotextiles"*, CIRIA, London, 1996
4. Das, B. M., *"Principles of Foundation Engineering"*, Cengage Learning, 2010 (seventh Edition).
5. Jones, J.E.P., *"Earth Reinforcement and Soil structure"*, Butterworths, 1985
6. Balasubramaniam, A.S., *"Symposium on Recent Developments in Ground improvement Techniques"*, Balkema Publishers, 1985
7. Koerner, R.M. and Welsh, J.P., *"Contruction and Geotechnical Engineering Using Synthetic Fabrics"*. John Wiley, 1990
8. Balasubramaniam, A.S., Bergado, D.T., Yodbhir, Seah T. S. Nutalaya, P. and Phienwej, N., "*Prediction versus performance in Geotechnical Engineering*", Bangkok, Balkema, A.A. 1992
9. Hehn, R.V., *"Practical Guide to Grouting of Underground structures"*, ASCE 1996
10. Shroff, A. V., "*Grouting Technology in Tunneling and Dam*", Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1999
11. www.geoforum.com

Course Code	**SEISMIC RETROFIT OF BUILDINGS**	**L**	**T**	**P**	**C**
ST2123		**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
PURPOSE					
To get conversant with latest techniques in seismic Retrofit of Buildings.					
INSTRUCTIONAL OBJECTIVES					
1.	To introduce the basics of seismic				
2.	To know the basic concepts of seismic analysis and design				
3.	To understand retrofit of buildings, and seismic vulnerability assessment				

4.	To introduce retrofit strategies for different types of buildings
5.	To understand retrofit of historical buildings

UNIT I-BASIC CONCEPTS (9 hours)

To know the basic concepts of earthquakes seismic design and retrofit of buildings, seismic vulnerability assessment, retrofit strategies for different types of buildings. BASIC CONCEPTS Making buildings safe against earthquakes-Introduction to earthquakes-factors affecting the response of a building-Importance of lateral strength-importance of ductility-importance of integrity-essentials of seismic design of masonry buildings, RC buildings - how EQ-safe is our building-To retrofit or not-retrofit of non engineered and Masonry Buildings, RC Buildings. Need for seismic evaluation of existing buildings-attributes to seismic design-lateral strength-lateral stiffness-ductility-stability-integral action retrofit us repair and rehabilitation-retrofit-goals and objectives-steps in seismic retrofit.

UNIT II-SEISMIC ANALYSIS AND DESIGN (INTRODUCTION AND BASICS ONLY) (9 hours)

Causes and effects of EQ-Characterize of EQ-Response spectrum-Basics of seismic analysis-layout and configuration for seismic design-lateral load resisting systems-capacity based design-performance based design-Rapid visual screening, data collection and preliminary evaluation - Overview-rapid visual screening of Masonry R.C. and steel Buildings and as per FEMcontentlink54 and 155 Data Collection-preliminary evaluation - Condition Assessment of Existing Buildings: Overview-Introduction-property of materials w.r.t the materials in existing buildings-its deterioration-Visual inspection-Detailed investigation-NDT-intrusive rests.

UNIT III-REPAIR AND RETROFIT OF NON-ENGINEERED BUILDINGS (9 hours)

Introduction-Vulnerability of buildings-seismic resistance features-repair materials-repair techniques-strengthening of roofs-strengthening of up stair floors-strengthening of walls-strengthening of pillars-techniques of global strengthening.

UNIT IV-RETROFIT OF BUILDINGS (9 hours)

Introduction-seismic analysis-building deficiencies strengthening of roofs and upstairs floors-strengthening of pillars-stress relieving techniques-global retrofitting techniques. Building deficiencies-retrofit strategies-Global and local-importance of seismic evaluation and selection of retrofit strategy. Deficiencies and retrofit strategies for single storey buildings, multi storeyed

buildings-retrofit of foundations. Deficiencies in foundations-condition assessment-methods of analysis-Types of interventions.

UNIT V-RETROFIT OF HISTORICAL BUILDINGS (9 hours)

Introduction-recommendation of the international council on monuments and sites (ICOMOS)-condition assessment-strengthening of Masonry walls-strengthening of arches, vaults and domes, towers and spires-reduction of seismic effect on structure-Strengthening of soil and foundation-archeological reconstruction.

REFERENCES

1. Hand book on *"Seismic retrofit of Buildings-brought out by CPWD"*, Indian Buildings congress (IBC) and Indian Institute of Technology, Madras-Narosa publishing House, 2008
2. IS13920, 1993, Reaffirmed 1998,Edition 1.2(2002-2003) *"Indian Standard Code of Practice for Ductile Detailing of R.C. Structures Subjected to Seismic forces"*, Bureau of Indian Standards
3. IS13935, 2009, *"Indian Standard for Repair and Seismic strengthening of Building Guidelines"*, Bureau of Indian Standards
4. Park R and Paulay T(1975) *"Reinforced Concrete Structures"*, John Wiley and Sons
5. Murthy, C.V.R(2005) *"Earthquake Tips"*, Indian Institute of Technology, kanpur, Project sponsored by Building material and Technology Promotion Council

Course Code	FLUID STRUCTURE INTERACTION (MATHEMATICAL APPROACH)	L	T	P	C
ST2124		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To provide a comprehensive knowledge to the Students doing research the rudiments of mathematics so as to enable them to apply in the field of Dam Safety. The knowledge of mathematics and its applications so as to enable them to apply them the above field.

INSTRUCTIONAL OBJECTIVES

1.	To know the fluid properties

2.	To assess the fluid pressure
3.	To assess the Hydro dynamic effect
4.	To know the flow measurements techniques
5.	To understand the boundary layer theory

UNIT I-KINEMATICS OF FLUID MOTION (9 hours)

Real fluids and Ideal fluids - Velocity of a fluid at a point - Stream lines and path lines, steady and unsteady flow - the velocity potential - the vorticity vector - Local and particles rates of change - The equation of continuity - Acceleration of a fluid - Conditions at a rigid boundary.

UNIT II-EQUATION OF MOTION OF A FLUID (9 hours)

Pressure at a point in a fluid at rest - pressure at a point in a moving fluid - Conditions at a boundary of two inviscid immersible fluids - Eulers equation of motion - Bernoullis equation - Discussion of the case of steady motion under conservative body forces - some flows involving axial symmetry.

UNIT III-FLUID PROPERTIES AND FLUID STATICS (9 hours)

Properties of fluid - Pressure - Thrust - Hydro static force on horizontal, vertical, inclined and Curved Surfaces.

UNIT IV-BOUNDARY LAYER THEORY (9 hours)

Properties of Navier's Stokes equation (Matching Techniques) - 2D - Boundary Layer Equation - Displacement, Momentum and energy. Thickness of 2-D flows - Momentum Intergral equation for Boundary layer flow - Displacement, Momentum energy thickness for axially symmetric flows - Boundary Layer flow near a stagnation point.

UNIT V-FLOW MEASUREMENT (9 hours)

Notches - V, Rectangular Notches - Flow over weirs - Sharp crested weirs - Broad crested weirs.

REFERENCES

1. Text book of *"Fluid dynamics"* by F. Chorlton, CBS publication, reprinted 2004.
2. *"Boundary layer theory"* by H.Schlichting and k.Gersten ,springer-verlag Heidelberg 2000,8 th edition, corrected reprinting 2003.
3. "*Fluid Mechanics*", by Dr. R.K. Bansal, Lakshmi Publications (P) Ltd., New Delhi, Ninth Edition 2010.

Course Code	ENGINEERING FRACTURE MECHANICS	L	T	P	C
ST2125		3	0	0	3
	Total Contact Hours - 45				

PURPOSE

To impart the overall knowledge about the stationary crack under static loading energy balance, fatigue crack growth curve and applications of fracture mechanics.

INSTRUCTIONAL OBJECTIVES

1.	To develop systematic knowledge of stress strain concept
2.	To familiarize with the fundamentals of stationary crack under static loading.
3.	To develop the knowledge about energy balance and crack growth.
4.	To introduce fatigue crack growth curve.
5.	To know about the applications of fracture mechanics.

UNIT I-ELEMENTS OF SOLID MECHANICS (9 hours)

The geometry of stress and strain, elastic deformation, plastic and elasto – plastic deformation – limit analysis – Airy's function – field equation for stress intensity factor.

UNIT II-STATIONARY BALANCE AND CRACK GROWTH (9 hours)

Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation – plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.

UNIT III-ENERGY BALANCE AND CRACK GROWTH (9 hours)

Griffith analysis – stable and unstable crack growth – Dynamic energy balance- crack arrest mechanism – K1c test methods –R curves – determination of collapse load.

UNIT IV-FATIGUE CRACK GROWTH CURVE (9 hours)

Empirical relation describing crack growth law – life calculation for a given load amplitude – effects of changing the load spectrum – rain flow methods – external factors affecting the K1c values- leak before break analysis.

UNIT V-APPLICATION OF FRACTURE MECHANICS (9 hours)

Crack initiation under large scale yielding – thickness as a design parameter – mixed mode fractures – crack instability in thermal and residual stress fields – numerical methods.

REFERENCES

1. David Broek, *"Elemetary Engineering fracture Mechanics"*, Fifthoff and Norerdhoff International publisher, 1978.
2. Kare Hellan, *"Introduction of Fracture Mechanics"*, McGraw-Hill Book Company, 1985.
3. Preshant Kumar, *"Elements of Fracture Mechanics"*, Wheeler Publishing, 1999.
4. John M.Barson and Stanly T.Rolfe , *"Fatigue and fracture control in structures"* Prentice hall Inc. Englewood cliffs 1977.

Course Code	**ANALYSIS AND DESIGN OF STRUCTURAL SANDWICH PANELS**	**L**	**T**	**P**	**C**
ST2126		**3**	**0**	**0**	**3**
	Total Contact Hours - 45				

PURPOSE	
To introduce the basic principles related to the structural sandwich panels.	
INSTRUCTIONAL OBJECTIVES	
1.	To learn about methods of analysis of sandwich panels.
2.	To know about design methodologies of sandwich panels.
3.	To learn about various standards for testing and procedures.
4.	To know buckling loads of sandwich panels
5.	To know the application of sandwich panels

UNIT I-ANALYSIS OF SANDWICH FLEXURAL ELEMENTS

(9 hours)

Introduction – Sandwich beams – Analysis of Antiplane core and thin faces-faces of unequal thickness-cases of core with modulus of elasticity considerable-deflection- symmetrical load- unsyymetrical load-including point load and udl

UNIT II-BUCKLING OF SANDWICH STRUTS **(9 hours)**

Sandwich struts – Buckling – Analysis of sandwich-beam and sandwich strut by strain energy method –Isotropic – Orthotropic sandwich struts by Ritz's method.

UNIT III-SANDWICH PANELS UNDER BENDING AND BUCKLING

(9 hours)

Differential equations of bending and buckling of isotropic sandwich panels - Wrinkling and other forms of local instability – Formulae for analysis.

UNIT IV-DESIGN OF SANDWICH PANELS (9 hours)

Theory of sandwich panels – Simply supported edge – large deflection – Initial deformations –Design of sandwich beams, Struts and panels.

UNIT V-TESTING OF SANDWICH PANELS (9 hours)

Testing of materials used in sandwich constructions – Phase materials – Core materials – Test on sandwich constructions – Properties of materials.

REFERENCES

1. HOWARD G.ALLEN, *"Analysis and design of structural sandwich panels"* – First edition 1969, PERGAMON PRESS.
2. DAVID RANDAL AND STEVE LEE, *"The Polyurathanes Book"*- November, 2002, JOHN WILEY, LTD.

Course Code	EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION	L	T	P	C
ST2127		3	0	0	3
	Total Contact Hours - 45				

PURPOSE	
To impart knowledge about various destructive, nondestructive testing techniques and instrumentation.	
INSTRUCTIONAL OBJECTIVES	
1.	To know about various load, stress, strain measurement devices and their principle of operation
2.	To introduce various devices that are used for vibrating systems
3.	To familiarize with wind and sound wave pressure measurements
4.	To introduce various techniques for distress measurement
5.	To impart know about various nondestructive testing methods

UNIT I-FORCE AND STRAIN MEASUREMENTS (9 hours)

Strain gauges, principle, types, performance and uses - Electrical resistance strain gauges - Gauge sensitivity - gauge factor - Simple strain gauge circuits - application - Photo elasticity, principle and applications-Polariscopes-Isoclinics-Isochromatics - Hydraulic jacks and pressure gauges - Electronic load cells - Proving Rings - Calibration of testing Machines.

UNIT II-VIBRATION MEASUREMENTS(9 hours)

Characteristics of structural vibrations - Linear variable differential transformer (LVDT) - Transducers for velocity and acceleration measurements - Vibration meter - Seismographs - Vibration analyzer - Electro Dynamic Exciters - Display and recording of signals - Cathode Ray Oscilloscope - XY Plotters - Strip Chart recorders - Digital data Acquisition systems - principles and applications.

UNIT III-ACOUSTICS AND WIND FLOW MEASUREMENTS (9 hours)

Pressure transducer - sound level meter - Wind tunnel and its use in structural analysis - structural modeling - direct and indirect model analysis - application to structural problems-Testing of Transmission line towers.

UNIT IV-DISTRESS MEASUREMENTS (9 hours)

Diagnosis of distress in structures - crack observation and measurement - Cracking due to corrosion of reinforcement in concrete - Half cell, construction and use - Damage assessment - controlled blasting for demolition.

UNIT V-NON DESTRUCTIVE TESTING METHODS (9 hours)

Load testing of structures, Buildings, bridges - Rebound Hammer - Ultrasonic Testing, Principles and applications - Moire fringes - brittle coatings - holography - use of Lasers for structural testing.

REFERENCES

1. Ganesan T.P., *"Model Analysis of Structures"*, Universities Press, Hyderabad, 2000
2. Sirohi.R.S., Radha Krishna.H.C., *"Mechanical Measurements"*, New Age International (P) Limited, 1997
3. Sadhu Singh, *"Experimental Stress Analysis"*, Khanna Publishers, New Delhi, 1996
4. Dalley.J.W. and Riley.W.F., *"Experimental Stress Analysis"*, Tata McGraw Hill company Ltd. New York, 1991

5. Bray.D.E., and Stanley.R.K., *"Non-Destructive Evaluation"*, McGraw Hill Publishing Co., New York, 1989
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AMENDMENTS

S.No.	Details of Amendment	Effective from	Approval with date
