NANDHA ENGINEERING COLLEGE

(An Autonomous Institution affiliated to Anna University Chennai and approved by AICTE, New Delhi)
Erode-638 052, Tamilnadu, India, Phone: 04294 – 225585

Curriculum and Syllabus

for

M.E. Structural Engineering [R15]

(This Curriculum and Syllabi are applicable to Students admitted from the academic year 2015-2016 onwards)

JUNE 2015

Approved by third Academic council

NANDHA ENGINEERING COLLEGE
(Autonomous Institution Affiliated to Anna University, Chennai)
DEPARTMENT OF CIVIL ENGINEERING

M.E. STRUCTURAL ENGINEERING
(For the students admitted during 2015-2016 and onwards)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Programme Educational Objectives are designed for M.E. Structural Engineering programme in Civil Engineering based on the Department Mission to provide higher engineering education and motivate research in the field of Civil Engineering

PEO1 The Graduates of structural Engineering will strong analytical and design knowledge will make them fit their professional career in industry.

PEO2 The Graduates of structural Engineering will demonstrate an exceptional involvement and active participation in Research and Development activities related to structural Engineering and publish / present technical research papers of high quality in accordance with codal provisions.

PEO3 Graduates engage themselves in life-long learning and research activities to solve advanced technological, social, economic and environmental problems.

PEO4 Graduates will excel in their profession with teamwork and leadership qualities in executing the multidisciplinary projects with ethical standards.

PROGRAMME OUTCOMES (POs)

Students in the Department of Civil Engineering M.E. Structural Engineering programme should at the time of their graduation are in possession of

PO1. To demonstrate knowledge of mathematics, science and basic engineering principles.

PO2. To analyze and design various components of structures and conduct experiments to interpret data.

PO3. To design advanced structural engineering elements and structures.

PO4. To execute and manage the multidisciplinary projects with global standards.

PO5. To critically identify, formulate and solve structural engineering problems.

PO6. To demonstrate knowledge of professional and ethical responsibilities.

PO7. To have the broad education necessary to understand the impact of engineering solutions in a global, economic and societal context and also will be aware of contemporary issues.

PO8. To develop confidence for self-education and ability for life-long learning and research activities.

PO9. To demonstrate knowledge of advanced mathematics to analyze and solve complex structural engineering design problems.

PO10. To use modern engineering tools, software and equipment to analyze problems.

NANDHA ENGINEERING COLLEGE, ERODE-52

REGULATIONS 2015

M.E. (STRUCTURAL ENGINEERING)

(FULL TIME)

CURRICULUM & SYLLABUS

SEMESTER I

THEORY					
Course code	**Course Title**	**L**	**T**	**P**	**C**
15ST101	Applied Mathematics for Structural Engineering	3	2	0	4
15ST102	Concrete Structures	3	2	0	4
15ST103	Structural Dynamics	3	2	0	4
15ST104	Theory of Elasticity	3	2	0	4
15ST105	Design of Sub-Structures	3	0	0	3
15ST106	Advanced Concrete Technology	3	0	0	3
PRACTICAL					
15ST111	Advanced Structural Engineering Laboratory	0	0	4	2
15ST121	Technical Seminar – I	0	0	2	1
	TOTAL	**18**	**8**	**6**	**25**

SEMESTER II

THEORY					
Course code	**Course Title**	**L**	**T**	**P**	**C**
15ST201	Experimental Techniques and Instrumentation	2	0	2	3
15ST202	Advanced Design of Steel Structures	3	2	0	4
15ST203	Earthquake Analysis and Design of Structures	3	0	0	3
E1	Elective – I (PE)	3	0	0	3
E2	Elective – II (PE)	3	0	0	3
E3	Elective – III (PE)	3	0	0	3
PRACTICAL					
Course code	**Course Title**	**L**	**T**	**P**	**C**
15ST211	Structural Analysis & Design Laboratory	0	0	4	2
15ST221	Technical Seminar – II	0	0	2	1
	TOTAL	**17**	**2**	**8**	**22**

SEMESTER III

THEORY					
Course code	**Course Title**	**L**	**T**	**P**	**C**
E4	Elective – IV (PE)	3	0	0	3
E5	Elective – V (PE)	3	0	0	3
E6	Elective – VI (OE)	3	0	0	3
PRACTICAL					
Course code	**Course Title**	**L**	**T**	**P**	**C**
15ST331	Project Work Phase – I	0	0	12	6
15ST311	Industrial Internship	0	0	0	0
	TOTAL	**9**	**0**	**12**	**15**

SEMESTER IV

THEORY					
Course code	**Course Title**	**L**	**T**	**P**	**C**
15ST431	Project Work Phase –II	0	0	24	12
	TOTAL	**0**	**0**	**24**	**12**

TOTAL NUMBER OF CREDITS: 25 + 22 + 15 +12 = 74

NANDHA ENGINEERING COLLEGE

REGULATIONS 2015 (R-15)

M.E.STRUCTURAL ENGINEERING

I TO VI SEMESTERS (PART TIME) CURRICULUM & SYLLABUS

SEMESTER I

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
15ST101	Applied Mathematics for Structural Engineering	3	2	0	4
15ST102	Concrete Structures	3	2	0	4
15ST103	Structural Dynamics	3	2	0	4
PRACTICAL					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
15ST111	Advanced Structural Engineering Laboratory	0	0	4	2
15ST121	Technical Seminar – I	0	0	2	1
	TOTAL	**9**	**6**	**6**	**15**

SEMESTER II

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
15ST201	Experimental Techniques and Instrumentation	2	0	2	3
15ST202	Advanced Design of Steel Structures	3	2	0	4
E1	Elective – I (PE)	3	0	0	3
PRACTICAL					
15ST211	Structural Analysis & Design Laboratory	0	0	4	2
15ST221	Technical Seminar – II	0	0	2	1
	TOTAL	**8**	**2**	**8**	**13**

SEMESTER III

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
15ST104	Theory of Elasticity	3	2	0	4
15ST105	Design of Sub-Structures	3	0	0	3
15ST106	Advanced Concrete Technology	3	0	0	3
	TOTAL	**9**	**2**	**0**	**10**

SEMESTER IV

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
15ST203	Earthquake Analysis and Design of Structures	3	0	0	3
E2	Elective – II (PE)	3	0	0	3
E3	Elective – III (PE)	3	1	0	4
	TOTAL	**9**	**2**	**0**	**9**

SEMESTER V

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
E4	Elective - IV (PE)	3	0	0	3
E5	Elective - V (PE)	3	0	0	3
E6	Elective - VI (OE)	3	0	0	3
PRACTICAL					
15ST331	Project Work Phase - I	0	0	12	6
15ST311	Industrial Internship	0	0	0	0
	TOTAL	**9**	**0**	**12**	**15**

SEMESTER VI

THEORY					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
15ST431	Project Work Phase –II	0	0	24	12
	TOTAL	**0**	**0**	**24**	**12**

Total Number of Credits: 15+13+10+9+15+12 = 74

LIST OF ELECTIVES
M.E - STRUCTURAL ENGINEERING

PROFESSIONAL ELECTIVES (PE)					
Course code	**Course Title**	**L**	**T**	**P**	**C**
15STX01	Analysis and Design of Tall Buildings	3	0	0	3
15STX02	Optimization of Structures	3	0	0	3
15STX03	Design of Bridges	3	0	0	3
15STX04	Design of Shell and Spatial Structures	3	0	0	3
15STX05	Design of Steel Concrete Composite Structures	3	0	0	3
15STX06	Mechanics of Composite Materials	3	0	0	3
15STX07	Non-Linear Analysis of Structures	3	0	0	3
15STX08	Stability of Structures	3	0	0	3
15STX09	Theory of Plates	3	0	0	3
15STX10	Industrial Structures	3	0	0	3
15STX11	Pre Stressed Concrete	3	0	0	3
15STX12	Prefabricated Structures	3	0	0	3
15STX13	Advanced Structural Analysis	3	0	0	3
15STX14	Maintenance and Rehabilitation of Structures	3	0	0	3
15STX15	Off Shore Structures	3	0	0	3
15STX16	Wind and Cyclone Effects on Structures	3	0	0	3
15STX17	Smart Structures	3	0	0	3
OPEN ELECTIVES (OE)					
Course code	**Course Title**	**L**	**T**	**P**	**C**
15STZ01	Finite Element Analysis	3	0	0	3
15STZ02	Solid and Hazardous Waste Management	3	0	0	3
15STZ03	Energy Efficient Structures	3	0	0	3

***PE- Professional Electives *OE-Open Electives**

15ST101 APPLIED MATHEMATICS FOR STRUCTURAL ENGINEERING

L	T	P	C
3	2	0	4

OBJECTIVES:

- To make available the advanced concepts of Engineering Mathematics to the structural engineers and to provide the necessary mathematical skills that are needed in modeling physical processes.

COURSE OUTCOMES:

CO 1: To familiarize the students in the field of differential and elliptic equations to solve boundary value problems associated with engineering applications.

CO 2 :To expose the students to variational formulation and numerical integration techniques and their applications to obtain solutions for buckling, dynamic response, heat and flow problems of one and two dimensional conditions.

UNIT I ONE DIMENSIONAL WAVE AND HEAT EQUATIONS (9+3)

Laplace transform methods for one - dimensional wave equation – Displacements in a long string – Fourier transform methods for one - dimensional heat conduction problems in infinite and semi - infinite rods.

UNIT II PROBABILITY AND RANDOM VARIABLES (9+3)

Probability Random variables and Moments – Moments Generating Function - Functions of random variables – Two dimensional random variables - Simple Correlation and regression.

UNIT III CALCULUS OF VARIATIONS (9+3)

Concept of variation and its properties – Euler's equation-Functional dependant on first and higher order derivatives – Functional dependant on functions of several independent variables - Variational problems with moving boundaries - Direct methods – Ritz and Kantorovich methods.

UNIT IV EIGEN VALUE PROBLEMS (9+3)

Methods of solutions: Faddeev – Leverrier Method & Power Method with deflation – Approximate Methods: Rayleigh-Ritz method.

UNIT V NUMERICAL INTEGRATION (9+3)

Gaussian Quadrature – One and Two Dimensions – Gauss-Hermite Quadrature – Monte Carlo Method – Multiple Integration by using mapping function.

TOTAL: L: 45 +T:15= 60 PERIODS

REFERENCES:

1. Grewal.B.S.,"Higher Engineering Mathematics",39th edition,Khanna publishers,New Delhi,2006.
2. Sankara Rao,K., "Introduction to Partial Differential Equations",Third edition, Prentice Hall of India Pvt.Ltd.,New Delhi,2011.
3. Gupta,A.S., "Calculus of variations with Applications", Prentice Hall of India Pvt.Ltd.,New Delhi,1996.
4. Andrews, L.C. and Shivamoggi, B.K., "Integral Transforms for Engineers",Prentice Hall of India Pvt.Ltd., New Delhi,2003.
5. Veerarajan.T, "Probability, Statistics and Random Process", Tata McGraw Hill Publication Company Ltd., 2010.
6. M.K.Venkataraman "Engineering Mathematics", Volume II, National Publishing Company, 2nd Edition, 1989.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*Pos*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	*x*				*x*			*x*		
2		*x*		*x*			*x*		*x*	
3	*x*		*x*					*x*		
4				*x*		*x*			*x*	
5		*x*			*x*					*X*

15ST102 CONCRETE STRUCTURES

L	T	P	C
3	2	0	4

OBJECTIVES:

- The course objective is to make familiar to students in the field of inelastic behavior of concrete structures which helps them to learn about yield line theory, rotation curves and ductile detailing.

COURSE OUTCOMES:

CO 1: Design the reinforced concrete beams, slabs and columns with reference to IS code.
CO 2: Understand and analyze the behavior of RCC elements subjected to flexure, shear and axial loading.
CO 3: To familiarize the students to design the flat slabs and plates.
CO 4: Enumerate the concept of reinforced concrete using moment redistribution & Baker's method.
CO 5: Understand the detailing for ductility and quality control of concrete. Familiarize on Design Calculations and drawings in appropriate professional formats.

UNIT I OVERALL REVIEW **(9+3)**

Review of limit state design of beams, slabs and columns according to IS Codes - Calculation of deflection and crack width according to IS and ACI Codes.

UNIT II DESIGN OF SPECIAL RC ELEMENTS **(9+3)**

Design of slender columns - Design of RC walls - ordinary and shear walls. Strut and tie method of analysis for Corbels and Deep Beams - Design of Corbels, Deep-beams and grid floors.

UNIT III FLAT SLABS AND YIELD LINE THEORY **(9+3)**

Design of flat slabs and flat plates according to IS and ACI methods - Design of shear reinforcement - Design of spandrel beams - Yield line theory and Hillerborgs strip method of design of slabs.

UNIT IV INELASTIC BEHAVIOUR OF CONCRETE STRUCTURES **(9+3)**

Inelastic behaviour of concrete beams and frames - moment-rotation curves - moment redistribution - Baker's method of plastic design - Design of cast-in-situ joints in frames.

UNIT V DETAILING AND FIELD PRACTICE **(9+3)**

Detailing for ductility as per IS: 13920 - Fire resistance of structural members - Quality of control of concrete. Reinforcement detailing of structural members as per SP: 34 & IS: 5525.

TOTAL = 60PERIODS

REFERENCES:

1. Unnikrishna Pillai and Devdas Menon "Reinforced concrete Design', Tata McGraw Hill Publishers Company Ltd., New Delhi, 2009.
2. Varghese, P.C, "Advanced Reinforced Concrete Design", Prentice Hall of India, 2005.
3. Subramanian. N, "Design of Reinforced Concrete Structures", Oxford University Press, New Delhi, 2013.
4. Sinha. N.C. and Roy S.K., "Fundamentals of Reinforced Concrete", S. Chand and Company Limited, New Delhi, 2009.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*POs*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	*x*		*x*			*x*				
2				*x*				*x*		*x*
3		*x*			*x*	*x*			*x*	
4				*x*		*x*		*x*		
5	*x*				*x*		*x*			*x*

15ST103 STRUCTURAL DYNAMICS

L	T	P	C
3	2	0	4

OBJECTIVES:

- To expose the students the principles and methods of dynamic analysis of structures and to prepare them for designing the structures for wind, earthquake and other dynamic loads.

COURSE OUTCOMES:

CO 1: Understand the response of structural systems to dynamic loads and displacements.
CO 2: Realize the behaviour and response of linear and non-linear SDOF and MDOF structures with Various dynamic loading.
CO 3: Understand the behaviour and response of MDOF structures with various dynamic loading.
CO 4: Find suitable solution for continuous system.
CO 5: Understand the behaviour of structures subjected to dynamic loads such as wind, Earthquake and blast.

UNIT I PRINCIPLES OF VIBRATION ANALYSIS (9+3)

Equations of motion by equilibrium and energy methods, free and forced vibration of single degree of freedom systems - Effect of damping - Transmissibility.

UNIT II TWO DEGREE OF FREEDOM SYSTEMS (9+3)

Formulation of Structure - Equations of Motion of Two degree of freedom systems - Damped and undamped free vibrations – Undamped forced vibration - normal modes of vibration – applications.

UNIT III DYNAMIC ANALYSIS OF MDOF (9+3)

Multi degree of freedom systems - Orthogonality of normal modes - approximate methods - Mode superposition technique - Numerical Integration procedure - Central Difference – Newmark's method.

UNIT IV DYNAMIC ANALYSIS CONTINUOUS SYSTEMS (9+3)

Free and forced vibration of continuous systems, Rayleigh-Ritz method - Formulation using Conservation of Energy – Formulation using Virtual Work.

UNIT V PRACTICAL APPLICATIONS (9+3)

Idealization and formulation of mathematical models for wind, earthquake, blast and impact loading, aerodynamics, gust phenomenon & principles of analysis.

TOTAL = 60 PERIODS

REFERENCES:

1. Mario Paz, Structural Dynamics: "Theory and Computation", Kluwer Academic Publication, 2004.
2. Anil K.Chopra, "Dynamics of Structures", Pearson Education, 2007.
3. Ray W. Clough & Joseph Penzien, "Dynamics of Structures", Computers & Structures, USA 2003.
4. Jagmohan L. Humar, "Dynamics of Structures", A.A. Balkema Publishers, Rotterdam, 2002.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	Pos									
	1	2	3	4	5	6	7	8	9	10
1	x			x		x				
2		x			x			x		
3		x		x						X
4	x		x					x		
5				x			x		x	

15ST104 THEORY OF ELASTICITY

L	T	P	C
3	2	0	4

OBJECTIVES:

- To make students to understand the concept of elasticity, plane stress and plane strain problems, membrane analogy, torsion and energy thermos this helps in 3D stress and strain analysis.

COURSE OUTCOMES:

CO 1: Understand the concept of stresses and strains.
CO 2: To obtain solutions for elasticity problems in rectangular and polar coordinates
CO 3: Analyze torsion of non-circular sections and thin walled sections.
CO 4: Analyze the beams and columns using energy methods
CO 5: Gain the knowledge on fracture mechanics in elasticity.

UNIT I ELASTICITY **(9+3)**

Analysis of stress and strain, Equilibrium equations - Compatibility equations – stress strain relationship. Generalized Hooke's law.

UNIT II ELASTICITY SOLUTION **(9+3)**

Methods of formulation of elasticity problems, methods of solution of elasticity problems -- Plane stress and Plane strain problems - Simple two dimensional problems in Cartesian and polar co-ordinates.

UNIT III TORSION OF NON-CIRCULAR SECTION **(9+3)**

St.venant's approach - Prandtl's approach – Membrane analogy - Torsion of thin walled open and Closed sections.

UNIT IV ENERGY METHODS **(9+3)**

Strain energy – Principle of virtual work – Energy theorems – Rayleigh Ritz method – Finite difference method – Application to elasticity problems.

UNIT V FRACTURE MECHANICS **(9+3)**

Introduction - Linear Elastic Fracture Mechanics - Geometric Model of a Crack - Review of Elasticity - Complex variable Method in Elasticity.

TOTAL = 60 PERIODS

REFERENCES:

1. Timoshenko, S. and GoodierJ.N."Theory of Elasticity", McGraw Hill Book Co., Newyork, 2010.
2. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 2005.
3. Chou P.C. and Pagano, N.J. "Elasticity Tensor, Dyadic and Engineering Approaches", D.VanNostrand Co., Inc., London, 1992.
4. Irving H.Shames and James, M.Pitarresi, "Introduction to Solid Mechanics", Prentice Hall of India Pvt. Ltd., New Delhi 2000.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	Pos									
	1	2	3	4	5	6	7	8	9	10
1		x			x					X
2			x				x		x	
3	x			x				x		
4			x			x			x	
5		x				x		x		

15ST105 DESIGN OF SUB STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To gain familiarity with different types of foundation.
- To explore the students to the design of shallow foundations and deep foundations.
- To understand the concept of designing well, machine and special foundations.

COURSE OUTCOMES:

CO 1: Be capable of ensuring investigation & design concepts of shallow foundation
CO 2: Be efficient in selecting suitable type of pile for different soil stratum and in evaluation of group pile capacity by formulation.
CO 3: Enumerate the Design & construction of well foundation
CO 4: Understand the basic principles of design of machine foundation & vibration analysis.
CO 5: Deliver the design concepts for transmission line tower foundation.

UNIT I SHALLOW FOUNDATIONS **9**

Soil investigation – Basic requirements of foundation – Types and selection of foundations. Bearing capacity of soil - plate load test – Design of reinforced concrete isolated, strip, combined and strap footings – mat foundation.

UNIT II PILE FOUNDATIONS **9**

Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles – different shapes of piles cap – structural design of pile cap.

UNIT III WELL FOUNDATIONS **9**

Types of well foundation – Grip length – load carrying capacity – construction of wells – Failures and Remedies – Design of well foundation – Lateral stability.

UNIT IV MACHINE FOUNDATIONS **9**

Introduction – Types of machine foundation – Basic principles of design of machine foundation – Dynamic properties of soil – vibration analysis of machine foundation – Design of foundation for Reciprocating machines and Impact machines – Reinforcement and construction details – vibration isolation.

UNIT V SPECIAL FOUNDATIONS **9**

Foundation on expansive soils – choice of foundation – under-reamed pile foundation. Foundation for concrete Towers, chimneys – Design of anchors- Reinforced earth retailing walls.

TOTAL = 45 PERIODS

REFERENCES:

1. Bowles .J.E., "Foundation Analysis and Design", McGraw Hill Publishing co., New York, 1986.
2. Swamy Saran, Analysis and Design of substructures, Oxford and IBH Publishing Co. Pvt. Ltd., 2006.
3. Tomlinson.M.J, "Foundation Design and Construction", Longman, Sixth Edition, New Delhi, 1995.
4. Varghese.P.C, "Design of Reinforced Concrete Foundations" – PHI learning private limited, New Delhi, 2009.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x				x				x	
2		x		x			x			
3			x			x				x
4	x			x				x		
5		x				x				x

15ST106 ADVANCED CONCRETE TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To enable the students to design concrete mixes as per ACI and IS methods.
- To make the students understand the properties of fresh and hardened concrete and to know the tests for determining these properties

COURSE OUTCOMES:

CO 1: Gain knowledge the properties of material like grade of cement & testing of aggregate & chemical Compositions.
CO 2: Execute mix proportioning of concrete and describe how the strength of concrete can be modified by changing the proportions.
CO 3: Understand about Stress strain characteristics & Non-destructive tests as per IS Code.
CO 4: Use suitable concrete for different structures considering the prevailing weathering conditions.
CO 5: Decide the correct concreting methods in the field depending upon the requirement and site conditions.

UNIT I INTRODUCTION **9**

Concrete: Past, Present and Future - Constituent Materials -- Strength of Concrete - Dimensional Stability of Concrete - Chemical and Mineral Admixtures - Properties of Fresh and hardened Concrete.

UNIT II MIX DESIGN **9**

Principles of Concrete Mix Design - Factors in the choice of mix proportions - Mix design methods - A.C.I .Methods - I.S. Methods - Mix proportion - Correction for moisture content – Bulking - Yield of concrete - Design of High strength concrete and Self compacting concrete - EFNARC Specifications - Design of concrete mix with Fly ash and silica fume.

UNIT III CONCRETE TESTING **9**

Workability – Compression – Tension – Flexure - Bond strength - Factors affecting the results - Accelerated strength results - Stress strain characteristics - Modulus of Elasticity - In situ strength determination - Variation in results - Distribution of strength - Standard deviation - Nondestructive tests - I.S. code provision.

UNIT IV SPECIAL CONCRETES **9**

Lightweight and Heavy Weight Concrete - High Strength Concrete - High Performance Concrete - Polymers in Concrete - Steel fiber Reinforced Concrete - Ferrocement Concrete - Vaccum Concrete – Shotcrete - Ready Mixed Concrete – Self compacting concrete - Geopolymer concrete.

UNIT V DURABILITY OF CONCRETE **9**

Permeability - chemical attack - sulphate attack - Quality of water - marine conditions - Thermal properties of concrete - fire resistance - Methods of making durable concrete - Mass Concrete – Formwork - Structural Concrete Block Masonry - Quality Control of Concrete Construction.

TOTAL = 45 PERIODS

REFERENCES:

1. Neville, A.M., Properties of Concrete, Pitman Publishing Limited, London, 1995.
2. ShettyM.S.,ConcreteTechnology,S.Chand and Company Ltd,.New Delhi, 2005.
3. Gambir,M.L. “Concrete Technology”, Tata McGraw Hill, Publishing Co,Ltd, New Delhi, 2004.
4. Krishnaraju.N, “Design of Concrete mixes”, CBS Publishers, New Delhi, 2015.
5. Santhakumar,A.R., Concrete Technology, Oxford University Press, New Delhi, 2007.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1		x			x		x			
2	x		x			x				
3				x				x		x
4		x				x			x	
5			x		x		x			

15ST111 ADVANCED STRUCTURAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To study the structural behavior of concrete & steel structures.

COURSE OUTCOMES:

CO1: On completion of this laboratory course students will be able to cast and test RC beams for strength and deformation behaviour.

CO2: They will be able to test dynamic testing on steel beams, static cyclic load testing of RC frames and non-destruction testing on concrete.

List of Experiments:

1. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour.
2. Testing of simply supported steel beam for strength and deflection behaviour.
3. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.
4. Dynamic testing of cantilever steel beam
    a. To determine the damping coefficients from free vibrations.
    b. To evaluate the mode shapes.
5. Static cyclic testing of single bay two storied steel frames and evaluate
    a. Drift of the frame.
    b. Stiffness of the frame.
    c. Energy dissipation capacity of the frame.
6. Determination of in-situ strength and quality of concrete using
    a. Rebound hammer
    b. Ultrasonic Pulse Velocity Tester.
7. Effect of admixtures in concrete for workability, strength and durability

TOTAL = 60 PERIODS

REFERENCES:

1. Dally J W, and Riley W F, “Experimental Stress Analysis”, McGraw-Hill Inc. New York, 1991.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*POs*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	×		×	×			×			
2		×	×						×	×

15ST121 TECHNICAL SEMINAR - I

L	T	P	C
0	0	2	1

OBJECTIVES:

- To provide exposure to the students to refer, read and review the research articles in referred journals and conference proceedings. To improve the technical report writing and presentation skills of the students.

COURSE OUTCOMES:

CO 1: At the end of the course the student will be able to read and review the research articles and Publish a technical Paper.

METHODOLOGY

- Each student is allotted to a faculty of the department by the HOD.
- By mutual discussions, the faculty guide will assign a topic in the general/ Subject area to the student.
- The students have to refer the Journals and Conference proceedings and collect the published literature.
- The student is expected to collect at least20 such Research Papers published in thelast5 years.
- Using OHP/PowerPoint, the student has to make presentationfor15-20 minutes followed by10 minutes discussion.
- The student has to make two presentations, one at the middle and the other near the end of the semester.
- The student has to write aTechnicalReportforabout30-50 pages (Title page, one page Abstract, Review of Research paper under various subheadings, Concluding Remarks and List of References).The technical report has to be submitted to the HOD one week before the final presentation, after the approval of the faculty guide.

EXECUTION

Week	Activity
I	Allotment of Faculty Guide by the HoD
II	Finalizing the topic with the approval of Faculty Guide
III-IV	Collection of Technical papers
V-VI	Mid semester presentation
VII-VIII	Report writing
IX	Report submission
X-XI	Final presentation

EVALUATION

100%by Continuous Assessment — **3 Hrs/week and 1 credits**

Component	Weightage
Mid semester presentation	25%
Final presentation (Internal)	25%
End Semester Examination Report	30%
Presentation	20%
Total	100%

Mapping of COs and POs											
COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1						×	×	×	×	×	×

15ST201 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION

L	T	P	C
2	0	2	3

OBJECTIVES:

- The course objective is to make students to know the concepts of measurements of static and dynamic response of Structures and to analyze the structure.

COURSE OUTCOMES:

CO 1: Choose the methodology of measuring errors and strains and calibrate the machineries and Equipment used in the laboratory.
CO 2: Use various vibration measuring instruments and analyze the structures using digital display unit.
CO 3: Scale the model using direct and indirect model analysis (Using Buckingham PI Theorem).
CO 4: Measure distress in the structures using various electronic equipment.
CO 5: Perform advanced NDT methods in accessing the load testing of structures.

UNIT I FORCES AND STRAIN MEASUREMENT (6+6)

Choice of Experimental stress analysis methods, Errors in measurements – Strain gauge, principle, types, performance and uses. Photo elasticity - principle and applications - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines – Long-term monitoring – vibrating wire sensors – Fibre optic sensors.

UNIT II VIBRATION MEASUREMENTS (6+6)

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.

UNIT III ACOUSTICS AND WIND FLOW MEASURES (6+6)

Principles of Pressure and flow measurements – pressure transducers – sound level meter – venturimeter and flow meters – wind tunnel and its use in structural analysis – structural modelling – direct and indirect model analysis.

UNIT IV DISTRESS MEASUREMENTS AND CONTROL (6+6)

Diagnosis of distress in structures – crack observation and measurements – corrosion of reinforcement in concrete – Half cell, construction and use – damage assessment – controlled blasting for demolition – Techniques for residual stress measurements.

UNIT V NON DESTRUCTIVE TESTING METHODS (6+6)

Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing – Brittle coating, Advanced NDT methods – Ultrasonic pulse echo, Impact echo, impulse radar techniques, GECOR & Ground penetrating radar (GPR).

TOTAL = 60 PERIODS

REFERENCES:

1. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, 4th Edition, New Delhi, 2006.
2. Dalley .J.W and Riley.W.F, "Experimental Stress Analysis", McGraw Hill Book Company, N.Y. 1991.
3. Srinath.L.S, Raghavan.M.R, ingaiah.K, Gargesha.G, Pant.B and Ramachandra.K, "Experimental Stress Analysis", Tata McGraw Hill Company, New Delhi, 1984.
4. C. S. Rangan, Instrumentation – Devices and Systems, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1983.

Mapping of Course Outcomes(COs) and Programme Outcomes(Pos)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x		x			x		x		
2		x		x			x			x
3	x		x		x			x		
4		x		x		x			x	
5			x		x		x			x

15ST202 ADVANCED DESIGN OF STEEL STRUCTURES

L	T	P	C
3	2	0	4

OBJECTIVES:

- The course objective is to highlight students in general, the load on structures with lateral loads and design of connections and analysis of steel structure. This also explains the plastic analysis of structure. This will also serve as a basis for this research.

COURSE OUTCOMES:

CO 1: Familiarize on behaviour of members and connections.
CO 2: Design on flexural composite members and encased eccentric column.
CO 3: Design of with cold formed steel beam and column with stiffeners.
CO 4: Practice on analysis and design of steel towers & chimneys.
CO 5: Concept on Aseismic analysis and design of steel structures.

UNIT I DESIGN OF CONNECTIONS (9+3)

Bracket connections - Shear connections – fin plate, end plate and cleat connections – moment connection – direct welded, strap plate and plate connections – semi rigid connections.

UNIT II DESIGN OF COMPOSITE CONSTRUCTION (9+3)

Concepts – design of beams – shear connectors. Encased columns – in filled columns – Uni-axial and Biaxial eccentric columns – design of deck slab.

UNIT III DESIGN OF SLENDER COLUMNS (9+3)

Hot rolled and cold rolled sections – stiffened and un stiffened beams – Laterally un restrained beams – effective area of columns – Beams with slender webs.

UNIT IV INDUSTRIAL STRUCTURES (9+3)

Design of Chimneys – Self-supporting and guyed chimneys – Design of Silos – Bunker design – Design of frames and towers.

UNIT V ASEISMIC DESIGN FOR STEEL STRUCTURES (9+3)

Advantages of steel – steps in seismic analysis – conceptual design – dissipative and non-dissipative elements capacity design – Moment resisting frame- plastic hinges and connections in MRF – Braced frame – Criteria for end connection.

TOTAL = 60 PERIODS

REFERENCES:

1. Subramanian.N, “Design of Steel Structures”, Oxford University Press, 2008.
2. Dayaratnam.P, “Design of Steel Structures”, A.H.Wheeler, India, 2008.
3. Linton E. Grinter, “Design of Modern Steel Structures”, Eurasia Publishing House, New Delhi, 1996.
4. FrdericoM.Mazzolani& Robert Tremblay,”Behaviour of steel structures in seismic areas” A. A. Balkema Publishers, Brookfield, USA, 2000.
5. Bungale. S. Taranath, “Structural Analysis and design of Tall Buildings – Steel and composite construction”, CRC Press Taylor and Francis Group, BacoRatan, US, 2012.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x				x				x	
2		x		x				x		
3			x			x	x			
4				x		x		x		
5		x			x				x	

15ST203 EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to gain knowledge of earth quake monitoring and seismic instrumentation, estimation of earth quake parameters, dynamics of structures and Earth quake resistant design of masonry and Reinforced Concrete Structures.

COURSE OUTCOMES:

CO 1: Describe ground motion and its relationship to seismic design of structures.
CO 2: Understand about the evaluation of Earthquake forces as per IS Code.
CO 3: Design consideration on earthquake resistant features in masonry buildings.
CO 4: Apply the basic principles of conceptual design for earthquake resistant RC building and carry out the detailed design of earthquake resistant RC buildings.
CO 5: Adopt vibration control methods for buildings located in earthquake zone.

UNIT I EARTHQUAKES AND GROUND MOTION (9)

Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake Phenomenon) - Seismotectonics and Seismic Zoning of India - Earthquake Monitoring and Seismic Instrumentation - Characteristics of Strong Earthquake Motion - Estimation of Earthquake Parameters - Microzonation.

UNIT II EFFECTS OF EARTHQUAKE ON STRUCTURES (9)

Dynamics of Structures (SDOFS/ MDOFS), Response Spectra - Average Response Spectra - Design Response Spectra - Evaluation of Earthquake Forces as per codal provisions - Effect of Earthquake on Different Types of Structures - Lessons Learnt From Past Earthquakes.

UNIT III EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES (9)

Structural Systems - Types of Buildings, Causes of damage, Planning Considerations, Philosophy and Principle of Earthquake Resistant Design - Guidelines for Earthquake Resistant Design - Earthquake Resistant Earthen Buildings - Design consideration - Guidelines.

UNIT IV EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES (9)

Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis - Design and detailing - Rigid Frames - Shear wall - Coupled Shear wall.

UNIT V RECENT ADVANCAMENTS IN EARTHQUAKES (9)

Mathematical modeling of multistoried RC Buildings - Vibration Control - Tuned Mass Dampers - Principles and application, Basic Concept of Seismic Base Isolation - Various System.

TOTAL = 45 PERIODS

REFERENCES:

1. Pankaj Agarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures”, Prentice Hall of India, 2006.
2. S K Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, 2007.
3. Course Notes "Design of Reinforced Concrete Buildings", IIT Kanpur, June 1999.
4. Paulay,T and Priestly, M.N.J., “Aseismic Design of Reinforced Concrete and Masonry buildings”, John Wiley and Sons, 1991.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x		x						x	
2		x		x			x			
3		x			x			x		
4	x		x				x			
5		x		x					x	

15ST211 STRUCTURAL ANALYSIS &DESIGN LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- On completion of the design project students will have a better experience in designing various design problems related to civil engineering.

COURSE OUTCOMES:

CO 1: Use analysis and design package for designing structural elements and structures and also to Utilize drafting packages Simulate, model and analyse trusses, steel beams, RC beams and Columns using software

List of Experiments

1. Design of an RC structure
2. Design of industrial building
3. Design of a foundation system
4. Design of steel structures
5. Design of gantry girder
6. Design of water tank
7. Design of culvert
8. Design of chimney
9. Design of steel tower
10. Design of bridges

Note:

At the end of the course the student should submit a complete report on the design problem consisting of the data given, the design calculations, specifications if any and complete set of drawings which follow the design .

TOTAL = 60 PERIODS

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*POs*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	*x*		*x*		*x*		*x*	*x*		

15ST221 TECHNICAL SEMINAR - II

L	T	P	C
0	0	2	1

OBJECTIVES:

- To provide exposure to the students to refer, read and review the research articles in referred journals and conference proceedings. To improve the technical report writing and presentation skills of the students.

COURSE OUTCOMES:

CO 1: At the end of the course the student will be able to read and review the research articles and publish a technical Paper.

METHODOLOGY

- Each student is allotted to a faculty of the department by the HOD.
- By mutual discussions, the faculty guide will assign a topic in the general/ Subject area to the student.
- The students have to refer the Journals and Conference proceedings and collect the published literature.
- The student is expected to collect at least20 such Research Papers published in thelast5 years.
- Using OHP/PowerPoint, the student has to make presentationfor15-20 minutes followed by10 minutes discussion.
- The student has to make two presentations, one at the middle and the other near the end of the semester.
- The student has to write aTechnicalReportforabout30-50 pages (Title page, one page Abstract, Review of Research paper under various subheadings, Concluding Remarks and List of References).The technical report has to be submitted to the HOD one week before the final presentation, after the approval of the faculty guide.

EXECUTION

Week	Activity
I	Allotment of Faculty Guide by the HoD
II	Finalizing the topic with the approval of Faculty Guide
III-IV	Collection of Technical papers
V-VI	Mid semester presentation
VII-VIII	Report writing
IX	Report submission
X-XI	Final presentation

EVALUATION

100%by Continuous Assessment — **3 Hrs/week and 1 credits**

Component	Weightage
Mid semester presentation	25%
Final presentation (Internal)	25%
End Semester Examination Report	30%
Presentation	20%
Total	100%

Mapping of COs and POs											
COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1						×	×	×	×	×	×

15STX01 ANALYSIS AND DESIGN OF TALL BUILDINGS

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop the knowledge of design principles of tall buildings, gravity loading, earth quake loading and 3 dimensional analysis & modeling, stability of tall building.

COURSE OUTCOMES:

CO 1: Knowledge on design principles and different types of loading
CO 2: Describe the various structural systems used in the construction of tall structures.
CO 3: Capable of analyse and Design the tall structures.
CO 4: Design of structural elements for secondary effects.
CO 5: Execute stability analysis, overall buckling analysis of frames, and analysis for various secondary effects such as creep, shrinkage and temperature.

UNIT I DESIGN PRINCIPLES AND LOADING (9)

Design philosophy, loading, sequential loading, and materials - high performance, concrete - Fibre reinforced Concrete - Lightweight concrete design mixes. Gravity loading - Wind loading - Earthquake loading.

UNIT II BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS (9)

Factors affecting growth, Height and Structural form. High rise behaviour, Rigid frames, braced frames, In filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, futrigger - braced and hybrid mega systems.

UNIT III ANALYSIS AND DESIGN (9)

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural system considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist, computerized general three dimensional analysis.

UNIT IV STRUCTURAL ELEMENTS (9)

Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow, Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance.

UNIT V STABILITY OF TALL BUILDINGS (9)

Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P Delta analysis, Translational, Torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation.

TOTAL = 45 PERIODS

REFERENCES:

1. Bryan Stafford Smith and Alexcoull, "Tall Building Structures - Analysis and Design", John Wiley and Sons, Inc., 1991.
2. Taranath B.S., "Structural Analysis and Design of Tall Buildings", McGraw Hill, 1988.
3. Gupta.Y.P., Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi, 1995.
4. Bungale S.Taranath "Structural Analysis and Design of Tall buildings" CRC Press, London, 2011.
5. Sarkisian, M.P., Designing Tall buildings: Structure as Architecture,Routledge, 2011

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x			x						x
2		x			x			x		
3				x		x			x	
4	x		x		x			x		
5		x		x					x	

15STX02 OPTIMIZATION OF STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To study the optimization methodologies applied to structural engineering.

COURSE OUTCOMES:

CO 1: Apply the basic ideas in optimization to make the structures as lightly as possible.
CO 2: Apply the linear & Non-linear programming techniques in engineering optimization.
CO 3: Understand the methods in solving the problems related to geometric Programming
CO 4: Understand the methods in solving the problems related to dynamic Programming
CO 5: Design of structural elements water tanks using plastic theory.

UNIT I BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES 9

Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behaviour and other constraints - Design space - Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima. Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Khun - Tucker Criteria).

UNIT II LINEAR AND NON-LINEAR PROGRAMMING 9

LINEAR PROGRAMMING: Formulation of problems - Graphical solution - Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - simplex method - Two phase method - Penalty method - Duality theory - Primal - Dual algorithm. NON LINEAR PROGRAMMING: One Dimensional minimization methods: Uni-dimensional – Uni-modal function - Exhaustive and unrestricted search - Dichotomous search - Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques..

UNIT III GEOMETRIC PROGRAMMING 9

Posynomial - degree of difficulty - reducing G.P.P to a set of simultaneous equations - Unconstrained and constrained problems with zero difficulty - Concept of solving problems with one degree of difficulty.

UNIT IV DYNAMIC PROGRAMMING 9

Bellman's principle of optimality - Representation of a multistage decision problem - concept of sub-optimization problems using classical and tabular methods.

UNIT V STRUCTURAL APPLICATIONS 9

Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory - Minimum weight design for truss members - Fully stressed design - Optimization principles to design of R.C structures such as multistorey buildings, water tanks and bridges.

TOTAL = 45 PERIODS

REFERENCES:

1. Iyengar.N.G.R and Gupta.S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997.
2. Peter W.Christensen and Anders kalbring "Introduction to Structural Optimization" Springer publication, Sweden, 2009.
3. Uri Krish, "Optimum Structural Design", McGraw Hill Book Co. 1981.
4. William R. Spillers "Structural Optimization" Springer publication, Sweden, 2009.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*POs*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1		x			x				x	
2	x					x				x
3			x				x		x	
4	x			x				x		
5		x			x		x			

15STX03 DESIGN OF BRIDGES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop skills of students in designing various types of bridges.

COURSE OUTCOMES:

CO 1: Understand the design theories for super structure and sub structure of bridges
CO 2: Design short span bridges.
CO 3: Understand the behaviour of continuous bridges, box girder bridges.
CO 4: Design prestressed concrete bridges
CO5: Know the Different types of bearings, abutments, piers and various types of foundations for Bridges

UNIT I INTRODUCTION (9)

Classification, investigations and planning, choice of type, I.R.C. specifications for road bridges, standard live loads, other forces acting on bridges & general design considerations.

UNIT II SHORT SPAN BRIDGES (9)

Introduction - Design of Culvert - Deck slab bridge - Load distribution theories - Pigeaud's Theory - T-beam and girder bridges.

UNIT III LONG SPAN GIRDER BRIDGES (9)

Introduction – Procedure & Design principles of continuous bridges - box girder bridges - balanced cantilever bridges.

UNIT IV DESIGN OF PRESTRESSED BRIDGES (9)

Flexural and Torsional parameters – Courbon's theory – Distribution co-efficient by exact analysis – Design of girder section – maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable Zone in girder – check for stresses at various sections – Check for diagonal tension – Diaphragms – End block – short term and long term deflections.

UNIT V DESIGN OF BEARINGS AND SUBSTRUCTURES (9)

Different types of bearings – Design of bearings – Design of masonry and concrete piers and abutments – Types of bridge foundations – Design of foundations.

TOTAL = 45 PERIODS

REFERENCES:

1. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, New Delhi 2008.
2. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. New Delhi, 1990.
3. Harrison H.B., "Structural Analysis and Design Vol.I and II", Pergamon Press, 1991.
4. Krishna Raju.N "Design of Bridges"Oxford and IBH Publishing Company,4th Edition, New Delhi, 2008.
5. Jagadeesh T. R, Jayaram M. A "Design of Bridge Structures" PHI Publication, New Delhi, 2009.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*POs*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	x			x				x		
2			x			x				
3		x			x					
4				x			x			
5			x			x				x

15STX04 DESIGN OF SHELL AND SPATIAL STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop the skills of students in the areas of design of shell, folded plate, space frames & the application of FORMAIN software.

COURSE OUTCOMES:

CO 1: Analyse and design various shell and spatial structures &Design of domes.
CO 2: Understand the behavior of folded plates.
CO 3: Know the structural behaviour and philosophy of space frames.
CO 4: Analysis & design the space frame using recent software
CO 5: Application of Formex Algebra on spatial structures.

UNIT I CLASSIFICATION OF SHELLS (9)

Classification of shells, types of shells, structural action, - Design of circular domes, conical roofs, circular cylindrical shells by ASCE Manual No.31.

UNIT II FOLDED PLATES (9)

Introduction - Folded Plate structures - Structural behaviour, types, and design by ACI - ASCE Task Committee method – pyramidal roof.

UNIT III INTRODUCTION TO SPACE FRAME (9)

Introduction - Space frames - configuration - types of nodes - general principles of design Philosophy - Behaviour.

UNIT IV ANALYSIS AND DESIGN (9)

Analysis of space frames – detailed design of Space frames – Introduction to Computer Aided Design and Software Packages.

UNIT V SPECIAL METHODS (9)

Application of Formex Algebra, FORMIAN for generation of configuration.

TOTAL = 45 PERIODS

REFERENCES:

1. Billington.D.P, “Thin Shell Concrete Structures”, McGraw Hill Book Co., New York, 1982.
2. Santhakumar.A.R and Senthil.R, “Proceedings of International Conference on Space Structures”, Anna University, Chennai, 1997.
3. Pietraszkiewicz.W and Szymmczak.C “ Shell Structures” Taylor Francis Group, UK, 2005.
4. Bangesh.M.Y.H and Bangesh.T “Elements of Spatial Structures” Thomas telford publishning, US, 2003.
5. ASCE Manual No.31, “Design of Cylindrical Shells”.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*POs*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1			x				x	x		
2	x				x					
3			x			x				
4		x						x		
5	x				x				x	

15STX05 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop skills in design of composite beam, column, slab, trusses, this also helps to develop skills in design of connections and seismic behaviour of composite structures.

COURSE OUTCOMES:

CO 1: Possess knowledge of the composite behaviour of structures.
CO 2: Design various composite structural elements such as beams, columns, floors, slabs
CO 3: Analyse the connection behaviour and design.
CO 4: Enumerate the behaviour of box girder bridges and the design concepts of the same.
CO 5: Have practical knowledge of construction and design of various structural elements and design concepts through case studies.

UNIT I DESIGN OF COMPOSITE CONNECTION (9)

Introduction – composite Connection to steel - concrete composite construction - theory of composite structures - construction.

UNIT II DESIGN OF BEAMS,SHEAR CONNECTION (9)

Introduction - Design of composite beams, slabs, columns, beam – columns - Design of composite trusses.

UNIT III DESIGN OF COMPOSITE COLUMNS (9)

Deck slab – encased columns – in filled columns subjected to Uni-axial & Bi-axial Types of connections, Design of connections in the composite structures – shear connections. Degree of shear connection – Partial shear interaction

UNIT IV COMPOSITE CONSTRUCTION (9)

Introduction – composite construction - Behaviour of box girder bridges and its types - Design procedure & concepts.

UNIT V GENERAL (9)

Case studies on steel - concrete composite construction in buildings – seismic behaviour of composite structures.

TOTAL = 45 PERIODS

REFERENCES:

1. Johnson R.P., “Composite Structures of Steel and Concrete”, Blackwell Scientific Publications, UK, 2004.
2. Oehlers D.J. and Bradford M.A., “Composite Steel and Concrete Structural Members, Fundamental behaviour”, Pergamon press, Oxford, 1995.
3. Proceedings of Workshop on “Steel Concrete Composite Structures”, Anna University, 2007.
4. David A.Nethrcot “Composite Construction” Spon Press, UK, 2003.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*POs*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1		x	x	x	x	x				
2	x			x				x		
3		x				x			x	x
4			x		x		x			
5	x		x					x		

15STX06 MECHANICS OF COMPOSITE MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop knowledge on composite construction, properties unidirectional fibre components, residual stress, inter laminar stress and failure of composites.

COURSE OUTCOMES:

CO 1: Identify the fiber types and classify the composite material.
CO 2: Relate the stress –strain properties, longitudinal and transverse properties of composites.
CO 3: Analyse the laminated composites and compute the lamina strength.
CO 4: Find the failure criterion and fracture mechanics of composites.
CO 5: Find the failure criterion and fracture mechanics of composites.

UNIT I INTRODUCTION (9)

Introduction to Composites, Classifying composite materials, Commonly used fibre and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites, Short Fiber Composites.

UNIT II STRESS STRAIN RELATIONS (9)

Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses

UNIT III ANALYSIS OF LAMINATED COMPOSITES (9)

Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates. Inter laminar stresses.

UNIT IV FAILURE AND FRACTURE OF COMPOSITES (9)

Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

UNIT V APPLICATIONS AND DESIGN (9)

Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues.

TOTAL = 45 PERIODS

REFERENCES:

1. Daniel and Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2006.
2. Michael W.Hyer, "Stress Analysis of Fiber-Reinforced Composite Materials", McGraw Hill, 1999.
3. Mukhopadhyay.M, "Mechanics of Composite Materials and Structures", University Press, India, 2004.
4. Autar K.Kaw "Mechanics of Composite Materials" CRC Press, Florida, 2006.
5. Valery V.Vasiliev & Evgeny V.Morozov "Advanced Mechanics of Composite Materials" Elsevier Publication, UK, 2007.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x			x						
2		x			x		x			x
3				x		x		x		
4		x				x			x	
5	x			x				x		

15STX07 NON-LINEAR ANALYSIS OF STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop the knowledge of elastic inelastic nonlinear, vibration and instability of beams and hysteric analysis of members subjected to cyclic loading.

COURSE OUTCOMES:

CO 1: Understand the elastic analysis with various boundary conditions of structural members.
CO 2: Understand the inelastic analysis with various boundary conditions of structural members.
CO 3: Analyze of structural models under cyclic loading.
CO 4: Analyze of uniform and variable thickness plates.
CO 5: Instability analysis of elastic flexural members.

UNIT I ELASTIC ANALYSIS OF FLEXURAL MEMBERS (9)

Introduction to nonlinear mechanics; statically determinate and statically indeterminate flexible bars of uniform and variable thickness.

UNIT II INELASTIC ANALYSIS OF FLEXURAL MEMBERS (9)

Inelastic analysis of uniform and variable thickness members subjected to small Deformations; inelastic analysis of flexible bars of uniform and variable stiffness members with and without axial restraints.

UNIT III VIBRATION THEORY AND ANALYSIS OF FLEXURAL MEMBERS (9)

Vibration theory and analysis of flexible members; hysteretic models and analysis of uniform and variable stiffness members under cyclic loading.

UNIT IV ELASTIC AND INELASTIC ANALYSIS OF PLATES (9)

Introduction – differentiate elastic & inelastic analysis - Elastic and inelastic analysis of uniform and variable thickness plates.

UNIT V NONLINEAR VIBRATION AND INSTABILITY (9)

Introduction - Nonlinear vibration and Instabilities of elastically supported beams.

TOTAL = 45 PERIODS

REFERENCES:

1. Sathyamoorthy, M.,"Nonlinear Analysis of Structures", CRC Press, Boca Raton, Florida, 1997.
2. Fertis, D. G.,"Nonlinear Mechanics", CRC Press, Boca Raton, Florida, 1998.
3. Reddy.J.N, "Non linear Finite Element Analysis", Oxford University Press, 2004.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*POs*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1					x				x	
2		x		x				x		
3	x		x			x				
4		x		x			x		x	
5					x			x		x

15STX08 STABILITY OF STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course Objective is to develop the skill of the students to analyze columns for various boundary condition using equilibrium and effect of shear on buckling. This also develops the knowledge of torsional and lateral buckling of simply supported and cantilever beams. This course will serve as a prerequisite for research.

COURSE OUTCOMES:

CO 1: Know about the concept of equilibrium, Eigen value problems & numerical approach.
CO 2: Examine the behavior of beam columns and frames with and without side sway using classical and stiffness methods.
CO 3: Be well versed in the lateral buckling, torsional buckling, flexural torsional buckling of various beams and non-circular sections.
CO 4: Evaluate buckling of thin plates using energy methods and various numerical techniques
CO 5: Execute and work out the inelastic buckling using various methodologies.

UNIT I BUCKLING OF COLUMNS (9)

States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkins approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.

UNIT II BUCKLING OF BEAM-COLUMNS AND FRAMES (9)

Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples Analysis of rigid jointed frames with and without sway - Moment distribution - Slope deflection and stiffness method.

UNIT III TORSIONAL AND LATERAL BUCKLING (9)

Torsional buckling - Torsional and flexural buckling - Local buckling. Buckling of Open Sections - Numerical solutions - Lateral buckling of beams, pure bending of simply supported beam and cantilever.

UNIT IV BUCKLING OF PLATES (9)

Governing differential equation - Buckling of thin plates, various edge conditions - Analysis by equilibrium and energy approach - Approximate and Numerical techniques.

UNIT V INELASTIC BUCKLING (9)

Double modulus theory - Tangent modulus theory - Shanley's model – Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behaviour of plates.

TOTAL = 45 PERIODS

REFERENCES:

1. Timoshenko, S., and Gere., "Theory of Elastic Stability", McGraw Hill Book Company, 1963.
2.
3. Ashwini Kumar, "Stability of Structures", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1995.
4. Iyenger.N.G.R.,, "Structural stability of columns and plates", Affiliated East West Press, 1986.
5. Gambhir, "Stability Analysis and Design of Structures", springer, New York, 2004.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	*POs*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	x				x				x	
2		x					x			
3	x		x							x
4				x				x		
5		x			x		x			

15STX09 THEORY OF PLATES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to gain the knowledge of laterally loaded thin plates and anisotropic plates and moderately thick plates which is helpful for understanding the behaviour of plates.

COURSE OUTCOMES:

CO 1: Know about various plate theories
CO 2: Gain the knowledge of Navier's solution, Levy's solution and solve for the rectangular plates.
CO 3: Analyze circular plates for any boundary conditions.
CO 4: Knowledge on finite difference method for solving plate problems.
CO 5: Know about the orthotropic plates & grids

UNIT I INTRODUCTION TO PLATES THEORY (10)

Introduction - Thin Plates with small deflection - Laterally loaded thin plates - governing differential equation - various boundary conditions.

UNIT II RECTANGULAR PLATES (12)

Rectangular plates - Simply supported rectangular plates - Navier solution and Levy's method - Rectangular plates with various edge Conditions - plates on elastic foundation.

UNIT III CIRCULAR PLATES (8)

Bending of circular plates with clamped and simply supported edges - plate with central hole - Differential equation for Symmetrical bending of circular plates – Uniformly loaded circular plates – Plates with concentrated load

UNIT IV SPECIAL AND APPROXIMATE METHODS (8)

Solution of plate problems - Influence functions - Energy methods - Finite difference and Finite element methods – Complex variable method

UNIT V ANISOTROPIC PLATES AND THICK PLATES (7)

Introduction - Anisotropic Plates **-** Differential equation of Bent Plate - Orthotropic plates and grids - moderately thick plates.

TOTAL = 45 PERIODS

REFERENCES:

1. Timoshenko, S. and Krieger S.W. "Theory of Plates and Shells", McGraw Hill Book Company, New York, 1990.
2. Bairagi, "Plate Analysis", Khanna Publishers, 1996.
3. Reddy J N, "Theory and Analysis of Elastic Plates and Shells", McGraw Hill Book Company, 2006.
4. Szilard, R., "Theory and Analysis of Plates", Prentice Hall Inc., 1995.
5. Chandrashekahara, K. Theory of Plates, University Press (India) Ltd., Hyderabad, 2007

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1			x					x		x
2		x		x			x			
3	x		x		x				x	
4							x			x
5		x		x				x		

15STX10 INDUSTRIAL STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to form the layout requirement regarding lighting and ventilation and fire safety design of foundation, testing of towers and chimneys.

COURSE OUTCOMES:

CO 1: Know the planning and functional requirements of various industries.
CO 2: Get an idea about the materials used and design of industry structural elements.
CO 3: Realize the basic concepts and design of power plant structures.
CO 4: Design on power transmission structures.
CO 5: Possess the ability to understand the design concepts of chimneys, bunkers and silos.

UNIT I PLANNING AND FUNCTIONAL REQUIREMENTS (9)

Classification of Industries and Industrial structures - planning for Layout Requirements regarding Lighting, Ventilation and Fire Safety – Protection against noise and vibration - Guidelines of Factories Act.

UNIT II INDUSTRIAL BUILDINGS (9)

Roofs for Industrial Buildings - Steel and RCC - Gantry Girders - Design of Corbels and Nibs - Machine foundations.

UNIT III POWER PLANT STRUCTURES (9)

Introduction - Types of power plants – Design of Turbo generator foundation – containment structures.

UNIT IV POWER TRANSMISSION STRUCTURES (9)

Introduction – Transmission Line Towers - Substation Structures - Tower Foundations – Testing Towers.

UNIT V AUXILLIARY STRUCTURES (9)

Chimneys and cooling Towers – Bunkers and Silos – Pipe supporting structures.

TOTAL = 45 PERIODS

REFERENCES:

1. Manohar S.N, “Tall Chimneys - Design and Construction”, Tata McGraw Hill, 1985.
2. Santhakumar A.R.an d Murthy S.S., “Transmission Line Structures”, Tata McGraw Hill, 1992.
3. Srinivasulu P and Vaidyanathan.C, “Handbook of Machine Foundations”, Tata McGraw Hill, 1976.
4. Jurgen Axel Adam, KatharriaHausmann, Frank Juttner, Klauss Daniel, “Industrial Buildings: A Design Manual”, Birkhauser Publishers, 2004.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x				x			x		x
2		x		x			x			
3			x			x			x	
4	x				x				x	
5				x			x			

15STX11 PRESTRESSED CONCRETE

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop the skill of the student in gaining knowledge of prestressing principles, design of beams and tension and compression members and design of composite members.

COURSE OUTCOMES:

CO 1: Knowledge on the principle, types and systems of prestressing and analyze the deflections.
CO 2: Determine the flexural strength and design the flexural members, end blocks.
CO 3: Analyze the statically indeterminate structures and design the continuous beam.
CO 4: Design the tension and compression members and apply it for design of piles.
CO 5: Analyze the stress, deflections, flexural and shear strength and apply it for the design of Bridges.

UNIT I PRINCIPLES OF PRESTRESSING (9)

Principles of Prestressing - types and systems of prestressing, need for High Strength materials, Analysis methods losses, deflection (short-long term) - camber- cable layouts.

UNIT II DESIGN OF FLEXURAL MEMBERS (9)

Behaviour of flexural members, determination of ultimate flexural strength – Codal provisions -Design of flexural members, Design for shear, bond and torsion. Design of end blocks.

UNIT III DESIGN OF CONTINUOUS BEAMS (9)

Analysis and design of continuous beams - Methods of achieving continuity – concept of linear transformations, concordant cable profile and gap cables..

UNIT IV DESIGN OF TENSION AND COMPRESSION MEMBERS (9)

Design of tension members - application in the design of Prestressed pipes and Prestressed concrete cylindrical water tanks - Design of compression members with and without flexure - its application in the design piles, flag masts and similar structures.

UNIT V DESIGN OF COMPOSITE MEMBERS (9)

Composite beams - analysis and design, ultimate strength - their applications. Partial prestressing - its advantages and applications.

TOTAL = 45 PERIODS

REFERENCES:

1. Krishna Raju, “Prestressed Concrete”, Tata McGraw Hill Publishing Co, 2008.
2. Sinha.N.C.and.Roy.S.K, “Fundamentals of Prestressed Concrete”, S.Chand and Co., 1998.
3. Lin.T.Y, “Design of Prestressed Concrete Structures”, John Wiley and Sons Inc,1981.
4. Rajagopalan.N, “Prestressed Concrete” Narosa Publications, New Delhi, 2008.
5. Praveen Natarajan “Prestressed concrete Design” Pearson Education,1st Edition, New Delhi, 2013.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1		x			x	x				
2			x					x	x	
3		x		x						x
4			x				x		x	
5	x				x			x		

15STX12 PREFABRICATED STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop the knowledge of designing prefabricated structures.

COURSE OUTCOMES:

CO 1: Understand the basic concepts of prefabrication and their needs in construction industry.
CO 2: Know the behaviour of prefabricated structures.
CO 3: Design the cross section and joints of prefabricated units.
CO 4: Exhibit their knowledge in designing and detailing of prefabrication units.
CO 5: Design the industrial structures, folded plate loads using the hand book provisions.

UNIT I DESIGN PRINCIPLES (9)

General Civil Engineering requirements - specific requirements for planning and layout of prefabricates plant. IS Code specifications - Modular co-ordination – standardization - Disuniting of Prefabricates, production, transportation, erection - stages of loading and codal provisions, safety factors - material properties, Deflection control - Lateral load resistance - Location and types of shear walls.

UNIT II REINFORCED CONCRETE (9)

Prefabricated structures - Long wall and cross-wall large panel buildings, one way and two way prefabricated slabs, Framed buildings with partial and curtain walls - Connections – Beam to column and column to column.

UNIT III FLOORS , STAIRS AND ROOFS (9)

Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab design, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long term loads, Ultimate strength calculations in shear and flexure.

UNIT IV WALLS (9)

Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, approximate design of shear walls.

UNIT V INDUSTRIAL BUILDINGS AND SHELL ROOFS (9)

Components of single-storey industrial sheds with crane gantry systems, R.C. Roof Trusses, Roof Panels, corbels and columns, wind bracing design. Cylindrical, Folded plate and hypar - prefabricated shells, Erection and jointing - joint design - hand book based design.

TOTAL = 45 PERIODS

REFERENCES:

1. B.Lewicki, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam/ London/New York, 1966.
2. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precase Concrete, Netherland BetorVerlag, 1978.
3. Gerostiza. C.Z., Hendrikson, C. and Rehat D.R., Knowledge Based Process Planning for Construction and Manufacturing, Academic Press, Inc., 1989.
4. Warszawski, A., Industrialization and Robotics in Building - A managerial approach, Harper and Row, 1990.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1					x	x				
2			x	x						
3	x				x	x				
4							x	x		
5			x			x				

15STX13 ADVANCED STRUCTURAL ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES:

- The course objective is to make familiar to students in the field of inelastic energy concepts which helps them to learn about analysis of structures.

COURSE OUTCOMES:

CO 1: Understand the basic concept of flexibility and stiffness, principle of superposition and methods of structural analysis.
CO 2: Transform the flexibility and stiffness matrices from system coordinates to element coordinates.
CO 3: Identify the degree of freedom and to formulate flexibility matrix of components of structures.
CO 4: Formulate the stiffness matrix
CO 5: Analyse the frame through the iteration methods.

UNIT I FUNDAMENTAL CONCEPTS OF STRUCTURES (9)

Introduction - Types of Matrices – Matrix addition, Matrix multiplication, Inverse of a matrix of fourth order – Force and Displacement measurements - Force and Displacement Methods of Structural Analysis - Principles of superposition. Characteristics of Structures – Stiffness and Flexibility: Introduction to Equilibrium – Structures with single coordinate – Two coordinates – Stiffness and flexibility matrices in n Coordinates – Stiffness and flexibility matrices in constrained measurements.

UNIT II ENERGY CONCEPTS IN STRUCTURES (9)

Strain energy in terms of stiffness and flexibility matrices – Properties of stiffness and flexibility matrices – Interpretation of coefficients - Betti's Law – Other energy theorems - using matrix notations. Transformation of Information: Indeterminate Structures – Transformation of System force to element forces – Element Flexibility to System Flexibility – System Displacement to Element Displacement - Stiffness and Flexibility Matrices of the elements-Normal coordinates and orthogonal Transformation.

UNIT III FLEXIBILITY METHOD (9)

Statically Determinate and Indeterminate Structures – Choice of redundant leading to ill and well-Conditioned matrices – Automatic choice of redundant – Rank technique – Transformation to one set of Redundant to another – Internal forces due to thermal expansion and lack of fit – Reducing the size of Flexibility matrix – Application to pin-jointed plane truss – Continuous beams – Frames – Grids.

UNIT IV STIFFNESS METHOD (9)

Introduction – Development of the stiffness method – Analogy between flexibility and stiffness – Analysis due to thermal expansion - lack of fit – Application of stiffness approach to pin jointed plane and space Trusses – Continuous beams – Frames.

UNIT V ANALYSIS BY SUBSTRUCTURES (9)

Analysis by substructures using the stiffness and flexibility method with tridiagonalisation. Analysis by Iteration: Iteration method for frames with non-prismatic members – Iteration method applied to rigidly connected members – Efficiency of iteration method.

TOTAL = 45 PERIODS

REFERENCES:

1. F. M. Rubinstein, Matrix Computer Methods of Structural Analysis, Prentice Hall, 1966.
2. McGuire and R. H. Gallagher, Matrix Structural Analysis, John Wiley, 1999.
3. J. R. William Weaver and James M. Gere, Matrix Analysis of Framed Structures, CBS Publishers & Distributors, 2004.

Mapping of Course Outcomes(COs) and Programme outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1		x			x		x			
2	x			x					x	
3			x			x				x
4		x			x			x		
5			x			x				x

15STX14 MAINTENANCE AND REHABILITATION OF STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop the ability of students to assess the strength, durability of structures materials for repair and strengthening and stabilization techniques for repair. This also serves as a perquisite for research.

COURSE OUTCOMES:

CO 1: Recognize the mechanisms of degradation of concrete structures and to design durable concrete structures
CO 2: Plan towards the strength and durability of existing concrete structures.
CO 3: Realize the basic concepts and materials& techniques available for repair works.
CO 4: Knowledge on strengthening and stabilization on existing concrete structures.
CO 5: Posses the ability to find out suitable techniques for repair and demolition process.

UNIT I MAINTENANCE AND REPAIR STRATEGIES (8)

Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration.

UNIT II SERVICEABILITY AND DURABILITY OF CONCRETE (8)

Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking. - Effects due to climate, temperature, chemicals, corrosion - design and construction errors - Effects of cover thickness and cracking.

UNIT III MATERIALS AND TECHNIQUES FOR REPAIR (12)

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement and polymers coating for rebars loadings from concrete, mortar and dry pack, vacuum concrete, Gunite and Concrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels and cathodic protection

UNIT IV REPAIRS TO STRUCTURES (10)

Repair of structures distressed due to earthquake – Strengthening using FRP - Strengthening and stabilization techniques for repair.

UNIT V DEMOLITION OF STRUCTURES (7)

Introduction - types of demolition techniques - Engineered demolition techniques for structures - Case Studies

TOTAL =45 PERIODS

REFERENCES:

1. Denison Campbell, Allen and Harold Roper, “Concrete Structures, Materials, Maintenance and Repair”, Longman Scientific and Technical, UK, 1991.
2. Santhakumar A.R., “Concrete Technology” Oxford University Press, Printed in India by Radha Press, New Delhi, 2007.
3. Peter H.Emmons, “Concrete Repair and Maintenance Illustrated”, Galgotia Publications pvt. Ltd., 2001.
4. Dayaratnam.P and Rao.R, “Maintenance and Durability of Concrete Structures”, University Press, India, 1997.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1		x			x				x	
2			x	x	x		x			
3		x		x		x		x		
4		x		x	x		x		x	
5	x		x				x			x

15STX15 OFFSHORE STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop the knowledge of wave theories, wave generation, process and current forces. This also gives exposure to analysis of offshore structures and its dynamics.

COURSE OUTCOMES:

CO 1: Knowledge of finite amplitude wave theory for wave generation process.
CO 2: Know about types of forces on offshore structures.
CO 3: Analyse the content of offshore soil foundation modeling.
CO 4: Design the capacity of dynamic analysis for offshore structures.
CO 5: Learnt about design of helipads, cables and pipe lines.

UNIT I WAVE THEORIES (8)

Introduction - Wave generation process - small and finite amplitude wave theories – wave propagation theories.

UNIT II FORCES OF OFFSHORE STRUCTURES (8)

Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

UNIT III OFFSHORE SOIL AND STRUCTURE MODELLING (9)

Introduction – Offshore soil - Different types of offshore structures - foundation modeling, - structural modeling.

UNIT IV ANALYSIS OF OFFSHORE STRUCTURES (10)

Introduction – Procedure & concept of Static method of analysis, foundation analysis and dynamics of offshore structures.

UNIT V DESIGN OF OFFSHORE STRUCTURES (10)

Introduction – offshore structure - design of platforms – helipads - Jacket tower and mooring cables and pipe lines.

TOTAL =45 PERIODS

REFERENCES:

1. Chakrabarti, S.K. “Hydrodynamics of Offshore Structures”, Computational Mechanics Publications, 1987.
2. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.
3. Reddy, D.V. and Arockiasamy, M., “Offshore Structures”, Vol.1 and Vol.2, Krieger Publishing Company, Florida, 1991.
4. Mohamed Abdallah El-Reedy “Off shore structures” Gulf Professional Publication, 2012.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x				x					x
2		x		x				x	x	
3			x				x			
4	x			x		x			x	
5		x			x			x		

15STX16 WIND AND CYCLONE EFFECTS ON STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course objective is to develop to knowledge of effect of wind on structure and codal provision for design of tall structures. This also gives knowledge of cyclone effects on structures for helping in window glass design.

COURSE OUTCOMES:

CO 1: Knowledge on Wind velocity, calculation of speed & aspect ratio.
CO 2: Gain the knowledge of Wind Tunnel and its types & Aero-elastic models.
CO 3: Analyse the Wind on structures under static and dynamic effects.
CO 4: Design& construction the buildings, chimneys, shelters with reference to IS code.
CO 5: Design on cyclone effect on structures & cladding

UNIT I INTRODUCTION (10)

Introduction, Spectral studies, Gust factor, Wind velocity, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects.

UNIT II WIND TUNNEL STUDIES (5)

Introduction - Wind Tunnel Studies, Types of tunnels, Modeling requirements, Interpretation of results, Aero-elastic models.

UNIT III EFFECT OF WIND ON STRUCTURES (12)

Introduction - Wind on structures, Rigid structures, Flexible structures, Static and dynamic effects, Tall buildings, chimneys.

UNIT IV IS CODES AND SPECIAL STRUCTURES (12)

Application to design, IS 875 code method, Buildings, Chimneys, Roofs, Shelters & Plates

UNIT V CYCLONE EFFECTS (6)

Introduction - Cyclone effect on structures - Cladding Procedure and design - Window glass design and procedure

TOTAL =45 PERIODS

REFERENCES:

1. Cook.N.J., “The Designer's Guide to Wind Loading of Building Structures”, Butterworths, 1989.
2. Kolousek.V, Pirner.M, Fischer.O and Naprstek.J, “Wind Effects on Civil Engineering Structures”, Elsevier Publications, 1984.
3. Peter Sachs, “Wind Forces in Engineering”, Pergamon Press, New York, 1972.
4. Lawson T.V., “Wind Effects on Building Vol. I and II”, Applied Science Publishers London, 1980.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x					x		x		
2		x		x			x		x	
3			x		x	x				x
4				x	x				x	
5		x	x				x			

15STX17 SMART STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To describe the basic principles and mechanisms of smart materials and devices.
- To describe the basic principles and mechanisms of measuring techniques.
- To demonstrate knowledge and understanding of the engineering principles in smart sensors, actuators and transducer technology.

COURSE OUTCOMES:

CO 1: Handle various smart materials and devices.
CO 2: Carryout analytical approach on vibration absorbers.
CO 3: Workout various strain measurement using smart materials
CO 4: Deliver control strategies of smart structures.
CO 5: Apply principles of smart structures to civil engineering field.

UNIT I PROPERTIES OF MATERIALS AND ER AND MR FLUIDS **(9)**

Piezoelectric Materials and properties - Actuation of structural components - Shape Memory Alloys - Constitutive modeling of the shape memory effect, vibration control - Embedded actuators – Electro rheological and magnetorheological fluids - Mechanisms and Properties - Fiber Optics - Fibre characteristics - Fiber optic strain sensors

UNIT II VIBRATION ABSORBERS **(9)**

Parallel damped vibration absorber - Gyroscopic vibration absorber - Active vibration, absorber - Applications - Vibration Characteristics of mistuned systems - Analytical approach

UNIT III MEASURING TECHNIQUES **(9)**

Strain measuring techniques using electrical strain gauges - Types – Resistance – Capacitance – Inductance – Wheatstone bridges – Pressure transducers – Load cells – Temperature Compensation – Strain Rosettes.

UNIT IV CONTROL OF STRUCTURES **(9)**

Control modeling of structures - Control strategies and limitations - Classification of control systems - Classical control, Modern control, Optimal control and Digital control - Active structures in practice.

UNIT V APPLICATIONS IN CIVIL ENGINEERING **(9)**

Application of shape memory - Alloys in bridges – Concept of smart bridges – Application of ER fluids - Application of MR dampers in different structures – Application of MR dampers in bridges and high rise structures – Structural health monitoring - Application of optical fibres - Concept of smart concrete.

TOTAL =45 PERIODS

REFERENCES:

1. Srinivasan, A.V., and Michael McFarland. D., “Smart Structures – Analysis &Design”, Cambridge University Press, 2001.
2. Brian Culshaw, “Smart Structures and Materials”, Artech House, Boston, 1996.
3. Gandhi, M.V and Thompson, B.S., “Smart Materials and Structures”, Chapman and Hall, 1992.
4. Yoseph Bar Cohen, “Smart Structures and Materials”, the International Society for Optical Engineering, 2003.

Mapping of Course Outcomes(COs) and Programme Outcomes(Pos)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x				x			x		
2		x				x				
3			x		x			x		
4		x				x				
5				x			x			

15STZ01 FINITE ELEMENT ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES:

- The course objective is to develop the skills of the students in boundary value problems, Approximation concept, Plate bending and shell elements, meshing and its types and nonlinear variation problems.

COURSE OUTCOMES:

CO 1: Develop finite element formulations of one degree of freedom problems and solve them.
CO 2: Perform modal analysis to determine its natural frequencies, and analyze harmonically-forced vibrations.
CO 3: Use finite element analysis programs based upon either "p-method" or "h-method" finite element mathematical formulations
CO 4: Analysis the plane stress, plain strain and axis symmetric problems related to Triangular and Quadrilateral elements.
CO 5: Analysis on application of beams, columns using finite element analysis.

UNIT I INTRODUCTION (9)

Boundary Value Problems – Approximate Solutions – Variational and Weighed Residual Methods – Ritz and Galerkin Formulations – Concept of Piecewise Approximation and Finite Element – Displacement and Shape Functions –Weak Formulation – Minimum Potential Energy – Generation of Stiffness Matrix and Load Vector.

UNIT II STRESS ANALYSIS (9)

Two Dimensional problems – Plane Stress, Plane Strain and Axisymmetric Problems - Triangular and Quadrilateral Elements Natural Coordinates – Isoparametric Formulation - Numerical Integration -Plate Bending and Shell Elements –– Brick Elements –Elements for Fracture Analysis

UNIT III MESHING AND SOLUTION PROBLEMS (9)

Higher Order Elements - p and h Methods of Mesh Refinement - ill conditioned Elements -Discretization Errors – Auto and Adaptive Mesh Generation Techniques - Error Evaluation

UNIT IV NONLINEAR, VIBRATION AND THERMAL PROBLEMS (9)

Material and Geometric Nonlinearity – Methods of Treatment – Consistent System Matrices – Dynamic Condensation – Eigen Value Extraction - thermal analysis.

UNIT V APPLICATIONS (9)

Application of displacement finite elements to the analysis of simple problems like beams, pin jointed plane frames and plate problems**.**

TOTAL =45 PERIODS

REFERENCES:

1. S. S. Bhavikatti, "Finite Element Analysis", New Age Publishers, 2010.
2. C. S. Krishnamoorthy, "Finite Element Analysis: Theory and Programming", Tata McGraw-Hill, 1994.
3. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
4. Bathe, K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall Inc., 2009.
5. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India Pvt.Ltd., New Delhi, 2011.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1		x			x			x		
2			x			x	x			
3				x	x	x				
4		x			x		x			
5		x			x		x			

15STZ02 SOLID AND HAZARDOUS WASTE MANAGMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on the elements of managing solid wastes from Municipal and industrial sources including the related engineering principles, design criteria, methods and equipments.

COURSE OUTCOMES:

CO 1: To know the various types and sources of solid waste.
CO 2: Gain knowledge of characterization of waste.
CO 3: Know the ideas to collect, storage and transfer the solid wastes.
CO 4: Gain the knowledge of waste processing technologies.
CO 5: obtain the knowledge and choose the types of waste disposal and landfill remediation

UNIT I INTRODUCTION (9)

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste Management - Waste management planning - Elements of integrated waste management and roles of stakeholders - Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, lead acid batteries, electronic wastes ,plastics and fly ash – Financing waste management.

UNIT II WASTE CHARACTERIZATION AND SOURCE REDUCTION (8)

Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – waste sampling and characterization plan - Source reduction of wastes –Waste exchange – Extended producer responsibility - Recycling and reuse

UNIT III STORAGE, COLLECTION AND TRANSPORT OF WASTES (9)

Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations Optimizing waste allocation – compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport

UNIT IV WASTE PROCESSING TECHNOLOGIES (10)

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes

UNIT V WASTE DISPOSAL (9)

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps – landfill remediation

TOTAL =45 PERIODS

REFERENCES:

1.George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.
2.Michael D. La Grega, Philip L Buckingham, Jeffrey C. E vans and Environmental Resources Management, Hazardous waste Management, Mc-Graw Hill International edition, New York, 2001.
3.CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.
4. Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2002.

Mapping of Course Outcomes(COs) and Programme Outcomes(POs)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1	x					x		x		
2		x		x			x		x	
3			x		x	x				x
4				x	x				x	
5		x	x				x			

15STZ03 ENERGY EFFICIENT STRUCTURES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To create awareness of the necessity of energy needed for structures.
- To study the different climate types and their influence in building design.

COURSE OUTCOMES:

CO 1: Get introduced to various energy consumptions
CO 2: Master the climate and environmental factors affecting building design.
CO 3: Gain knowledge of design of buildings according to thermal environment.
CO 4: Acquire the skills of utilization of appliances and the principles behind them.
CO 5: Obtain the knowledge of energy audit in buildings

UNIT I INTRODUCTION **(9)**

Need of Energy in buildings – assessment - Energy consumption pattern of various types of buildings - Factors influencing the energy use in building - Concepts of energy efficient building.

UNIT II CLIMATE **(9)**

Study of Climate types - their influence in building design - Environmental factors affecting building design - Analysis of thermal and visual environment.

UNIT III HEAT AND LIGHT **(9)**

Heat gain and loss phenomenon in buildings - Thermal performance parameters - Role of building enclosures, openings and materials in thermal environment - Basic principles of light and daylight - Energy efficient light design of buildings - Daylight design of buildings.

UNIT IV APPLIANCES IN BUILDINGS **(9)**

Major appliances in building and their energy consumptions - Principles of solar heating, cooling and power (PV) systems - Integration of energy efficient appliances with the buildings.

UNIT V ENERGY AUDIT **(9)**

Energy survey and energy audit of buildings - Calculation of energy inputs and utilization in buildings – Energy audit reports of buildings - Concepts of Green Buildings - energy rating of buildings.

TOTAL =45 PERIODS

REFERENCES:

1. Chand, I. and Bhargava,P.K., “The Climatic Data Handbook”, Tata McGraw Hill Publishing Company Limited, New Delhi 1999.
2. Threlkeld, J.L,”Thermal Environmental Engineering”, Prentice-Hall, Englewood Cliffs, NJ, 1998.
3. LalJayamaha, “Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance”, Tata McGraw Hill, 2007.
4. Krishnan, A., Baker, N., Yannas, S. & Szokolay, S.V., “Climate Responsive Architecture – A Design Hand Book for Energy Efficient Buildings”, Tata McGraw Hill Publishing Company Ltd, Delhi, 2001.

Mapping of Course Outcomes(COs) and Programme Outcomes(Pos)

COs	POs									
	1	2	3	4	5	6	7	8	9	10
1		x			x		x			
2			x					x		
3		x				x				
4			x					x		
5		x				x				