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 [R17]

[CHOICE BASED CREDIT SYSTEM]

(This Curriculum and Syllabi are applicable to Students admitted from the academic year (2017-2018) onwards)

SEPTEMBER 2021

Civil Engineering Department PEOs and POs

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1 To become a successful Civil Engineer and to meet the demand driven needs so as to prepare them industry ready in the field of Civil Engineering and related profession.

PEO2 To exhibit good depth of knowledge in core areas of Civil and allied Engineering.

PEO3 To communicate profound knowledge in fundamentals, techniques and design of Civil Engineering system that encourages them to develop innovative techniques in their professional practice.

PEO4 To develop an understanding of the multidisciplinary approach and an ability to relate Engineering issues to broader social and human context, in which their Engineering contributions will be utilized.

PEO5 To Engage in life-long continuous learning through independent study and participation in professional conferences, seminars and workshops.

PROGRAMME OUTCOMES (POs)

a-l	GRADUATE ATTRIBUTEs	PO No.	PROGRAMME OUTCOMEs
a	Engineering Knowledge	**PO1**	To demonstrate knowledge of mathematics, science and basic engineering principles
b	Problem Analysis	**PO2**	To analyze and design various components of structures and conduct experiments to interpret data.
c	Design and Development of Solutions	**PO3**	To design advanced structural engineering elements and structures.
d	Investigation of Complex Problems	**PO4**	To critically identify, formulate and solve structural engineering problems
e	Modern Tool Usage	**PO5**	To use modern engineering tools, software and equipment to analyze problems.
f	The Engineer and Society	**PO6**	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.
g	Environment and Sustainability	**PO7**	To execute and manage the multidisciplinary projects with global standards.
h	Ethics	**PO8**	To demonstrate knowledge of professional and ethical responsibilities.
i	Individual and Team Work.	**PO9**	To demonstrate knowledge of advanced mathematics to analyze and solve complex structural engineering design problems
j	Communication	**PO10**	An ability to converse efficiently.
k	Project Management and Finance	**PO11**	An ability to apply, design and execute appliance tilting projects.
l	Lifelong Learning	**PO12**	To develop confidence for self-education and ability for life-long learning and research activities

PROGRAMME SPECIFIC OUTCOMES:

PSO1: Applying an analytical approach for the practical problems in the field of Structural Engineering.

PSO2: Engage in lifelong learning, commitment to quality and continuous improvement.

PSO3: Ability to work in multidisciplinary groups.

PSO4: To create the mathematical equations regarding the Structural Elements to resolve the practical difficulties / demands.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme objective and the outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
1	3	3	3	3	1	1	2	2	2	1	3	2
2	3	3	3	3	3	1	2	1	1	1	3	2
3	3	2	3	2	3	2	2	3	1	2	3	1
4	2	1	1	1	2	3	3	3	2	2	2	2
5	3	3	3	2	3	1	2	2	2	2	2	3

MAPPING OF PROGRAM SPECIFIC OUTCOMES WITH PROGRAMME OUTCOMES

A broad relation between the Program Specific Objectives and the outcomes is given in the following table

PROGRAM SPECIFIC OUTCOMES	PROGRAMME OUTCOMES											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
1	3	3	3	2	2	1	1	1	2	1	3	2
2	3	3	2	2	3	1	1	1	1	2	3	1
3	3	3	3	3	3	2	3	2	1	1	1	3
4	2	3	3	3	2	1	1	1	2	2	3	1

***Contribution** **1: Reasonable** **2: Significant** **3: Strong**

NANDHA ENGINEERING COLLEGE (Autonomous), Erode – 52

REGULATIONS 2017 (R17)

M.E. STRUCTURAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABI

SEMESTER - I

SEMESTER: I

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1.	17STA01	Advanced Mathematics	FC	Nil	4	3	1	0	4
2.	17STB01	Advanced Reinforced Concrete Structures	PC	Nil	4	3	1	0	4
3.	17STB02	Dynamics of Structures	PC	Nil	4	3	1	0	4
4.	17STB03	Applied Elasticity and Plasticity	PC	Nil	4	3	1	0	4
5.	17STB04	Advanced Concrete Technology	PC	Nil	3	3	0	0	3
6.	E1	Elective I	PSE	Ref.PSE	3	3	0	0	3
PRACTICALS									
7.	17STC01	Advanced Structural Engineering Laboratory	PC	Nil	4	0	0	4	2
8.	17STE01	Technical Seminar - I	EEC	Nil	2	0	0	2	1
				TOTAL	**28**	**18**	**4**	**6**	**25**

SEMESTER: II

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1.	17STB05	Experimental Stress Analysis and Techniques	PC	Nil	3	3	0	0	3
2.	17STB06	Behaviour and Design of Steel Structures	PC	Nil	4	3	1	0	4
3.	17STB07	Aseismic Design of Structures	PC	Nil	3	3	0	0	3
4.	17STB08	Finite Element Analysis	PC	Nil	4	3	1	0	4
5.	E2	Elective II	PSE	Ref.PSE	3	3	0	0	3
6.	E3	Elective III	PSE/OE	Ref.PSE	3	3	0	0	3
PRACTICALS									
7.	17STC02	Structural Analysis and Design Laboratory	PC	Nil	4	0	0	4	2
8.	17STE02	Technical Seminar - II	EEC	Nil	2	0	0	2	1
				TOTAL	**26**	**18**	**2**	**6**	**23**

SEMESTER III

SL.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1.	E4	Elective IV	PSE	Ref.PSE	3	3	0	0	3
2.	E5	Elective V	PSE	Ref.PSE	3	3	0	0	3
3.	E6	Elective VI	PSE	Ref.PSE	3	3	0	0	3
PRACTICALS									
4.	17STE03	Project Work Phase - I	EEC	Nil	12	0	0	12	6
TOTAL					**21**	**9**	**0**	**12**	**15**

SEMESTER: IV

SL.NO	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
PRACTICAL									
1.	17STE04	Project Work Phase - II	EEC	17STE03	24	0	0	24	12
TOTAL					**24**	**0**	0	**24**	**12**

FOUNDATION COURSE (FC)

Course Code	Course Title	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C	P.S
17STA01	Advanced Mathematics	BS	Nil	4	3	1	0	4	1
	LIST OF PROFESSIONAL CORE (PC)								
Course Code	**Course Title**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**	**P.S**
17STB01	Advanced Reinforced Concrete Structures	PC	Nil	4	3	1	0	4	1
17STB02	Dynamics of Structures	PC	Nil	4	3	1	0	4	1
17STB03	Applied Elasticity and Plasticity	PC	Nil	4	3	1	0	4	1
17STB04	Advanced Concrete Technology	PC	Nil	3	3	0	0	3	1
17STC01	Advanced Structural Engineering Laboratory	PC	Nil	4	0	0	4	2	1
17STB05	Experimental Stress Analysis and Techniques	PC	Nil	3	3	0	0	3	2
17STB06	Behaviour and Design of Steel Structures	PC	Nil	4	3	1	0	4	2
17STB07	Aseismic Design of Structures	PC	Nil	3	3	0	0	3	2
17STB08	Finite Element Analysis	PC	Nil	4	3	1	0	4	2
17STC02	Structural Analysis and Design Laboratory	PC	Nil	4	0	0	4	2	2

LIST OF PROGRAM SPECIFIC ELECTIVES (PSE)

Course Code	Course Title	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C	P.S
17STX01	Soil - Structure Interaction	PSE	Nil	3	3	0	0	3	1
17STX02	Design of Structural Optimization	PSE	Nil	3	3	0	0	3	1
17STX03	Prefabricated Structures	PSE	Nil	3	3	0	0	3	1
17STX04	Design of Substructures	PSE	Nil	3	3	0	0	3	1
17STX05	Behaviour and Analysis of Tall Buildings	PSE	Nil	3	3	0	0	3	2
17STX06	Design of Plates, Shell and Spatial Structures	PSE	Nil	3	3	0	0	3	2
17STX07	Design of Steel - Concrete Composite Structures	PSE	Nil	3	3	0	0	3	2
17STX08	Structural Stability	PSE	Nil	3	3	0	0	3	2
17STX09	Design of Industrial Structures	PSE	Nil	3	3	0	0	3	2
17STX10	Maintenance and Rehabilitation of Structures	PSE	Nil	3	3	0	0	3	2

17STX11	Design of Off Shore Structures	PSE	Nil	3	3	0	0	3	2
17STX12	Wind and Cyclone Effects on Structures	PSE	Nil	3	3	0	0	3	2
17STX13	Design of Bridges	PSE	Nil	3	3	0	0	3	3
17STX14	Fracture Mechanics	PSE	Nil	3	3	0	0	3	3
17STX15	Mechanics of Composite Materials	PSE	Nil	3	3	0	0	3	3
17STX16	Non-Linear Analysis of Structures	PSE	Nil	3	3	0	0	3	3
17STX17	Advanced Structural Analysis	PSE	Nil	3	3	0	0	3	3
17STX18	Smart Structures	PSE	Nil	3	3	0	0	3	3
17STX19	Design of Prestressed concrete structures	PSE	Nil	3	3	0	0	3	3
17STX20	Solid and Hazardous Waste Management	PSE	Nil	3	3	0	0	3	3
17STX21	Energy Efficient Structures	PSE	Nil	3	3	0	0	3	3
17STX22	Structural Health Monitoring	PSE	Nil	3	3	0	0	3	3
EMPLOYMENT ENHANCEMENT COURSES (EEC)									
17STE01	Technical Seminar - I	EEC	Nil	2	0	0	2	1	1
17STE02	Technical Seminar - II	EEC	Nil	2	0	0	2	1	2
17STE03	Project Work Phase - I	EEC	Nil	12	0	0	12	6	3
17STE04	Project Work Phase - II	EEC	17STE03	24	0	0	24	12	4

LIST OF OPEN ELECTIVES (OE)

Course Code	Course Title	CATEGORY	PRE-REQUISIT	CONTACT PERIODS	L	T	P	C	P.S
17BAZ01	Research Methodology	OE	-	3	3	0	0	3	II

SL. No.	SUBJECT AREA	CREDITS AS PER SEMESTER				
		I	II	III	IV	TOTAL
1.	FC	4	0	0	0	4
2.	PC	17	16	0	0	33
3.	PSE	3	6	9	0	18
4.	EEC	1	1	6	12	20
TOTAL		25	23	15	12	75

17STA01 ADVANCED MATHEMATICS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To provide basic concepts about Fourier series, applications of PDE and Fourier-transforms.	**1.1**	Students will be able to solve problems related to engineering applications by using Fourier transform techniques.	**a,b,c,f,k**
2.0	The probability distribution of random variable specifies its possible values and their probabilities.	**2.1**	Understand the axiomatic formulation of modern Probability Theory and think of random variables as an intrinsic need for the analysis of random phenomena.	**a,b,c,d,g,i,k**
3.0	T o understand the properties of geometrical problems.	**3.1**	To familiarize the students in the field of differential equations to solve boundary value problems associated with engineering applications	**a,b,c,g,k**
4.0	Describe the standard eigen value problem for an n × n matrix.	**4.1**	Understand the concept of eigen value problems	**a,b,c,d,f,g,k**
5.0	To solve various types of engineering problems using numerical integration.	**5.1**	Demonstrate the specific applications to Poisson and Gaussian processes and representation of low pass and band pass noise models	**a,b,c,e,f,i,j,k**

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, 5th Edition, 2004.

17STB01 ADVANCED REINFORCED CONCRETE STRUCTURES					
			L	T	P	C
			3	1	0	4
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To make familiar to students in Design standards. which helps them,	**1.1**	Design the reinforced concrete beams, slabs and columns with reference to IS code.	**a,b,e,j,k**	
2.0	Learn the design of special RC elements	**2.1**	Understand and analyze the behavior of RCC elements subjected to flexure, shear and axial loading	**a,d,e,i,L**	
3.0	Learn about yield line theory	**3.1**	To familiarize the students to design the flat slabs and plates.	**b,c,i,l**	
4.0	Study about the inelastic behavior in concrete	**4.1**	Enumerate the concept of reinforced concrete using moment redistribution & Baker's method.	**b,d,f,k**	
5.0	Study about the ductility and quality control in concrete	**5.1**	Understand the detailing for ductility and quality control of concrete.	**b,e,f,k**	

UNIT I DESIGN PHILOSOPHY **(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 BEAMS AND COLUMNS **(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 DUCTILE DETAILING **(9+3)**

Concepts of ductility – Measures and Detailing of ductility – Flexural yielding frames and walls - Fire resistance of structural members - Quality of control of concrete. Reinforcement detailing of structural members as per SP: 34 & IS: 5525.

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

REFERENCES:

1. Unnikrishna Pillai and Devdas Menon "Reinforced concrete Design', Tata McGraw Hill Publishers Company Ltd., New Delhi, 2009.
2. Varghese, P.C, "Limit State Design of Reinforced Concrete", Prentice Hall of India, 2007
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.

17STB02 DYNAMICS OF STRUCTURES							
				L	T	P	C
				3	1	0	4
COURSE OBJECTIVES AND OUTCOMES:							
Course Objectives		**Course Outcomes**		**Related Program outcomes**			
1.0	To expose the students the principles and methods of dynamic analysis	**1.1**	Understand the response of structural systems to dynamic loads and displacements.	**a,b,c,d**			
2.0	Learn damped and Undamped techniques	**2.1**	Realize the behaviour and response of linear and non-linear SDOF and MDOF structures with Various dynamic loading.	**a,e,j,k**			
3.0	Study the MDOF by approximate methods	**3.1**	Understand the behaviour and response of MDOF structures with various dynamic loading	**a,e,j,k**			
4.0	Dynamic analysis using virtual work method	**4.1**	Find suitable solution for continuous system.	**a,b,e,k**			
5.0	Analyse the various direct integration methods	**5.1**	Analyze dynamic response by direct integration method.	**a,e,c,k**			

UNIT I PRINCIPLES OF VIBRATION ANALYSIS **(9+3)**

Vibration and its importance to structural engineering problems - Elements of vibratory systems and simple harmonic motion - generalized mass - D'Alembert's principle - 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 DIRECT INTEGRATION METHODS FOR DYNAMIC RESPONSE **(9+3)**

Introduction - Damping in MDOF systems - Nonlinear MDOF systems - Direct integration methods - Wilson 'φ' method - New 'β'method - measurement of damping and vibration techniques -Application of structural dynamics in the design of block and frame foundations.

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

REFERENCES:

1. Roy R.Craig, Jr, Andrew J. Kurdila, "Fundamentals of Structural Dynamics", John Wiley& Sons. 2011.
2. Mario Paz, Structural Dynamics: "Theory and Computation", Kluwer Academic Publication, 2004.
3. Anil K.Chopra, "Dynamics of Structures", Pearson Education, 2007.
4. Leonard Meirovitch, "Elements of Vibration Analysis", McGraw Hill, 1986, IOS Press, 2006.
5. Ray W. Clough & Joseph Penzien, "Dynamics of Structures", Computers & Structures, USA 2003.
6. Jagmohan L. Humar, "Dynamics of Structures", A.A. Balkema Publishers, Rotterdam, 2002.

17STB03 APPLIED ELASTICITY & PLASTICITY					
			L	T	P	C
			3	1	0	4

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To understand the concept of elasticity	1.1	Understand the concept of stresses and strains.	a,b,c,k
2.0	To have knowledge about elasticity solution	2.1	To obtain solutions for elasticity problems in rectangular and polar coordinates	b,d,e,
3.0	To learn the Torsion of non circular	3.1	Analyze torsion of non-circular sections and thin walled sections.	a,b,,d
4.0	To study the energy by energy theorems	4.1	Analyze the beams and columns using energy methods	b,c,d,f
5.0	To learn the yield line criteria	5.1	Analyze using Plastic theories	c,d,f,k

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 PLASTICITY **(9+3)**

Physical Assumptions – Yield Criteria – Failure Theories – Applications of Thick Cylinder – Plastic Stress Strain Relationship. Elasto-Plastic Problems in Bending and Torsion.

TOTAL: L: 45 +T:15= 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. AC Ugural& SK Fenster, 'Advanced Strength and Applied Elasticity', Edward Arnold Publishers Ltd., UK, 2003.
4. Chou P.C. and Pagano, N.J. "Elasticity Tensor, Dyadic and Engineering Approaches", D.VanNostrand Co., Inc., London, 1992.
5. Irving H.Shames and James, M.Pitarresi, "Introduction to Solid Mechanics", Prentice Hall of India Pvt. Ltd., New Delhi 2000.

17STB04 ADVANCED CONCRETE TECHNOLOGY					
			L	T	P	C
			3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To enable the students to design concrete mixes as per ACI and IS methods	**1.1**	Gain knowledge the properties of material like grade of cement & testing of aggregate & chemical Compositions	**a,b,i,e.k**
2.0	To learn IS & ACI mix design methods	**2.1**	Execute mix proportioning of concrete and describe how the strength of concrete can be modified by changing the proportions.	**a,d,i,k**
3.0	To study the Stress strain characteristics as per IS provision	**3.1**	Understand about Stress strain characteristics & Non-destructive tests as per IS Code	**a,b,f,k**
4.0	To study the special concrete	**4.1**	Use suitable concrete for different structures considering the prevailing weathering conditions.	**a,b,c,i,l**
5.0	To learn about the durability and quality control in concrete	**5.1**	Decide the correct concreting methods in the field depending upon the requirement and site Conditions	**b,i,l**

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: L: 45 = 45 PERIODS

REFERENCES:

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

17STC01 ADVANCED STRUCTURAL ENGINEERING LABORATORY							
				L	T	P	C
				0	0	4	2
COURSE OBJECTIVES AND OUTCOMES:							
Course Objectives		**Course Outcomes**		**Related Program outcomes**			
1.0	To study the structural behavior of concrete & steel structures.	**1.1**	On completion of this laboratory course students will be able to cast and test RC beams for strength and deformation behaviour.	**a,c,e,l**			
2.0	To study the single bay two storied steel frames	**2.1**	They will be able to test dynamic testing on steel beams, static cyclic load testing of RC frames and non destruction testing on concrete	**a,c,e,j**			

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: P: 60 = 60 PERIODS

REFERENCES:

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

17STE01 TECHNICAL SEMINAR - I

L	T	P	C
0	0	2	1

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	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.	1.1	At the end of the course the student will be able to read and review the research articles and Publish a technical Paper.	a,b,f,j

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%

17STB05 - EXPERIMENTAL STRESS ANALYSIS AND TECHNIQUES					
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	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	**1.1**	Choose the methodology of measuring errors and strains and calibrate the machineries.	**a,b,e,i**
2.0	To measure the vibration by different techniques	**2.1**	Use various vibration measuring instruments and analyze the structures.	**a,b,i,e.k**
3.0	To learn the damage assessment	**3.1**	Measure distress in the structures using various electronic equipment	**a,b,e,i**
4.0	To study about the NDT methods	**4.1**	Perform advanced NDT methods in accessing the load testing of structures	**a,b,f,k**
5.0	To make the students to describe about the model analysis	**5.1**	To predict the behaviour of proto type structure by conducting model tests and analysis	**a,b,c,i,l**

UNIT I FORCES AND STRAIN MEASUREMENT (9)

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 (9)

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 DISTRESS MEASUREMENTS & CONTROL (9)

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 IV NON DESTRUCTIVE TESTING METHODS (9)

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 & GPR.

UNIT V MODEL ANALYSIS (9)

Model Laws – Laws of similitude – Model materials – Necessity for Model analysis – Advantages – Applications – Types of similitude – Scale effect in models – Indirect model study – Direct model study - Limitations of models – investigations – structural problems –Usage of influence lines in model studies.

TOTAL: L: 45 = 45 PERIODS

REFERENCES:

1. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, 4th Edition, New Delhi, 2006.
2. Ganesan.T.P, "Model Analysis of Structures", University Press, India, 2000.
3. Dalley .J.W and Riley.W.F, "Experimental Stress Analysis", McGraw Hill Book Company, N.Y. 1991.
4. 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.
5. C. S. Rangan, Instrumentation – Devices and Systems, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1983.

17STB06 BEHAVIOUR AND DESIGN OF STEEL STRUCTURES (IS 800:2007, IS 801:1975, IS805:1995, IS811:1987, IS875:1987 PART I, II, III)					
			L	T	P	C
			3	1	0	4
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To study the load on structures with lateral loads and design of connections	**1.1**	Familiarize on behaviour of members and connections	**a,c,d,f**	
2.0	To design the Multistoreyed builds	**2.1**	To know about the Design of industrial structures	**a,b,d,e,f**	
3.0	To learn and design the Light gauge sections	**3.1**	To learn about the design of light gauge steel Sections	**a,b,c,**	
4.0	To make the students to design the special structures	**4.1**	Practice on analysis and design of steel towers & chimneys	**a,b,c,**	
5.0	To study about the plastic analysis	**5.1**	To know about the design philosophy for plastic analysis	**a,b,e,f**	

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 INDUSTRIAL BUILDING **(9+3)**

Industrial building frames - wind load analysis-Calculation of wind load and its combination- Framing – Roof Bracing - Crane girders and columns - Analysis of Trussed bents – Design example - Design of rigid joints knee for gable frames. Structure of Multistoreyed Buildings - Bracing systems of Multistorey frames.

UNIT III LIGHT GAUGE SECTIONS **(9+3)**

Concepts -Design of cold formed sections - effective width - stiffened sections - multiple stiffened sections - design of light gauge beams and columns – Torsional – Flexural buckling – composite decks.

UNIT IV DESIGN OF SPECIAL STRUCTURES **(9+3)**

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

UNIT V PLASTIC ANALYSIS AND DESIGN **(9+3)**

Concept of plastic analysis-Theory of plastic bending - Plastic hinge - redistribution of moments - failure mechanisms - plastic analysis and design of fixed beams, continuous beams and portal frames by mechanism method.

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

REFERENCES:

1. N.Subramanian, “Design of Steel Structures”, Oxford University Press, 2008.
2. S. K. Duggal, Limit State Design of Steel Structures, McGraw Hill, 2014.
3. P.Dayaratnam, “Design of Steel Structures”, A.H.Wheeler, India, 2008.
4. Ramchandra (Vol I and II), Design of Steel Structures-1, Scientific Publishers, 2009.
5. Linton E. Grinter, “Design of Modern Steel Structures”, Eurasia Publishing House, New Delhi, 1996.
6. FrdericoM.Mazzolani& Robert Tremblay,”Behaviour of steel structures in seismic areas” A. A. Balkema Publishers, Brookfield, USA, 2000.
7. Bungale. S. Taranath, “Structural Analysis and design of Tall Buildings – Steel and composite construction”, CRC Press Taylor and Francis Group, BacoRatan, US, 2012.

17STB07 ASEISMIC DESIGN OF STRUCTURES						
				L	T	P	C
				3	0	0	3
COURSE OBJECTIVES AND OUTCOMES:						
Course Objectives		**Course Outcomes**		**Related Program outcomes**		
1.0	To gain knowledge of earth quake monitoring and seismic instrumentation, estimation of earth quake parameters.	**1.1**	Describe ground motion and its relationship to seismic design of structures.	**a,b,d,f**		
2.0	To understand the concepts of response spectra	**2.1**	Understand about the evaluation of Earthquake forces as per IS Code.	**a,e,f,h**		
3.0	To design the masonry structures as per codal provision	**3.1**	Design consideration on earthquake resistant features in masonry buildings	**e,f,h**		
4.0	To design the Earthquake Resistant Design. Buildings	**4.1**	Apply the basic principles of conceptual design for earthquake resistant RC building	**a,d,e,f**		
5.0	To study about the characteristics of Liquefaction and base isolation	**5.1**	Adopt vibration control methods for buildings located in earthquake zone.	**a,d,e,f**		

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 MODERN TOPICS (9)

Liquefaction, vibration control - Tuned mass dampers - Principles and application, Basic concept of seismic base Isolation - Various systems - Case studies.

TOTAL: L: 45 = 45 PERIODS

REFERENCES:

1. Pankaj Agarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures”, Prentice Hall of India, 2006.
2. C. A. Brebbia,”Earthquake Resistant Engineering Structures VIII”, WIT Press, 2011
3. S K Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, 2007.
4. Course Notes "Design of Reinforced Concrete Buildings", IIT Kanpur, June 1999.
5. Paulay,T and Priestly, M.N.J., “Aseismic Design of Reinforced Concrete and Masonry buildings”, John Wiley and Sons, 1991.

17STB08 FINITE ELEMENT ANALYSIS						
				L	T	P	C
				3	1	0	4
COURSE OBJECTIVES AND OUTCOMES:						
Course Objectives		**Course Outcomes**		**Related Program outcomes**		
1.0	To develop the skills in finite element method	**1.1**	Develop finite element formulations of one degree of freedom problems and solve them	**a,b,f,i**		
2.0	To acquire knowledge about Plane Stress and strain problems	**2.1**	Perform modal analysis to determine its natural frequencies, and analyze harmonically-forced vibrations.	**a,c,f,j**		
3.0	To gain the knowledge about the Meshing problems	**3.1**	Use finite element analysis programs based upon either "p-method" or "h-method" finite element mathematical formulations	**a,f,k**		
4.0	To learn about various vibration problems	**4.1**	Analysis the plane stress, plain strain and axis symmetric problems related to Triangular and Quadrilateral elements.	**a,b,c,l**		
5.0	To analyse the plate and shell elements	**5.1**	Analysis on application of beams, columns using finite element analysis.	**b,c,d,f**		

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

Approximate solutions of boundary value problems - Methods of weighted residuals, approximate solution using variational method, Modified Galerkin method, Boundary conditions and general comments. Basic finite element concepts - Basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using modified Galerkin method.

UNIT II STRESS ANALYSIS **(9+3)**

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+3)**

Higher Order Elements - P and H Methods of Mesh Refinement - ill conditioned Elements -Discretisation Errors – Auto and Adaptive Mesh Generation Techniques - Error Evaluation

UNIT IV NONLINEAR, VIBRATION AND THERMAL PROBLEMS **(9+3)**

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

UNIT V PLATE AND SHELL ELEMENTS **(9+3)**

Formation of stiffness matrix for plate bending elements of triangular and quadrilateral elements - Concept of four node and eight node isoparametric elements - Cylindrical thin shell elements.

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

REFERENCES:

1. S. S. Bhavikatti, "Finite Element Analysis", New Age Publishers, 2010.
2. Chandrupatla, R.T. and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2007
3. C. S. Krishnamoorthy, "Finite Element Analysis: Theory and Programming", Tata McGraw-Hill, 1994.
4. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
5. Bathe, K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall Inc., 2009.
6. Tirupathi R. Chandrupatla and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering" Prentice Hall of India Pvt. Ltd., New Delhi, 2011.

17STC02 STRUCTURAL ANALYSIS &DESIGN LABORATORY

	L	T	P	C
	0	0	4	2

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	On completion of the design project students will have a better experience in designing various design problems related to civil engineering	**1.1**	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 andColumns using software	**a,d,i,k**

List of Experiments

1. Design of an RC structure
2. Design of industrial building
3. Design of foundation system
4. Design of steel structures
5. Design of water tank
6. Design of chimney
7. Design of bridges
8. Design of steel towers

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: P:60= 60 PERIODS

17STE02 TECHNICAL SEMINAR - II

L	T	P	C
0	0	2	1

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	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	1.1	At the end of the course the student will be able to read and review the research articles and Publish a technical Paper.	a,b,f,j

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%

17STE03 PROJECT WORK PHASE - I						
			L	T	P	C
			0	0	12	6
COURSE OBJECTIVES AND OUTCOMES:						
Course Objectives		**Course Outcomes**		**Related Program outcomes**		
1.0	To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.	**1.1**	At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.	a,b,c,d,f		

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: P:180= 180 PERIODS

17STE04 PROJECT WORK PHASE - II					
			L	T	P	C
			0	0	24	12
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To solve the identified problem based on the formulated methodology	**1.1**	On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions	a,b,c,d,f	

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

17STX01 SOIL - STRUCTURE INTETRACTION					
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To assess its impact on the behaviour of a structure	**1.1**	To Demonstrate soil and foundation behavior	**a,b,c,e**
2.0	To study the analysis of beams in infinite beam	**2.1**	To know about the analysis finite and infinite beam	**a,b,e,k.l**
3.0	To understand the finite plates	**3.1**	Analysis the various types of plates on elastic medium	**a,b,k,l**
4.0	To gain the knowledge of analysis of pile	**4.1**	To Analyze various types of piles	**a, e, f, h**
5.0	To learn Load deflection prediction of elastic analysis	**5.1**	To Analyze laterally loaded piles	**a, e, k, l**

UNIT I SOIL-FOUNDATION INTERACTION **9**

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

Infinite beam, two parameters, Isotropic elastic half-space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness

UNIT III PLATE ON ELASTIC MEDIUM 9

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**

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**

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

TOTAL: L: 45 = 45 PERIODS

REFERENCES:

1. Hemsley, J.A, Elastic Analysis of Raft Foundations, Thomas Telford, 2013.
2. McCarthy, D.F. Essentials of Soil Mechanics and Foundations, basic geotechnics (6thEdition), Prentice Hall, 2006.
3. Scott, R.F., 'Foundation Analysis', Prentice Hall, 1981
4. ACI 336, Suggested Analysis and Design Procedures for Combined Footings and Mats, American Concrete Institute, Dehit, 1988.

17STX02 DESIGN OF STRUCTURAL OPTIMIZATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To study the optimization methodologies applied to structural engineering	1.1	Apply the basic ideas in optimization to make the structures as lightly as possible	a,c,f,j
2.0	To understand the concept of Basic feasible solution	2.1	Use linear programming techniques in Engineering Optimization	a,d,i,k
3.0	To acquire knowledge about the Non linear programming	3.1	Evaluate the Constrained and Unconstrained Techniques	a,b,f,k
4.0	To learn the concept of one degree of difficulty	4.1	Understand the methods in solving the problems related to geometric and dynamic Programming	a,b,f,i,k
5.0	To study the principles & design of R.C structures	5.1	Design of structural elements water tanks using plastic theory	a,b,c,i,l

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 PROGRAMMING (9)

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.

UNIT III NON LINEAR PROGRAMMING (9)

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 IV GEOMETRIC AND DYNAMIC PROGRAMMING (9)

Polynomial - 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. Bellman's principle of optimality - Representation of a multistage decision problem - concept of sub-optimization problems –

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 multistory buildings, water tanks and bridges.

TOTAL: L: 45 = 45 PERIODS

REFERENCES:

1. Belengundu A.D AND Chandrapatla T.R. "Optimisation concepts and Applications in Engineering" Pearson Education, 2011.
2. Deb .K "Optimisation for Engineering Design", Algorithms and examples, Prentice Hall, New Delhi, 2012
3. Iyengar.N.G.R and Gupta.S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997.
4. Peter W.Christensen and Anders kalbring "Introduction to Structural Optimization" Springer publication, Sweden, 2009.
5. Arora J.S "Introduction to Optimum Design" Mc- Graw Hill Book Company, 2011

17STX03 PREFABRICATED STRUCTURES					
			L	T	P	C
			3	0	0	3
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	This course objective is to develop the knowledge of designing prefabricated structures	**1.1**	Understand the basic concepts of prefabrication and their needs in construction industry	**a,b,f,k**	
2.0	To study about the connections	**2.1**	Know the behaviour of prefabricated structures.	**a,j,l**	
3.0	To learn the shear and flexure	**3.1**	Design the cross section and joints of prefabricated units.	**a,b,e,k**	
4.0	To understand the concept of Eccentricity and stability	**4.1**	Exhibit their knowledge in designing and detailing of prefabrication units	**a,b,f,k**	
5.0	To learn the industrial buildings with shell roofs	**5.1**	Design the industrial structures, folded plate loads using the hand book provisions	**a,j,e,k**	

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: L: 45 = 45 PERIODS

REFERENCES:

1. B.Lewicki, Building with Large Prefabricates, Elsevier Publishing Company, New York, 1966.
2. Laszlo Mokk, Prefabricated Concrete for Industrial and Public Structures, Akademiai, Budapest, 2007
3. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precase Concrete, Netherland BetorVerlag, 1978.
4. Warszawski, A., Industrialization and Robotics in Building - A managerial approach, Harper and Row, 1990.

17STX04 DESIGN OF SUB STRUCTURES					
			L	T	P	C
			3	0	0	3
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To gain familiarity with different types of foundation.	**1.1**	Be capable of ensuring investigation & design concepts of shallow foundation	**a,d,i,k**	
2.0	To explore the students to the design of shallow foundations and deep foundations.	**2.1**	Be efficient in selecting suitable type of pile for different soil stratum	**a,b,f,k**	
3.0	To understand the concept of designing well	**3.1**	Enumerate the Design & construction of well foundation	**a,b,c,i**	
4.0	To understand the concept of machine foundations.	**4.1**	Understand the basic principles of design of machine foundation & vibration analysis.	**a,b,f,k**	
5.0	To gain the knowledge about Miscellaneous structures foundations	**5.1**	Deliver the design concepts for transmission line tower foundation	**a,c,f,j**	

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 AND CAISSON FOUNDATIONS **(9)**

Well and caisson foundations – Structural elements of Caisson and Well foundations – Elements of well foundation – Forces acting on Caisson and well foundations – Design of individual components of Caisson and well foundation (only forces acting and design principles) – Sinking of well – Shifts and tilts in Well foundations – Preventive measures.

UNIT IV MACHINE FOUNDATIONS **(9)**

Types of machine foundation - General requirements and design criteria - General analysis of machine foundations - Dynamic properties of soil - soil system - Stiffness and damping parameters - Tests for design parameters - Reinforcement and construction details – Vibration isolation.

UNIT V FOUNDATIONS FOR MISCELLANEOUS STRUCTURES **(9)**

Foundations for towers, Chimneys, Silos – Structural Design of supports for foundation excavations - Case studies – Design of Anchors - Foundation in Expansive Soils - Introduction - Identification of expansive soils Swell potential and swelling pressure - Methods of foundation in expansive soils.

TOTAL: L: 45 = 45 PERIODS

REFERENCES:

1. Das, B.M. Principles of Foundation Engineering, 8th Edition, Cengage Learning, 2015
2. Swami Saran, 'Analysis and Design of Substructures', Oxford & IBH Publishing Company Private Limited, 2009.
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.

17STX05 BEHAVIOUR AND ANALYSIS OF TALL BUILDINGS					
			L	T	P	C
			3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To develop the knowledge about design principles	**1.1**	Knowledge on design principles and different types of loading	**a, e, f, h**
2.0	To enable the student to understand the behaviour of structural systems	**2.1**	Describe the various structural systems used in the construction of tall structures	**a, e, k, l**
3.0	To learn & analyse the buildings as total structural system	**3.1**	Capable of analyse and Design the tall structures	**a,b,f,k**
4.0	To study the deflection, cracking and temperature effects in structures	**4.1**	Design of structural elements for secondary effects	**a,b,c,i,l**
5.0	To design the Stability of tall buildings	**5.1**	Execute stability analysis, overall buckling analysis of frames, and analysis for various effects	**b, k, l**

UNIT I DESIGN PRINCIPLES AND LOADING (9)

Design philosophy, loading, sequential loading, and materials - high performance concrete - Fibre reinforced Concrete – Self compacting concrete - 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, tubulars, cores, outrigger - 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: L: 45 = 45 PERIODS

REFERENCES:

1. Bungale S.Taranath “Structural Analysis and Design of Tall buildings” CRC Press, London, 2011.
2. Sarkisian, M.P., Designing Tall buildings: Structure as Architecture,Routledge, 2011
3. Bryan Stafford Smith and Alexcoull, “Tall Building Structures - Analysis and Design”, John Wiley and Sons, Inc., 1991.
4. Taranath B.S., “Structural Analysis and Design of Tall Buildings”, McGraw Hill, 1988.
5. 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.
6.

17STX06 DESIGN OF PLATES, SHELL AND SPATIAL STRUCTURES					
			L	T	P	C
			3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	This course objective is to develop the skills of students in the areas of design of shell, folded plate, space frames &.	**1.1**	Analyse various shapes of plates using various methods	**a,b,c,e,i**
2.0	To design the folded plates by numerical methods	**2.1**	Understand the behavior folded plates	**a,c,f,k**
3.0	To design and analyse the shell	**3.1**	Know the structural behaviour and philosophy of shells	**a,e,f,i,k**
4.0	To learn the nodes and behaviour	**4.1**	Analysis & design the space frame	**a,c,d,j**
5.0	To design the space frames	**5.1**	Application of Formex	**a,d,j,k**

UNIT I SYMMETRICAL BENDING OF PLATES **(9)**

Equation of equilibrium and deformation of plates – Bending of rectangular plates and circular plates.

UNIT II NUMERICAL METHODS **(9)**

Energy method, finite difference and finite element methods for solution of plate bending problems. Principles of design of folded plates

UNIT III SHELLS **(9)**

Geometry of shells – Classification of Shells – membrane theory of circular and cylindrical shells – Detailed Analysis and design of cylindrical shells – Detailing of Reinforcement in shells, edge beams and transfer beam

UNIT IV INTRODUCTION TO SPACE FRAMES **(9)**

Space frames – configuration – types of nodes – general principles of design Philosophy – Behaviour

UNIT V ANALYSIS OF SPACE FRAMES **(9)**

Analysis of space frames – Formex Algebra, FORMIAN – detailed design of space frames

TOTAL: L: 45 = 45 PERIODS

REFERENCES:

1. Billington.D.P, “Thin Shell Concrete Structures”, McGraw Hill Book Co., New York, 1982.
2. G.S. Ramasamy, Design and Construction of Concrete Shell Roofs, CBS Publishers and Distributors, New Delhi, 2003.
3. Santhakumar.A.R and Senthil.R, “Proceedings of International Conference on Space Structures”, Anna University, Chennai, 1997.
4. Pietraszkiewicz.W and Szymmczak.C “Shell Structures” Taylor Francis Group, UK, 2005.
5. Bangesh.M.Y.H and Bangesh.T “Elements of Spatial Structures” Thomas Telford publishing, US, 2003.
6. Varghese.P.C., Design of Reinforced Concrete Shells and Folded Plates, PHI Learning Pvt. Ltd., 2010

17STX07 DESIGN OF STEEL - CONCRETE COMPOSITE STRUCTURES					
			L	T	P	C
			3	0	0	3
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	This course objective is to develop skills in design of composite beam.	**1.1**	Possess knowledge of the composite behaviour of structures.	**a,e,k,l**	
2.0	To design the composite members	**2.1**	Design various composite structural elements such as beams, columns, floors, slabs	**b,d,e,f,**	
3.0	To study about the composite columns	**3.1**	Analyse the connection behaviour and design	**a,c,e,i,j**	
4.0	To learn composite box girder bridges	**4.1**	Enumerate the behaviour of box girder bridges and the design concepts of the same.	**a,c,d,f,j**	
5.0	To understand the practical case studies about composite construction	**5.1**	Have practical knowledge of construction and design of various structural elements and design concepts through case studies.	**a,b,c,k**	

UNIT I DESIGN OF COMPOSITE CONNECTION **(9)**

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

UNIT II DESIGN OF COMPOSITE MEMBERS **(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 BOX GIRDER BRIDGES **(9)**

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

UNIT V CASE STUDIES **(9)**

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

TOTAL: L: 45 = 45PERIODS

REFERENCES:

1. Johnson R.P., “Composite Structures of Steel and Concrete”, Blackwell Scientific Publications, UK, 2008.
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.

17STX08 STRUCTURAL STABILITY					
			L	T	P	C
			3	0	0	3
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To develop the skill of the students to analyze columns for various boundary condition using equilibrium.	**1.1**	Know about the concept of equilibrium, Eigen value problems & numerical approach.	**a,b,c,i,l**	
2.0	To study the buckling of columns and frames	**2.1**	Examine the behavior of beam columns and frames with and without side sway using classical and stiffness methods	**a,b,f,i,k**	
3.0	To understand the torsional and lateral buckling	**3.1**	Be well versed in the lateral buckling, torsional buckling, flexural torsional buckling of various beams and non-circular sections.	**a,c,f,j**	
4.0	To learn the Buckling of plates	**4.1**	Evaluate buckling of thin plates using energy methods and various numerical techniques	**a,d,i,k**	
5.0	To study about the inelastic buckling	**5.1**	Execute and work out the inelastic buckling using various methodologies	**a,b,f,k**	

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: L: 45 = 45 PERIODS

REFERENCES:

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

17STX09 DESIGN OF INDUSTRIAL STRUCTURES					
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To form the layout requirement regarding lighting and ventilation.	1.1	Know the planning and functional requirements of various industries	a,b,c,d,f,l
2.0	To design the various industrial buildings	2.1	Get an idea about the materials used and design of industry structural elements	b,c,d,e
3.0	To study the power plant structures	3.1	Realize the basic concepts and design of power plant structures.	c,d,e,f,i,j,l
4.0	To understand the concept of transmission towers	4.1	Design on power transmission structures.	a,b,c,d,l
5.0	To design the auxiliary structures	5.1	Possess the ability to understand the design concepts of chimneys, bunkers and silos	c,d,i,l

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: L: 45 = 45 PERIODS

REFERENCES:

1. P.Srinivasulu and C.Vaidyanathan “Handbook of Machine Foundations”, Tata McGraw Hill, 2007.
2. Manohar S.N, “Tall Chimneys - Design and Construction”, Tata McGraw Hill, 1985.
3. Santhakumar A.R.an d Murthy S.S., “Transmission Line Structures”, Tata McGraw Hill, 1992.
4. Jurgen Axel Adam, KatharriaHausmann, Frank Juttner, Klauss Daniel, “Industrial Buildings: A Design Manual”, Birkhauser Publishers, 2004.

17STX10 MAINTENANCE AND REHABILITATION OF STRUCTURES					
			L	T	P	C
			3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To develop the ability of students to assess the strength, durability of structures materials	**1.1**	Recognize the mechanisms of degradation of concrete structures	**a,b,d,g**
2.0	To understand the Quality control in concrete construction	**2.1**	Plan towards the strength and durability of existing concrete structures	**a,c,e,k**
3.0	To learn the materials and techniques for repair	**3.1**	Realize the basic concepts and materials& techniques available for repair works.	**b,d,f,l**
4.0	To gain the knowledge about the demolition of structures	**4.1**	Knowledge on strengthening and stabilization on existing concrete structures	**a,b,i,l**
5.0	To learn the composite construction	**5.1**	Posses the ability to find out suitable techniques for repair and demolition process	**a,b,d,e,l**

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 - Types of demolition techniques - Engineered demolition techniques for structures - Case Studies

UNIT V STRENGTHENING OF STRUCTURES (7)

General principle – relieving loads – Strengthening super structures – plating – Conversation to composite construction – post stressing – Jacketing – bonded overlays – Reinforcement addition – strengthening substructures – under pinning – Enhancing the load capacity of footing – Design for rehabilitation

TOTAL: L: 45 = 45 PERIODS

REFERENCES:

1. Dodge Woodson.R,"Concrete Structures – protection, repair and rehabilitation", ElsevierUK, 2009.
2. Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical, UK, 1991.
3. Santhakumar A.R., "Concrete Technology" Oxford University Press, Printed in India by Radha Press, New Delhi, 2007.
4. Peter H.Emmons, "Concrete Repair and Maintenance Illustrated", Galgotia Publications pvt. Ltd., 2001.

17STX11 DESIGN OF OFFSHORE STRUCTURES					
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To develop the knowledge of wave theories, wave generation	**1.1**	Knowledge of finite amplitude wave theory for wave generation process	**a,c,f,i,k**
2.0	To study about the various forces in offshore structures	**2.1**	Know about types of forces on offshore structures.	**a,c,e,j**
3.0	To learn the offshore structures	**3.1**	Analyse the content of offshore soil foundation modeling	**b,c,d,e**
4.0	To analysis of offshore structures and its dynamics	**4.1**	Design the capacity of dynamic analysis for offshore structures	**c,d,e,i,j,l**
5.0	To understand and design of offshore structures and its dynamics	**5.1**	Learnt about design of helipads, cables and pipe lines.	**a,d,e,f**

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: L: 45 = 45 PERIODS

REFERENCES:

1. Reddy.D.V and Swamidas A.S.J.,Essential of offshore structures.CRC Press.2013
2. Mohamed Abdallah El-Reedy "Off shore structures" Gulf Professional Publication, 2012.
3. Chakrabarti, S.K. "Hydrodynamics of Offshore Structures", Computational Mechanics Publications, 1987.
4. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.
5. Reddy, D.V. and Arockiasamy, M., "Offshore Structures", Vol.1 and Vol.2, Krieger Publishing Company, Florida, 1991.

17STX12 WIND AND CYCLONE EFFECTS ON STRUCTURES						
				L	T	P	C
				3	0	0	3
COURSE OBJECTIVES AND OUTCOMES:						
Course Objectives		**Course Outcomes**		**Related Program outcomes**		
1.0	To develop knowledge about the effect of wind on structure and codal provision for design of tall structures.	**1.1**	Knowledge on Wind velocity, calculation of speed & aspect ratio	**a,c,e,j**		
2.0	To study about the wind tunnels	**2.1**	Gain the knowledge of Wind Tunnel and its types & Aero-elastic models.	**a,d,f,k,l**		
3.0	To learn the wind on different structures	**3.1**	Analyse the Wind on structures under static and dynamic effects	**a,c,f,i,k**		
4.0	To design the special structures as per codal provision	**4.1**	Design& construction the buildings, chimneys, shelters with reference to IS code.	**a,c,d,e,i,l**		
5.0	To learn the cyclone effects	**5.1**	Design on cyclone effect on structures & cladding	**a,c,f,i,k**		

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 DESIGN OF 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: L: 45 = 45 PERIODS

REFERENCES:

1. Cook.N.J., "The Designer's Guide to Wind Loading of Building Structures", Butterworth's, 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", Pergamum Press, New York, 1972.
4. Lawson T.V., "Wind Effects on Building Vol. I and II", Applied Science Publishers London, 1980.

17STX13 DESIGN OF BRIDGES					
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To develop skills of students in designing various types of bridges	1.1	Understand the design theories for super structure and sub structure of bridges	a,c,f,l
2.0	To design the short span bridges	2.1	Design short span bridges	c,f,i,k
3.0	To design the Long span bridges	3.1	Understand the behaviour of continuous bridges, box girder bridges	a,d,f,k
4.0	To design the prestressed bridges	4.1	Design prestressed concrete bridges	c,d,i,l
5.0	To design the bearings & concrete piers	5.1	Know the Different types of bearings, abutments, piers and various types of foundations for Bridges	a,c,e,l

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: L: 45= 45 PERIODS

REFERENCES:

1. Krishna Raju.N "Design of Bridges"Oxford and IBH Publishing Company,4th Edition, New Delhi, 2015.
2. T.R. Jagadeesh and M.A. Jayaram., "Design of Bridge Structures", Prentice Hall of India Pvt.Ltd. Second edition 2014.
3. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, New Delhi 2008.
4. D. Johnson Victor, Essentials of Bridge Engineering, Oxford and IBH Publishing Co.,New Delhi, Sixth edition, 2014.
5. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. New Delhi, 1990.
6. Harrison H.B., "Structural Analysis and Design Vol.I and II", Pergamon Press, 1991.

17STX14 FRACTURE MECHANICS					
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To give an outline of the total field of fracture mechanics	1.1	Understand the design theories for super structure and sub structure of bridges	a,b,f,k
2.0	To analyse the fracture at critical stress	2.1	Design short span bridges.	a,b,c,i,l
3.0	To familiarize students with problems that can be solved with fracture mechanics concepts.	3.1	Understand the behaviour of continuous bridges, box girder bridges	a,b,f,i,k
4.0	To study the materials behaviour of fracture	4.1	Design prestressed concrete bridges	a,c,f,j
5.0	To learn the integral analysis on structures	5.1	Know the Different types of bearings, abutments, piers and various types of foundations for Bridges	a,d,i,k

UNIT I INTRODUCTION **(9)**

Courses of failures of structures – case studies Fracture Mechanics Approach to Design: Energy Criterion – Stress intensity approach – Time dependent crack growth – Effect of Material Properties on Fracture.

UNIT II LINEAR ELASTIC FRACTURE MECHANICS **(9)**

An atomic view of fracture – Stress concentration Effect of Flows – The Griffith Energy Balance – Comparison with the Critical Stress Criterion – Modified Griffith equation – The Energy Release rate – Instability and the R Curve – Stress analysis of cracks – Crack tip plasticity – Plane strain fracture – Mixed mode fracture

UNIT III ELASTIC – PLASTIC FRACTURE MECHANICS **(9)**

Crack –tip- opening displacement – J contour integral – Crack growth resistance curves – J - controlled fracture – Crack tip constraint under large –scale yielding – Sealing model for clearage fracture.

UNIT IV DYNAMIC AND TIME – DEPENDENT FRACTURE **(9)**

Dynamic fracture and crack arrest – Creep crack growth – Viscoelastic fracture mechanics. Material Behaviour: Fracture mechanisms in metals, plastics, ceramics, ceramic composites and concrete.

UNIT V APPLICATION TO STRUCTURES **(9)**

Linear Elastic Fracture Mechanics – Elastic plastic J – integral analysis – Failure Assessment Diagrams- Application to welded structures - Primary VS secondary stresses in the FAD Method – Ductile –Tearing analysis with FAD – Probabilistic Fracture Mechanics - Fatigue crack propagation - Environmentally assisted cracking in metals.

TOTAL: L: 45 = 45 PERIODS

REFERENCES:

1. Anderson, T.L. “Fracture Mechanics Fundamentals and Applications”, Taylor & Francis Group, 2015.
2. David Broek “Elementary engineering fracture mechanics” Kluwer Academic Publisher, 2012.

17STX15 MECHANICS OF COMPOSITE MATERIALS					
			L	T	P	C
			3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To develop knowledge on composite construction and its properties.	1.1	Identify the fiber types and classify the composite material.	a,b,f,j
2.0	To study the orthotropic and anisotropic of materials	2.1	Relate the stress –strain properties, longitudinal and transverse properties of composites	a,c,e,j
3.0	To understand the concept of Static, dynamic and stability analysis	3.1	Analyse the laminated composites and compute the lamina strength	a,d,f,k
4.0	To study the Fracture Mechanics of Composites	4.1	Find the failure criterion and fracture mechanics of composites	a,c,f,i,k
5.0	To learn the Metal and Ceramic Matrix Composites materials	5.1	Find the failure criterion and fracture mechanics of composites	a,i,k

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: L: 45 = 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.

17STX16 NON-LINEAR ANALYSIS OF STRUCTURES					
			L	T	P	C
			3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To develop the knowledge of elastic inelastic nonlinear, vibration and instability of beams and hysteric analysis of members subjected to cyclic loading.	**1.1**	Understand the elastic analysis with various boundary conditions of structural members	**a,c,f,i,k**
2.0	To understand the concept of inelastic analysis of flexural members	**2.1**	Understand the elastic analysis	**a,c,d,e,i,l**
3.0	To gain the knowledge about the vibration theory	**3.1**	Analyze of structural models under cyclic loading.	**a,c,i,k**
4.0	To study about the elastic and inelastic plates	**4.1**	Analyze of uniform and variable thickness plates	**a,c,e,j**
5.0	To understand the nonlinear vibration	**5.1**	Instability analysis of elastic flexural members.	**a,d,f,k**

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: L: 45 = 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.

17STX17 ADVANCED STRUCTURAL ANALYSIS					
			L	T	P	C
			3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To make familiar students structures.	**1.1**	Understand the basic concept of flexibility and stiffness	**a,c,d,h**
2.0	To understand the strain energy in structures	**2.1**	Transform the flexibility and from system coordinates to element coordinates	**a,b,c,e,l**
3.0	To analyse the flexibility method	**3.1**	Identify the degree of freedom and to formulate flexibility matrix of components of structures	**a,d,f,k,l**
4.0	To analyse the stiffness method	**4.1**	Formulate the stiffness matrix	**a,f,i,k**
5.0	To analyse the substructures	**5.1**	Analyse the frame through the iteration methods	**a,d,i,l**

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: L: 45 = 45 PERIODS

REFERENCES:

1. Weaver, J.R and Gere, J.M., 'Matrix Analysis of Framed Structures', Kluwer Academic Publishers, 2012
2. M. L. Gambhir Fundamentals of Structural Mechanics and Analysis, PHI Learning, Newdelhi,2011.
3. McGuire and R. H. Gallagher, Matrix Structural Analysis, John Wiley, 1999.
4. J. R. William Weaver and James M. Gere, Matrix Analysis of Framed Structures, CBS Publishers, 2004.

17STX18 SMART STRUCTURES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

	Course Objectives		Course Outcomes	Related Program outcomes
1.0	To describe the basic principles and mechanisms of smart materials and devices	**1.1**	Handle various smart materials and devices	**a,b,d,f,l**
2.0	To learn about the vibration abosrbers	**2.1**	Carryout analytical approach on vibration absorbers	**a,b,e,f,k**
3.0	To describe the basic principles and mechanisms of measuring techniques.	**3.1**	Workout various strain measurement using smart materials	**a,c,d,e**
4.0	To design the control modelling strcutres	**4.1**	Deliver control strategies of smart structures	**a,b,d,e**
5.0	To demonstrate knowledge and understanding of the engineering principles in smart sensors, actuators and transducer technology	**5.1**	Apply principles of smart structures to civil engineering field	**a,b,c,e**

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: L: 45 = 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.

17STX19 DESIGN OF PRESTRESSED CONCRETE STRUCTURES					
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To develop the skill of the student in gaining knowledge of prestressing principles.	1.1	Knowledge on the principle, types and systems of prestressing and analyze the deflections.	a,c,e,l
2.0	To design the flexural members as per codal provision	2.1	Determine the flexural strength and design the flexural members, end blocks	a,c,e,k
3.0	To design the continuous beam by Method of achieving continuity	3.1	Analyze the statically indeterminate structures	a,b,d,l
4.0	To learn and design the compression member with flexure	4.1	Design the tension and compression members	a,b,f,k,l
5.0	To analyze the continuous beam and its applications	5.1	Analyze the stress, deflections, flexural and shear strength and apply it for the design of Bridges	a,b,d,k

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: L: 45 = 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.

17STX20 SOLID AND HAZARDOUS WASTE MANAGMENT					
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To impart knowledge about, managing solid wastes from industrial sources	**1.1**	To know the various types and sources of solid waste.	**a,c,d,e**
2.0	To study about the waste generation rates and variation	**2.1**	Gain knowledge of characterization of waste	**a,c,d,g**
3.0	To learn the analysis of collections systems	**3.1**	Know the ideas about, storage and transfer the solid wastes	**a,c,e,l**
4.0	To learn the waste processing technologies	**4.1**	Gain the knowledge of waste processing technologies	**a,e,f,l**
5.0	To study about the Waste disposal and Landfill Classification	**5.1**	choose the types of waste disposal and landfill remediation	**a,b,d,k**

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: L: 45 = 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.

17STX21 ENERGY EFFICIENT STRUCTURES					
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Related Program outcomes
1.0	To create awareness of the necessity of energy needed for structures.	**1.1**	Get introduced to various energy consumptions	**a,b,d,i,k**
2.0	To study the different climate types and their influence in building design	**2.1**	Master the climate and environmental factors affecting building design.	**a,b,c,f,j**
3.0	To study about the Thermal performance in building design	**3.1**	Gain knowledge of design of buildings according to thermal environment	**a,d,i,j,k**
4.0	To learn the energy consumptions in buildings	**4.1**	Acquire the skills of utilization of appliances and the principles behind them	**a,b,f,k**
5.0	To understand the concept of energy audit and its applications	**5.1**	Obtain the knowledge of energy audit in buildings	**a,b,i,k**

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: L: 45 = 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.

17BAZ01- RESEARCH METHODOLOGY				
L	T	P	C	
3	0	0	3	

PREREQUISITE: NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Program outcomes
1.0	To understand the basic concepts of research and its methodologies, sources of information for literature review	**1.1**	Demonstrate the concepts of research and its methodologies, sources of information for literature review	**a,c,d,e,f,g,h,j,k,l**
2.0	To identify the various procedures to formulate appropriate research design, data collection and measurement.	**2.1**	Formulate appropriate research design, data collection and conduct the experiments using systematic methods.	**a,b,c,e,f,g,h,i,k,l**
3.0	To summarize various methods for data preparation and analysis	**3.1**	Identify the design for coding, editing and analysis of data	**b,c,d,e,f,g,h,i,j,k**
4.0	To provide knowledge of report types, report writing and guidelines to review report	**4.1**	Choose the process like drawing and drafting tools and reviewing research papers	**c,d,e,f,g,h,i,j,k,l**
5.0	To summarize the Intellectual property rights and Ethics in research	**5.1**	Formulate the design for Intellectual property rights and code of ethics	**b,c,d,e,f,h,i,j,k,l**

UNIT I : INTRODUCTION **(7)**

Research methodology - Understanding the language of research – Concepts, constructs, operational definitions, variables, propositions, hypotheses, theories, and models - Research process- Literature review -Types of research.

UNIT II : RESEARCH DESIGN, DATA COLLECTION AND MEASUREMENT **(10)**

Problem identification and formulation - Research question – Research hypothesis - Measurement issues - Methods of data collection Types of data- Primary data- Scales of measurement- Sources and collection of data Observation method- Interview method– Survey- Experiments- Secondary data-Research design- Qualitative and Quantitative Research.

UNIT III : DATA PREPARATION AND ANALYSIS **(10)**

Processing and analysis of data- Sampling- Steps and characteristics of sampling design Sampling: concepts of Population, Sample, Sampling Frame, - Sample size and its determination - Types of sampling distributions - Sampling error - Statistics in research Descriptive statistics and inferential statistics- Measures of central tendency, dispersion, skewness, asymmetry- Measures of relationship- Correlation and regression- Simple regression analysis- Multiple regression -Hypothesis Testing - parametric and non-parametric tests- Analysis of single factor experiments.

UNIT IV : REPORT WRITING AND DESIGN **(10)**

Reporting and presenting research - Written and oral communications -Hallmark of great scientific writing-The reading toolkit - Pre-writing considerations - Format of dissertations-Drawing and Drafting Tools, research reports, and research papers – Paper title and keywords – Writing an abstract – Writing the different sections of a paper - Revising a paper - Responding to peer reviews - Reviewing research papers - Plagiarism - Conference and poster presentations - Language aspects of report writing -Verb, tense and voice in scientific writing - Errors in grammar - Sentence and paragraph constructions -Paraphrasing - Measures of research impact.

UNIT V : INTELLECTUAL PROPERTY RIGHTS AND ETHICS IN RESEARCH (8)

Intellectual property rights-Co-creation Methodology to make products from projects - Copyright - Patents - The codes of ethics - Avoiding the problems of biased survey -Occupational health and safety.

TOTAL : L: 45 = 45 PERIODS

REFERENCES:

1. Cooper, D. R. and Schindler, P. S., (2009), *Business Research Methods*, Tata McGraw Hill, 9th Edition.
2. Jackson, S.L., *Research Methods and Statistics*, Cengage Learning India Private Limited, New Delhi, 2009
3. Krishnaswamy, K.N., Sivakumar, A.I., and Mathirajan, M., *Management Research Methodology*, Pearson Education , 2006.
4. Lebrun, J-L., *Scientific Writing: A Reader and Writer's Guide*, World Scientific Publishing Co. Pte. Ltd., Singapore, 2007.
5. MLA, MLA *Handbook for Writers of Research papers*, Seventh Edition, Affiliated East West Press Pvt Ltd, New Delhi, 2009.
6. Thiel, D. V., *Research Methods for Engineers*, Cambridge University Press, 2014.

17STX22 STRUCTURAL HEALTH MONITORING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL		**QUESTION PATTERN : TYPE-3**			

COURSE OBJECTIVES AND OUTCOMES

Course Objectives		Course Outcomes The students will be able to		Related Program outcomes
1.0	To learn the concept of structural health monitoring process	**1.1**	Understand the structural health monitoring process	**a,g**
2.0	To study the methods of health monitoring systems	**2.1**	Identify Structural Health Monitoring Methods	**a,e**
3.0	To identify the suitable methods for structural damages	**3.1**	Analyze the damage identification methods	**d,e**
4.0	To realize the types of sensors for SHM systems	**4.1**	Identify the sensors for structures based on damage level	**a,e**
5.0	To impart knowledge on applications of SHM	**5.1**	Apply the structural health monitoring strategy for various structures	**a,f**

UNIT I - INTRODUCTION TO STRUCTURAL HEALTH MONITORING	**(9)**
Introduction - Necessity - Components - Challenges - Advantages - Components of SHM process -SHM issues applied to concrete structures - Level of uncertainties in SHM process	
UNIT II - STRUCTURAL HEALTH MONITORING METHODS	**(9)**
Short term and Long term Monitoring - Local and Global Monitoring - Static and Vibration based SHM - SHM planning and Management - SHM Methods	
UNIT III - DAMAGE IDENTIFICATION METHODS	**(9)**
Damage Identification - Visual Inspection - Comparison of damage identification methods - Non Destructive testing and Evaluation - Vibration based damage detection	
UNIT IV - SENSORS FOR HEALTH MONITORING SYSTEMS	**(9)**
Acoustic emission sensors, ultrasonic sensors, piezoceramic sensors and actuators, fibre optic sensors - Laser stereography techniques - Imaging techniques.	
UNIT V - APPLICATIONS OF STRUCTURAL HEALTH MONITORING	**(9)**
SHM layout design of offshore structures -SHM Design - Application of SHM in bridges, buildings and offshore structures - Applications of structural control strategies - Future of SHM.	
	TOTAL (L: 45) = 45 PERIODS

REFERENCES:

1. Armer, G.S.T (Editor), Monitoring and Assessment of Structures, Spon, London, 2001.
2. Rao, J.S., Vibratory condition monitoring of machines, Narosa Publishing House, India, 2000.
3. Glisic, B. and Inaudi, D. Fibre optic methods for structural health monitoring. JohnWiley & Sons, 2008
4. Nagayama, T. and Spencer Jr, B.F. Structural health monitoring using smart sensors.
5. Newmark Structural Engineering Laboratory. University of Illinois at Urbana-Champaign, 2007