M.E. (Structural Engineering)

2015 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai
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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

By completing the programme M.E. (Structural Engineering), the students will be able

I. To make the students familiar with the latest developments in concrete technology and composite materials, their properties and practical applications.

II. To make the students understand the concepts and principles involved in the analysis of stresses and strains in 2D and 3D cases by classical and finite element approaches.

III. To familiarize the students with the advanced analysis of structures under static and dynamic forces with the application of FEM and with the aid of software packages. To make the students study the analysis and design methods of super structures and sub structures to instil confidence among students and to face boldly the challenges prevailing in the construction field.

IV. To expose the students the method of repair and rehabilitation of structures, strength and stability of structures, testing procedure to know the strength and behaviour of structural components, the method of doing independent research and preparation of research report. To improve the communication skill of students through seminars and paper presentations in technical journals and conferences and to make them participate effectively in team work.

PROGRAMME OUTCOMES (POs)

By completing the programme M.E. (Structural Engineering), the students will be able to:

(a) Design all types of concrete mixes, and suggest the adoption of appropriate type of concrete in the construction field

(b) Identify and define problems, gather data related to the problem, generate and prioritize a set of alternative solutions, and select and implement the best alternative incorporating the recommendations of relevant codes of practice.

(c) Analyse structures for stresses and stress resultant using advanced methods and software packages.

(d) Design and prepare detailed drawings of structures that are necessary for field execution with high level of accuracy.

(e) Understand and perform research by identifying the nature of the information required, investigation sources of information including professionals, texts, and databases; organize the information by employing a variety of techniques such as spreadsheets, graphs and charts, examine the information to select the most relevant, important and useful items for structural engineering.

(f) Use the techniques, skills, advanced modern engineering tools, instrumentation and software packages necessary for structural engineering practice.

(g) Lead, manage and be productive in a multidisciplinary team with good communication skill.

(h) Recognize the need for and to engage in continual learning through sustained education to meet the challenging and demand – driven needs of the structural engineering field.

MAPPING OF PEOs AND POs

PEO(s)	Programme Outcome (s)							
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
I	x		x	x		x		
II		x	x	x		x		
III		x	x	x	x	x		
IV	x	x		x	x	x	x	x

M.E. Structural Engineering (Full Time)
Minimum credits to be earned: 80

First Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
15ST11	Structural Dynamics	I	(c)	3	0	0	3
15ST12	Advanced Reinforced Concrete Design	III	(d)	3	2	0	4
15ST13	Stability of Structures	III	(f)	3	2	0	4
15ST14	Applied Elasticity and Plasticity	II	(b)	3	2	0	4
15ST15	Design of Foundation Structures	III	(b), (f)	3	2	0	4
	Elective I			3	0	0	3
15ST17	Structural Engineering and Dynamics Laboratory	I, IV	(f)	0	0	4	2
15ST18	Advanced Computer Aided Analysis and Design Laboratory	III	(c), (d), (f)	0	0	4	2
15GE19	Business English I[α]	IV	(f), (h)	1	0	2	2
			Total	**19**	**8**	**10**	**28**

Second Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
15ST21	Research Methodology	IV	(b), (e)	3	0	0	3
15ST22	Earthquake Resistant Design of Structures	III	(c), (e)	3	2	0	4
15ST23	Advanced Design of Steel Structures	III	(b)	3	2	0	4
15ST24	Finite Element Analysis	II	(c)	3	2	0	4
	Elective II			3	0	0	3
	Elective III			3	0	0	3
15ST27	Advanced Structural Design Practice	III	(b), (d)	0	0	4	2
15ST28	Technical Seminar			0	0	2	1
15GE29	Business English II[α]	IV	(f), (h)	1	0	0	1
			Total	**19**	**6**	**6**	**25**

Third Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
	Elective IV			3	0	0	3
	Elective V			3	0	0	3
	Elective VI			3	0	0	3
15ST34	Project Work - Phase I	IV	(a), (d), (e), (f), (g)	-			6
			Total	**9**	**0**	**0**	**15**

Fourth Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
15ST41	Project Work - Phase II	IV	(a), (d), (e), (f), (g)	-			12
			Total				**12**

[α] Common to all M.E. / M.Tech. Programmes

M.E. – Structural Engineering (Part Time)

First Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
15ST11	Structural Dynamics	I	(c)	3	0	0	3
15ST12	Advanced Reinforced Concrete Design	III	(d)	3	2	0	4
15ST13	Stability of Structures	III	(f)	3	2	0	4
15ST17	Structural Engineering and Dynamics Laboratory	I, IV	(f)	0	0	4	2
15GE19	Business English I[α]	IV	(f), (h)	1	0	2	2
			Total	**10**	**4**	**6**	**15**

Second Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
15ST21	Research Methodology	IV	(b), (e)	3	0	0	3
15ST22	Earthquake Resistant Design of Structures	III	(c), (e)	3	2	0	4
15ST23	Advanced Design of Steel Structures	III	(b)	3	2	0	4
15ST27	Advanced Structural Design Practice	III	(b), (d)	0	0	4	2
15GE29	Business English II[α]	IV	(f), (h)	1	0	0	1
			Total	**10**	**4**	**4**	**14**

Third Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
15ST14	Applied Elasticity and Plasticity	II	(b)	3	2	0	4
15ST15	Design of Foundation Structures	III	(b), (f)	3	2	0	4
15ST24	Finite Element Analysis	II	(c)	3	2	0	4
15ST18	Advanced Computer Aided Analysis and Design Laboratory	III	(c), (d), (f)	0	0	4	2
			Total	**9**	**6**	**4**	**14**

Fourth Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
	Elective I			3	0	0	3
	Elective II			3	0	0	3
	Elective III			3	0	0	3
15ST28	Technical Seminar			0	0	2	1
			Total	**9**	**0**	**2**	**10**

Fifth Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
	Elective IV			3	0	0	3
	Elective V			3	0	0	3
	Elective VI			3	0	0	3
15ST34	Project Work - Phase I	IV	(a), (d), (e), (f), (g)	-	-	-	6
			Total	**9**			**15**

Sixth Semester

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
15ST41	Project Work - Phase II	IV	(a), (d), (e), (f), (g)	-			**12**

[α] Common to all M.E. / M.Tech. Programmes

List of Core Electives							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15ST51	Theory of Plates and Shells	II	(c), (d)	3	0	0	3
15ST52	Structural Optimization Techniques	III	(b), (f)	3	0	0	3
15ST53	Design of Steel – Concrete Composite Structures	III	(b), (d)	3	0	0	3
15ST54	Behaviour and Analysis of Tall Structures	III	(c)	3	0	0	3
15ST55	Repair and Rehabilitation of Structures	IV	(b)	3	0	0	3
15ST56	Design of Prestressed Concrete Structures	III	(d)	3	0	0	3
15ST57	Design of Bridges	III	(d), (f)	3	0	0	3
15ST58	Design of Industrial Structures	III	(d)	3	0	0	3
15ST59	Prefabricated Structures	III	(f)	3	0	0	3
15ST60	Advanced Structural Analysis	III	(c), (f)	3	0	0	3
15ST61	Offshore Structures	III	(c)	3	0	0	3
15ST62	Advanced Concrete Technology	I	(a)	3	0	0	3
15ST63	Experimental Stress Analysis and Techniques	I	(f)	3	0	0	3
15ST64	Soft Computing in Structural Engineering	III	(f)	3	0	0	3
15ST65	Fracture Mechanics	II	(c)	3	0	0	3
15ST66	Smart Structure and Applications	II, III	(b), (c)	3	0	0	3
15ST67	Hydraulic Structures	III	(c), (d)	3	0	0	3
15ST68	Soil – Structure Interaction	III	(b), (f)	3	0	0	3
One Credit Courses							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15STXA	Design of multi-storeyed steel building using software			1	0	0	1

15ST11 - STRUCTURAL DYNAMICS

3 0 0 3

Course Objectives

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

Course Outcomes (COs)

1. After completion of the course, the students will have the knowledge of vibration analysis ofSystems.
2. The students able to analyse the structures with different degrees of freedom and they know the method of dampingthe systems.
3. The students able to know the structures for wind and other dynamic loads

UNIT I
PRINCIPLES OF STRUCTURAL DYNAMICS

Overview of Structural Dynamics: Degree of freedom -Simple harmonic motion - Newton's second law of motion -D'Alembert's principle -Energy method -Equation of motion for SDOF system- Damped and un-damped free vibrations and forced vibration - Logarithmic decrement.

9 Hours

UNIT II
MULTI DEGREE OF FREEDOM SYSTEMS

Mathematical models of two degrees of freedom systems - free and forced vibrations of two degrees of freedom systems, normal modes of vibration. Multi-degree of freedom systems - orthogonality of normal modes, free and forced vibrations of multi degree of freedom systems: Mode superposition technique, Iteration due to Holzer and Stodola method, applications.

9 Hours

UNIT III
RESPONSE TO GENERAL DYNAMIC LOADING

Fourier series expression for loading (blast or earthquake) - Duhamel's integral, vibration analysis by Rayleigh's method, Rayleigh - Ritz method -Earthquake response analysis of Multi-DOF systems subjected to earthquake ground motion - Idealization of multi-storeyed frames.

9 Hours

UNIT IV
DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS

Vibration of springs - Free longitudinal vibration of a bar - Free flexural vibration of simply supported beams and beams with other end conditions -Vibration analysis using finite element method for beams and frames.

9 Hours

UNIT V
DIRECT INTEGRATION METHODS FOR DYNAMIC RESPONSE

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

9 Hours

UNIT VI[$]

Application of software packages for structural dynamics problems.

Total: 45 Hours

Reference(s)

1. Mario Paz, Structural dynamics, CBS Publishers 1987.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

2. Anil K. Chopra, Dynamics of structures: Theory and applications to earthquake Engineering, PHI Ltd., 1997.
3. Manickaselvam, V.K., "Elementary Structural Dynamics", Dhanapat Rai& Sons, 2001.
4. Roy R.Craig, Jr, Andrew J. Kurdila, "Fundamentals of Structural Dynamics", John Wiley& Sons. 2011.
5. Leonard Meirovitch, "Elements of Vibration Analysis", McGraw Hill, 1986, IOS Press, 2006.

15ST12 ADVANCED REINFORCED CONCRETE DESIGN

3 2 0 4

Course Objectives

- To impart knowledge on the limit state design of RC Structural components
- To enhance the confidence level of students to design the special structural elements as per Indian standard codes of practice.

Course Outcomes (COs)

1. By the end of this course, students will have a good understanding of the design and behaviour of reinforced concrete beams, columns, slabs and framed structures.
2. Students will be able to design and detail the RC structural components in accordance with relevant IS codes and standards.
3. They will be able to analyse and design slabs and hyperstatic structures by the ultimate load method

UNIT I
DESIGN OF BEAMS AND COLUMNS

Properties and behaviour of concrete and steel – Behaviour and design of R.C. beams in flexure, shear, torsion and combined loadings applied gradually – modes of failure interaction effects – Design of uncracked section - analysis and design for serviceability limit states – calculations of deflections and crack width as per I.S 456 – behaviour of slender R.C. columns under gradually increasing load – failure modes and interaction curves – calculation of design moments for braced and un- braced long columns- design of slender columns.

10 Hours

UNIT II
DESIGN OF HYPER STATIC R.C. BEAMS AND FRAMES

Design and detailing of continuous beams and portal frames – design of multibay, multi-storeyed R.C. frames: preliminary design – use of substitute frames for calculating stress resultants caused by gravity loading –portal method for wind and earthquake forces – design of members and detailing of reinforcements.

9 Hours

UNIT III
DESIGN OF SPECIAL R.C. ELEMENTS

Design and detailing of deep beams and corbels – braced and un-braced walls – approximate analysis – design of beams circular in plan and spandrel beams.

9 Hours

UNIT IV
DESIGN OF SLABS

Yield line theory of slabs – virtual work and equilibrium methods – Hillerborg's method of design – design of flat slabs and supporting columns - design of grid floors as per I.S.456

9 Hours

UNIT V
INELASTIC BEHAVIOUR AND ULTIMATE LOAD ANALYSIS

Conditions for ultimate load analysis – Concept of moment redistribution and moment rotation characteristics of a R.C. section – Plastic hinges – check for rotation capacity of sections – Ultimate load analysis by mechanism method

8 Hours

UNIT VI[$]
Ultimate load design of R.C. hyper static beams and frames.

Total: 45+30 Hours

Reference(s)

1. S. Unnikrishnan Pillai and Devados Menon, Reinforced Concrete Design, Tata McGraw – Hill Education, 2011
2. P.C. Varghese, Advanced Reinforced Concrete Design, Prentice Hall International Edition, 2006
3. N. Krishnaraju, Advanced Reinforced Concrete Design, CBS Publishers and Distributors, 2013
4. R. Park and T. Paulay, Reinforced Concrete Structures, John Wiley Sons, 2009
5. Gambhir, M.L. Design of Reinforced Concrete Structures, Prentice Hall of India, 2012
6. S.N. Sinha, Handbook of Reinforced Concrete Design, Tata McGraw –Hill Education, 2004
7. N. Subramanium, "Design of Reinforced Concrete Structures, Oxford University Press, 2014

15ST13 - STABILITY OF STRUCTURES

3 2 0 4

Course Objectives

- To impart Knowledge on phenomenon of buckling and its effects on structural components.
- a rigorous grounding in the behaviour of structural components and systems that suffer from failure due to geometric, rather than material, nonlinearity

Course Outcomes (COs)

1. The students will get in-depth knowledge on structural stability and behaviour of individual components subjected to buckling loads.
2. The students able to analyse geometrically perfect and imperfect systems for structural stability
3. The Students able to understand how basic structural components and systems behave when they are subject to instability

UNIT I
FUNDAMENTAL CONCEPTS OF STABILITY
Criterion for design of structures: strength, stability and stiffness – concepts of stability, instability and bifurcation – stability criteria – Concepts of Equilibrium, Energy and Dynamic approaches – South well Plot – Stability of Link models.

9 Hours

UNIT II
BUCKLING OF COLUMNS
Governing differential equations – Higher order differential equations – Analysis for various boundary conditions – Behaviour of imperfect column – initially bent column – eccentrically loaded column – Energy method – Rayleigh Ritz, Galerkin methods – Effect of shear on buckling – Large deflection analysis of columns.

9 Hours

UNIT III
BUCKLING OF BEAM – COLUMN & FRAMES
Buckling of beam column – Derivation of stability function for standard cases of beam columns: Beam – columns with concentrated lateral loads – distributed loads – effect of axial loads on bending stiffness. Buckling of frames: Mode of buckling – Single storey frames with sway and no sway; Buckling analysis of frames with various methods: Slope deflection and Stiffness methods.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

UNIT IV
LATERAL STABILITY OF BEAMS
Differential equations for lateral buckling – lateral buckling of beams in pure bending – lateral buckling of cantilever and simply supported I beams. Buckling of Thin Walled Open Sections: Introduction – torsional buckling – torsional flexural buckling – Equilibrium and energy approaches.

9 Hours

UNIT V
STABILITY OF PLATES & INELASTIC BUCKLING
Governing Differential equation – Equilibrium, energy concepts – Buckling of rectangular plates for various edge conditions – Finite difference method – post –buckling strength. Introduction to inelastic buckling – Double modulus theory (reduced modulus) - tangent modulus theory- Shanley's theory – determination of double modulus for I section and rectangular section. Application: Review of relevant codal provisions for the design of steel, concrete and masonry structures incorporating buckling phenomenon.

9 Hours

UNIT VI[$]
Buckling of R.C thin shells and pre stressed concrete beams with thin webs.

Total: 45 Hours

Reference(s)

1. A. Chajes, Principles of Structural Stability Theory, Prentice Hall, 2008.
2. N.G.R. Iyengar, Structural Stability of Columns and Plates, Affiliated East West press Pvt. Ltd, New Delhi -2000.
3. D.O.Brush, and B.O. Almorth, Buckling of Bars, Plates and Shells, McGraw Hill, 2006.
4. S.O. Timoshnko and J.M. Gere, Theory of Elastic Stability, McGraw Hill, 2009.
5. M.S. El Naschies, Stress, Stability and Chaos in Structural Engineering: An Energy Approach, McGraw Hill International Editions, 1999.
6. AshwiniKukar, Stability of Structures, Allied Publishers LTD, New Delhi, 2003.

15ST14 APPLIED ELASTICITY AND PLASTICITY

3 2 0 4

Course Objectives

- To understand the concept of 3D stress-strain analysis and its applications to simple problems
- To give an exposure on the plastic behaviour of materials

Course Outcomes (COs)

1. The students will be in a position to find out the stresses and strains in bodies subjected to two-dimensional & three dimensional forces
2. The students will be able to develop a mathematical model for two-dimensional problems
3. Students will be able to determine stresses under plastic condition

UNIT I
ANALYSIS OF STRESS AND STRAIN
Analysis of stress (two and three dimension)- Body force, surface force - Uniform state of stress – Principal stresses - stress transformation laws - Differential equations of equilibrium. Analysis of strain (two and three dimension) Strain displacement relations - state of strain at a point – strain transformation - principal strain - principle of superposition. Stress - strain relations- Compatibility equations - generalized Hooke's law - Lame's constants

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

UNIT II

TWO DIMENSIONAL PROBLEMS IN CARTESIAN COORDINATES

Methods of formulation of elasticity problems - Equilibrium equations in terms of displacements - compatibility equations - Boundary value problems. Plane stress and Plane strain problems - Airy's stress function - polynomials – Direct method of determining Airy's polynomial stress function - solution of Biharmonic equation - St. Venant principle- two dimensional problems in Cartesian Co-ordinates-bending of a cantilever loaded at end

9 Hours

UNIT III

TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES

Equilibrium equations in polar coordinates - stress distribution symmetrical about an axis - pure bending of curved bars - strain components in polar coordinates - displacements for symmetrical stress distribution - Rotating Disc - Bending of a curved bar by force at the end - Effect of circular hole on stress distribution - concentrated force at a point of a straight boundary - Forces on wedges - A circular disc with diametric loading.

9 Hours

UNIT IV

TORSION OF PRISMATIC BARS

General solutions of the problem by displacement (St. Venant's warping function) and force (Prandtl's stress function) approaches - Membrane analogy-Torsion of shafts of circular and noncircular (elliptic, triangular and rectangular) cross sectional shapes. Torsion of thin rectangular section - Torsion of thin walled single and multi celled sections.

9 Hours

UNIT V

INTRODUCTION TO PLASTICITY

Introduction to stress-strain curve - Visco elastic material - Ideal plastic body - criterion of yielding –Theories of failure - yield surface - Flow rule (plastic stress- strain relation) PrandtlReuss equations - Plastic work - Plastic potential - uniqueness of stress distribution - Elastoplastic problems of beams in bending – thick hollow spheres and cylinders subjected to internal pressure - General relations - plastic torsion –Nadai's sand heap analogy.

9 Hours

UNIT VI[$]

Application of software packages for the determination of stresses in bodies under any type of loading and boundary condition.

Total: 45 + 30 Hours

Reference(s)

1. S. Timoshenko and J. N. Goodier, Theory of Elasticity, McGraw Hill Book Co., 2007
2. Sadhu Singh, Theory of Elasticity, Khanna Publishers, New Delhi, 2005.
3. Sadhu Singh, Theory of Plasticity, Khanna Publishers, New Delhi, 2008.
4. P. C. Chow and N. J. Pagano, Elasticity, Tensor, Dyadic and Engg. Approaches, D. Vannostrard Co., New York, 1992
5. T. Chakrabarthy, Theory of Plasticity, McGraw Hill Book Co., New Delhi, 2007
6. N.Krishnaraju, Advanced mechanics of solids, Narosa Publishing House,1997
7. L. S. Srinath, Advanced mechanics of solids, Tata McGraw Hill Publishing Company Ltd, 2009

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15ST15 DESIGN OF FOUNDATION STRUCTURES

3 2 0 4

Course Objectives

- To impart knowledge on the selection of best foundation solutions for different types of soils and structures
- To equip the students to evaluate the load carrying capacity of piles and well foundation
- To build the necessary theoretical background for design and construction of foundation on difficult soils

Course Outcomes (COs)

1. The students will be able to design and analyze a variety of geotechnical engineering structures including deep foundations, retaining walls, geosynthetic-reinforced soil structures and machine foundations
2. The students able to gain knowledge on stability analysis and design of retaining structures
3. Able to gain knowledge on design and construction of machine foundation

UNIT I

INTRODUCTION

Soil investigation report for foundation structure – Types and selection of suitable foundation - Basic requirement of foundation–Bearing Capacity–Theoretical methods (Terzaghi's, Meyorhof's, Vesic's) – IS method–Penetration tests–SPT,SCPT&DCPT–Plate load test–Types of shallow foundations - General principle of design of raft foundation – Introduction to Floating foundation. Demonstration of SPT and Cone penetration test – use of pressure bulbs

9 Hours

UNIT II

DEEP FOUNDATIONS

Introduction – Load carrying capacity of different types of piles and pile groups according to IS:2911-2010 – Pile load test -Settlement of piles- Negative skin friction-Lateral load resistance of individual piles and pile groups – Design of Piles and Pile cap and detailing of reinforcements– Caissons– Types and Design - Design of well foundation (IS and IRC approaches).

Case studies on deep foundations – Design of piled raft foundation

9 Hours

UNIT III

EARTH RETAINING STRUCTURES

Sheet pile structures-Cantilever sheet pile walls in granular soils and cohesive soils-Anchored Bulk head- Free earth support method- Fixed earth support method – lateral earth pressure on Braced sheet pile walls- Construction of diaphragm walls- Design of Cofferdams.

9 Hours

UNIT IV

SPECIAL FOUNDATIONS

Expansive Soils-Introduction-Identification of expansive soils–Swell potential and swelling pressure- Foundations on expansive soils - Design and detailing of Under reamed pile foundation –Reinforced Earth - Introduction–Basic Mechanism of reinforced earth-Choice of soil and reinforcement-Reinforced earth retaining walls – Design and check for stability-Case studies on reinforced soil.

9 Hours

UNIT V

MACHINE FOUNDATIONS

Introduction–Fundamentals of soil dynamics-Types of machine foundations–General criteria for design of machine foundation-Vibration analysis of machine foundation-Design of foundation for Reciprocating Machines and Impact machines–Vibration isolation–Construction aspects of machine foundations.Study experiment – Block vibration test.

9 Hours

UNIT VI[$]

Application of Software in the analysis and design of foundations

Total: 45 +30 Hours

Reference(s)

1. V.N.S. Murthy, Advanced Foundation Engineering, CBS Publisher, 2007
2. Das, B.M. Principles of Foundation Engineering, 8th Edition, Cengage Learning, 2015
3. P.C.Varghese, Foundation Engineering, Prentice-Hall of India Private Ltd, New Delhi,2006
4. Swami Saran, Soil Dynamics and Machine Foundations, Galgotia Publications Private Ltd, 1999.
5. Poulos, H. G. and Davis, E. H. (1980). Pile Foundation analysis and design, John Willey and Sons, Inc., New York.
6. Robert M. Koerner, Designing with Geosynthetics, 6th Edition, Vol. 1, Xlibris Corporation, USA, 2012.
7. IS Codes: IS6403: 1981(R2002); IS2911:Part1:Sec1 to 4:2010; IS 2911:Part1:1980; IS 4091: 1979 (R2000); IS 9556: 1980 (R2003); IS 9527(3):1983; IS 2974 (1-4): 1979
8. IRC Codes: IRC 78; IRC SP: 102

15ST17 - STRUCTURAL ENGINEERING AND DYNAMICS LABORATORY

0 0 4 2

Course Objectives

- To impart training to student on concrete mix design, and determination of properties of concrete in fresh and hardened states
- To impart training on NDT Testing of concrete
- To study the strength and behaviour of RC Beams
- To study the behaviour of model structural components subjected to vibration

Course Outcomes (COs)

1. Design concrete mixes for a given target strength and determine the properties of fresh and hardened concrete
2. Conduct prototype test on RCC beams
3. Determine strength of concrete by NDT Test
4. Make use of shake table for knowing the behaviour of model structural components subjected to vibration

List of Experiments

1. Mix design for high strength concrete and properties of fresh concrete
2. Tests on mechanical properties of hardened concrete
3. Tests on durability of concrete
4. Method of manufacture and test on self-compacting concrete
5. Method of manufacture and test on self-curing concrete
6. Effect of different types of curing on strength of concrete
7. Casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour
8. Non-destructive testing of concrete using
   i) Rebound hammer
   ii) Ultra sonic pulse velocity method
9. Tests on the behaviour of model frames under vibration

Total: 60 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15ST18 ADVANCED COMPUTER AIDED ANALYSIS AND DESIGN LABORATORY

0 0 4 2

Course Objectives

- To train the students in the application of computer software for the analysis and design of structures
- To guide the students to develop computer programs for the analysis of structures and design of RC structural components

Course Outcomes (COs)

1. The students will be able to develop computer programs for the analysis of structures and design of RC structural components.
2. Students will be able to use computer software packages for the analysis and design of structures

List Of Experiments

1. Solution of Linear System of Equations using mathematical Software
   - Cramer's Rule
   - Gauss Siedel Iteration
2. Design of RC Structural components by developing programs
   - Design of Singly reinforced beams
   - Design of Rectangular Columns
   - Design of Raft foundations
3. Computer aided analysis and Design of a
   - 2D steel truss.
   - 3D steel truss.
   - Single-storey building frame.
   - Multi-storey building frame.
   - T-beam Bridge subjected to moving load.
   - Multi-storey building frame subjected to wind forces.
   - Multi-storey building frame subjected to seismic forces.
4. Finite Element Analysis of
   - Deep beams
   - Shell Structures

Total: 60 Hours

15GE19 BUSINESS ENGLISH I

1 0 2 2

Course Objectives

- To acquire skills for using English in workplace effectively.
- To communicate for essential business needs.
- To prepare students for taking BEC Vantage level examination which is an International Benchmark for English language proficiency of Cambridge English Language Assessment (CELA).

Course Outcomes (COs)

1. To enable students to get International recognition for work and study.
2. To use English confidently in the International business environments.
3. To be able to take part in business discussion, read company literature, write formal and informal business correspondences and listen and understand business conversations.

UNIT I
GRAMMAR AND VOCABULARY

Comparison of adjectives – forming questions – asking complex questions – expressing purpose and function – tenses – conditionals – time statements – modal verbs – active and passive voice –

articles – direct and indirect speech – cause and effect – relative pronouns – expressions followed by – *ing* forms – countable / uncountable – acronyms – marketing terms / vocabulary – financial terms – collocations – discourse markers.

10 Hours

UNIT II
LISTENING

Purposes of listening – features of listening texts – potential barriers to listening – specific listening skills – strategies to use when listening– distinguishing relevant from irrelevant information – gap filling exercise – multiple-choice options – note completion – matching and multiple choice questions – listening for specific information, gist, topic, context and function.

7 Hours

UNIT III
SPEAKING

Word and sentence stress – clear individual sounds – turn taking – initiating and responding - intonation patterns – pronunciation – mother tongue intrusion– conversation practice – turn-taking and sustaining the interaction by initiating and responding appropriately.

10 Hours

UNIT IV
READING

Purposes of reading – potential barriers to reading – paraphrasing – identifying facts and ideas – skimming and scanning for information – matching statements with texts– spotting reference words – understanding text structure – understanding the ideas in a text – distinguishing between the correct answer and the distractor – understanding cohesion in a text – deciphering contextual meaning of words and phrases – cloze – proof reading - transcoding.

8 Hours

UNIT V
WRITING

Paragraphing a text – using appropriate connectives – editing practice –Longer Documents: writing a proposal.

10 Hours
Total: 45 Hours

Reference(s)

1. Guy Brook-Hart, "BEC VANTAGE: BUSINESS BENCHMARK Upper-Intermediate – Student's Book", 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE – Self-study Edition", Cambridge University Press, UK, 2005.

15ST21 RESEARCH METHODOLOGY

3 0 0 3

Course Objectives

- To understand some basic concepts of engineering research and its methodologies.
- To identify various sources of information for literature review and data collection.
- To families the various procedures to formulate appropriate research problem and design of experiments.

Course Outcomes (COs)

The students will be able to

1. Demonstrate the concepts of engineering research and its methodologies.
2. Understand the various methods used to collect the data to research.
3. Formulate appropriate research problem and conduct the experiments using systematics methods.

Unit I

Introduction

Definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modelling research, algorithmic research, Research process- steps.

Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

9 Hours

Unit II

Sampling Methods

Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non-probability sampling method – convenience sampling, judgment sampling, quota sampling.

9 Hours

Unit III

Hypotheses Testing

Testing of hypotheses concerning means -one mean and difference between two means -one tailed and two tailed tests, concerning variance – one tailed Chi-square test.

9 Hours

Unit IV

Experimental Research in Structural Engineering

Determination of principal strains using mechanical and electrical strain gauges – Measurement of loads using proving rings – Measurement of deflections by dial gauges and LVDT – Nondestructive testing methods using rebound hammer and ultrasonic pulse velocity method – model studies pertaining to structural engineering and interpretation of results.

9 Hours

Unit V

Reporting and thesis writing

Structure and components of scientific reports – types of report – technical reports and thesis – significance – different steps in the preparation – layout structure and language of typical reports – illustrations and tables – bibliography, referencing and footnotes – oral presentation – planning – preparation – practice – making presentation – use of visual aids – importance of effective communication

9 Hours

Unit VI[$]

Case Studies on Comparing theoretical values with experimental results

Total: 45 Hours

Reference(s)

1. Kothari, C.R., *Research Methodology –Methods and techniques*, New Age Publications, New Delhi, 2009.
2. Panneerselvam, R., *Research Methodology*, Prentice-Hall of India, New Delhi, 2004.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15ST22 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

3 2 0 4

Course Objectives

- To study the effects of earthquake on structures and to estimate earthquake forces
- To impart knowledge on earthquake design of structures and vibration control

Course Outcomes (Cos)

1. Students will be able to analyze and design the structures subjected to earthquake forces.
2. Students able to Understand why earthquakes occur, how they are measured and categorized and the effect they may have on engineering structures.
3. Students able to Predict the Dynamic Behavior of simple structural systems

UNIT I
EARTHQUAKE AND GROUND MOTION

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

9 Hours

UNIT II
EFFECTS OF EARTHQUAKE ON STRUCTURES

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

9 Hours

UNIT III
EARTHQUAKE RESISTANT DESIGN ON MASONRY STRUCTURES

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

9 Hours

UNIT IV
EARTHQUAKE RESISTANT DESIGN ON RC STRUCTURES

Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis – Capacity based Design and detailing – Rigid Frames – Shear wall frame systems- Khan and Saboronis method – Coupled shear wall system – Rosman's method

9 Hours

UNIT V
VIBRATION CONTROL TECHNIQUES

Vibration Control - Tuned Mass Dampers – Principles and application, Basic Concept of Seismic Base Isolation – various Systems- Case Studies, Important structures.

Computer Aided Analysis And Design: Computer Analysis and design of Building systems to Earthquake loads – response spectrum and time history methods – Hands on session using Software packages.

9 Hours

UNIT VI[$]

Rehabilitation of earthquake damaged structures

Total: 45 +30 Hours

Reference(s)

1. Bruce A Bolt, "Earthquakes" W H Freeman and Company, New York, 2004.
2. C. A. Brebbia,"Earthquake Resistant Engineering Structures VIII", WIT Press, 2011

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

3. Mohiuddin Ali Khan "Earthquake-Resistant Structures: Design, Build and Retrofit", Elsevier
Science & Technology, 2012
4. PankajAgarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India, 2009.
5. Paulay,T and Priestley, M.J.N., "Seismic Design of Reinforced Concrete and Masonry buildings", John Wiley and Sons, 1992.
6. S K Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2007.

15ST23 ADVANCED DESIGN OF STEEL STRUCTURES

3 2 0 4

Course Objectives

- To impart knowledge on the design of bolted and welded connections.
- To impart knowledge on the design of industrial structures, transmission towers and light gauge Section.
- To impart knowledge on the plastic analysis and design of hyper static steel structures.

Course Outcomes (COs)

1. On completion of this course, students will be able to design bolted and welded connections.
2. At the end of this course students will be in a position to analyze and design various types of steel structures.
3. They also know the plastic analysis and the design of light gauge steel structures.

UNIT I
STRUCTURAL CONNECTIONS

Design of high strength function grip bolts - Design of bolted connections at the junctions of beams and columns in frames - Design of un-stiffened & stiffened seat connections - Welded connections - eccentric connections - Beam end connections - Direct web fillet welded connections - Direct web Butt welded connection - Double plate web connection - Double angle web connection - Un-stiffened and stiffened seat connection - Moment resistant connection -T stub connections.

9 Hours

UNIT II
INDUSTRIAL BUILDING

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.

9 Hours

UNIT III
ANALYSIS AND DESIGN OF SPECIAL STRUCTURES

Design of steel bunkers and silos - Janssen's theory - Airy's theory - design parameters-design criteria. Design and detailing of self-supporting and guyed steel chimneys. Transmission line towers. Types of towers - tower configuration, Load analysis and design of members.

9 Hours

UNIT IV
LIGHT GAUGE SECTIONS

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.

9 Hours

UNIT V
PLASTIC ANALYSIS AND DESIGN
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.

9 Hours

UNIT VI[$]
Health monitoring and fine protection of steel structures

Total: 45 + 30 Hours

REFERENCE(S)

1. N. Subramanian, Steel Structures Design and Practice, Oxford University Press 2011.
2. S. K. Duggal, Limit State Design of Steel Structures, McGraw Hill, 2014.
3. Ramchandra (Vol I and II), Design of Steel Structures-1, Scientific Publishers, 2009.
4. S. Lynn Beedle, "Plastic Design of Steel frames", John Wiley and Sons, 1990.
5. R. Narayanan et.al., " Teaching Resource on Structural Steel Design", INSDAG, Ministry of Steel Publishing, 2002.
6. IS 800-2007, General Construction in Steel-Code of Practice (Third revision).
7. IS 811 - 1987, Specification for cold formed light gauge structural steel sections.
8. IS 9178 (Part 1)-1989, Design and construction of steel chimney code of practice.
9. IS 9178 (Part 2)-1979, Criteria for design of steel bins for storage of bulk materials.
10. Structural Design of Steelwork to EN 1993 and EN 1994 by L.H. Martin & J.A. Purkiss (Third edition) Publisher Butterworth-Heinemann.
11. Steel Structures Practical design studies by T.J.MacGinley Second edition Publisher E & FN SPON London and New York

15ST24 - FINITE ELEMENT ANALYSIS

3 2 0 4

Course Objectives

- To impart fundamental knowledge on the Finite Element Method and its applications.
- To train the students to carry out dynamic analysis of beams and frames using finite elements

Course Outcomes (COs)

1. On completion of the course studentswill be able to apply finite element techniques for the analysis of trusses, rigid jointed frames, shells, folded plates and Eigen value problems.
2. Perform analysis of 2-D structures using plane stress and plane strain cases.
3. Carry out dynamic analysis of beams and frames using finite elements

UNIT I
INTRODUCTION TO FINITE ELEMENT ANALYSIS
Introduction: Basic concepts of finite element analysis - Steps involved in finite element analysis - one, two and three dimensional elements - Shape functions - Convergence Requirements.
Energy Principles and Method of Weighted Residuals: Variational principles - Rayleigh Ritz method - Method of collocation - Subdomain method - Galerkin's method - Method of least squares.

9 Hours

UNIT II
ANALYSIS OF TRUSSES, BEAMS AND FRAMES
Stiffness matrix for an axial element - Coordinate transformation - Analysis of plane truss -

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Beam stiffness - Analysis of beams –Direct Stiffness method - Analysis of rigid plane frames - Analysis of grids.

9 Hours

UNIT III

Two Dimensional and Three Dimensional Elements

Plane Stress and Plane Strain Problems: Constant Strain Triangle - Element stiffness matrix– Higher Order Triangular elements - Comparison of different methods - Rectangular element - Serendipity family - Lagrangian family - Hermitian family.

Isoparametric Elements and Axisymmetric Elements: Sub - iso - super parametric elements - Shape functions mapping - Linear isoparametric quadrilateral - Simple problems - Axisymmetric stress analysis

Three Dimensional Elements: Tetrahedron element family - Hexahedron element family - ZIB8 and ZIB20 elements - Comparison.

9 Hours

UNIT IV

APPLICATION TO PLATES AND SHELLS

Plate Bending Problems: Basic concepts - Derivation of element stiffness matrix - Four noded, eight noded rectangular and isoparametric element - BFS element - Effect of shear deformation in plates - Introduction to finite strip method - Application to folded plates.

Shell elements: Concepts of shell elements - Degenerated shell elements - Derivation of stiffness matrix for degenerated shell elements.

9 Hours

UNIT V

OTHER APPLICATIONS

Non - Linear Analysis: Types of non - linearities - Solution techniques - Load - deformation response considering geometric, material and both non - linearities.

Additional Applications of FEM: Fluid flow problems - Field problems such as seepage - torsion - Solution to Eigen value problems:Free vibration analysis - Buckling analysis, etc.

9 Hours

UNIT VI[$]

Use of FEM packages for analysis: Stress analysis of deep beam using FEM packages - Analysis of folded plates and shells using FEM package - Analysis of grids using FEM package.

Total: 45+30 Hours

Reference(s)

1. Daryl L Logan, A First Course in the Finite Element Method, Cengage Learning, 2010
2. K. J. Bathe, Finite Element Procedure, Prentice Hall of India, and New Delhi, 2007
3. O. C. Zienkiewinz, The Finite Element method Vol. 1 & 2, TMH, New York, 2002
4. C. S. Krishnamoorthy, Finite Element Method - Theory and Programming, Tata McGraw Hill Publishing Company, New Delhi, 1994.
5. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India Pvt. Ltd., New Delhi, 2002
6. S. Rajasekaran, Finite Element Analysis in Engineering Design, S. Chand Publishing, 1999
7. Singaresu.S.Rao, "The Finite Element Method in Engineering", Butterworth-Heinemann, 2010

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15ST27 ADVANCED STRUCTURAL DESIGN PRACTICE

0 0 4 2

Course Objectives

- To impart knowledge on the analysis and design of complicated structures
- To make the students prepare detailed drawings pertaining to the designs they make with drafting softwares.

Course Outcomes (COs)

1. At the end of the course students will be able to design multi- storey building, shell structures, storage structures, bridges and industrial structures

List Of Experiments

1. Design of water tanks
2. Design of bunkers and silos
3. Multiple Cylindrical Shells
4. Northlight Cylindrical Shell
5. Hyperbolic Paraboloid Shell
6. Trough type Folded Plate
7. R.C.C Gabled Frame
8. T-beam Slab bridge
9. Prestressed concrete bridge deck slab
10. A Twin-box Culvert bridge
11. Industrial building with Gantry girder

Total: 60 Hours

Reference(s)

1. O.P Jain and Jai Krishna, *Plain reinforced Concrete*, Nem Chand and Brothers, 2007.
2. N.KrishnaRaju " Advanced Reinforced Concrete Structures", CBS Publishers , 2013
3. P.C Varghese "Design of Reinforced Concrete Shells and Folded Plates", PHI Learning, 2010.

15GE29 BUSINESS ENGLISH II

1 0 0 1

Course Objectives

- To acquire skills for using English in business environment .
- To communicate appropriately in business contexts.
- To prepare students for taking BEC Vantage level examination conducted by the Cambridge English Language Assessment (CELA).

Course Outcome (COs)

1. To enable students to acquire business terms for communication.
2. To use English confidently in the business contexts.
3. To be able to take part in business discussion and write formal and informal business correspondences.

UNIT I

SPEAKING

Non-verbal communication – agreeing / disagreeing, reaching decisions, giving and supporting opinions – making mini presentations – extending on conservations – collaborative task – tongue twisters.

6 Hours

UNIT II

WRITING

Business letters – fax – Shorter Documents: e-mail - memo – message - note – report writing – formal / informal styles.

9 Hours

Total: 15 Hours

Reference(s)

1. Guy Brook-Hart, "BEC VANTAGE: BUSINESS BENCHMARK Upper-Intermediate – Student's Book", 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE – Self-study Edition", Cambridge University Press, UK, 2005.

15ST51 THEORY OF PLATES AND SHELLS

3 0 0 3

Course Objectives

- To impart Knowledge on the analysis of different types of plates and shells under different boundary conditions.
- To impart knowledge on the methods of design of RC folded plates and shell roof structures.

Course Outcomes (COs)

1. Students will be able to analyse rectangular and circular plates.
2. The students will be able to design RC folded plates and roof.
3. Students will be able to design various types of shells structures.

UNIT I

ANALYSIS OF RECTANGULAR PLATES

Introduction- General Behavior of plates-Assumptions – Small deflection theory of thin plates – Governing differential equation for deflection of plate – Boundary conditions. Bending of Isotropic Rectangular Plates: Navier solution for an all – round simply supported rectangular plate subjected to uniformly distributed load sinusoidal load and point load – Levy's solution for a rectangular plate with different boundary conditions and subjected to uniformly distributed load.

9 Hours

UNIT II

ANALYSIS OF CIRCULAR PLATES

Symmetrical bending of circular Plates – Simply supported solid circular plate subjected to a uniformly distributed load, an end moment and partially distributed load.

9 Hours

UNIT III

ANALYSIS AND DESIGN OF FOLDED PLATES

Structural behaviour of folded plates – Assumptions – Analysis of folded plates – Design of prismatic folded plate roofs as per ACI- ASCE task committee recommendations – Reinforcements details.

9 Hours

UNIT IV

ANALYSIS OF SHELL STRUCTURES

Structural behaviour of thin Shells – Classification of shells – methods of generating the surface of different shells like conoid, hyperbolic and elliptic paraboloid – Membrane Theory of shells – Edge disturbances – Geometry of hypar Shell – Analysis of membrane forces – forces in the edge members.

9 Hours

UNIT V

DESIGN OF SHELL STRUCTURES

Design of cylindrical shells with edge beams using theory for long shells – Design of cylindrical shell with ASCE manual No.31 coefficients – Detailing of reinforcement in shells and edge beams – Design of R.C. hypar shell roof of the inverted and tilted inverted umbrella type – Design and detailing of RC spherical shell and conical shells – Design examples.

9 Hours

UNIT VI[$]

Analysis of plates and shells using software packages.

Total: 45 Hours

Reference(s)

1. N. Krishnaraju, Advanced Reinforced Concrete Design, CBS Publishers and Distributors, New Delhi, 2013.
2. G.S. Ramasamy, Design and Construction of Concrete Shell Roofs, CBS Publishers and Distributors, New Delhi, 2003.
3. B.K. Chatterjee, Theory and Design of Concrete Shells, Chapman and Hall Ltd., London, 1988.
4. Design of Cylindrical Concrete Shell Roofs ASCE – Manuals of Engineering Practice – No.31, ASCE, New York, 1952.
5. S. Timoshenko and S.W. Kreiger, Theory of Plates and Shells, McGraw – Hill Book Company, New York,1990.

15ST52 STRUCTURAL OPTIMIZATION TECHNIQUES

3 0 0 3

Course Objectives

- To impart knowledge on conventional and non-conventional optimization techniques for engineering applications
- To illustrate the application of optimization techniques for the design of structural elements

Course Outcomes (COs)

1. The students will get sound knowledge on traditional and non-traditional optimization techniques and be able to carry out optimal design of structural elements.

UNIT I

BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES

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).

9 Hours

UNIT II

LINEAR PROGRAMMING

Formulation of problems - Graphical solution – Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form – Basic feasible solution - simplex method - Two phase method -Penalty method - Duality theory -Primal - Dual algorithm

9 Hours

UNIT III

NON LINEAR PROGRAMMING

One Dimensional minimization methods: Unidimensional - Unimodal function - Exhaustive and unrestricted search – Dichotomous search - Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques.

9 Hours

UNIT IV

NON-TRADITIONAL TECHNIQUES

Genetic Algorithm And Evolution Strategies: Introduction – Representation of design variables, objective function and constraints – Choice of population – Genetic operators – survival

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

of the fittest – generation – generation history
Ant colony optimization: Probability – finding the shortest path – pheromone trail – travelling salesman problem.

9 Hours

UNIT V
STRUCTURAL APPLICATIONS
Methods for optimal design of structural elements, continuous beams and single storeyed frames using plastic theory - Minimum weight design for trusses- Fully stress design - Optimization principles to design of R.C. structures such as multi-storey buildings, water tanks and bridges**.**

9 Hours

UNIT VI[$]
Application of software packages in structural optimization.

TOTAL: 45 Hours

Reference(s)

1. Smith,A.A., Hinton,E and Lewis, L.W., " Civil Engineering Systems", John Wiley and sons, 1985.
2. Rao,S.S. " Optimization Theory and Applications", Wiley Eastern, 1995.
3. Spunt,L., "Optimum Structural Design ", Prentice Hall, New Jersey, 1971.
4. Iyengar.N.G.R and Gupta.S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997
5. Uri Krish, "Optimum Structural Design", McGraw Hill Book Co. 1981
6. Goldberg,D.E., "Genetic Algorithms in Search, Optimization and Machine Learning", Addison & Wesley ,1999.
7. Dorigo, M and Stutzle, T., "Ant Colony Optimization", Prentice Hall of India, 2005.

15ST53 DESIGN OF STEEL - CONCRETE COMPOSITE STRUCTURES

3 0 0 3

Course Objectives

- To develop an understanding of the behaviour and design procedure of steel – concrete composite elements and structures.
- To give an exposure on case studies related to steel-concrete composite construction.

Course Outcome (COs)

1. On completion of this course, students will be able to gain knowledge on theory of composite structures and steel – concrete – steel sandwich construction.
2. At the end of this course students will be in a position to design composite beams, columns, trusses, composite bridge deck and box-girder bridges including the related connections.
3. They will have knowledge on case studies related to steel-concrete composite constructions.

UNIT I
INTRODUCTION
Introduction to steel - concrete composite construction – Advantages - Theory of composite structures - Introduction to steel - Concrete - Steel sandwich construction.

9 Hours

UNIT II
DESIGN OF COMPOSITE BEAMS AND COLUMNS
Behaviour of composite beams - Design of composite beams including shear connector - Behaviour and design of composite columns and composite slab

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

UNIT III
COMPOSITE TRUSSES
Introduction – Stud shear connectors – Effective Concrete Slab - Design consideration: Preliminary design– Detailed analysis and design – Design of studs – Partial shear – Concrete cracking – Practical considerations – Cost imply
fications – Design problems.

9 Hours

UNIT IV
COMPOSITE BRIDGES
Introduction – design of composite bridge deck – Composite box girder bridges - Behaviour of composite box girder bridges - Design concepts.

9 Hours

UNIT V
GENERAL
Case studies on steel - Concrete composite construction -Seismic behavior of composite structures.

9 Hours

UNIT VI[$]
Introduction to Composite Frames - Design of Non sway composite frames.

Total:45 Hours

Reference(s)
1. N. Krishna Raju, Design of Bridges, Oxford & IBH Publishing Company Pvt. Ltd, New Delhi. Fourth edition 2015.
2. R. P. Johnson, Composite Structures of Steel and Concrete, Blackwell Scientific Publications, UK, 1994.
3. D.J. Oehlers and M.A. Bradford "Composite Steel and Concrete Structural Members, Fundamental behaviour", pergamon press, Oxford,1995.
4. G. W. Owens and P. Knowels, Steel Designers Manual, Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 1992.
5. INSDAG Hand book on Composite Construction – Institute for Steel Development and Growth Publishers, Calcutta.

15ST54 BEHAVIOUR AND ANALYSIS OF TALL STRUCTURES

3 0 0 3

Course Objectives
- To impart knowledge on behaviour of tall multi-bay and multi storeyed structures.
- To learn to analyse and design such structures taking in to account the effects of creep, shrinkage, and P-delta effect.

Course Outcomes (COs)
1. At the end of the course students will be to plan tall buildings considering structural systems, fire rating, local considerations etc
2. Able to analyze and design of tall structural systems including structural connections.
3. Able to analyse tube-in-tube construction and 3-dimensional analysis of shear core building.

UNIT I
INTRODUCTION AND DESIGN CRITERIA
Factors affecting growth, height and structural form. Tall building structure - design process - philosophy, scope and content - raisons D'etre. Design philosophy – loading – sequential loading. Strength and stability – stiffness and drift limitations – human comfort criteria – creep, shrinkage

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

and temperature effects – fire – foundations, settlement and soil – structure interaction.

9 Hours

UNIT II

LOADING

Gravity loading – method of live load reduction – impact gravity loading – construction loads. Wind loading – simple static approach – dynamic methods. Earthquake loading – equivalent lateral force procedure – modal analysis procedure, wind tunnel testing. Combinations of loading – working stress design – limit state design – plastic design.

9 Hours

UNIT III

STRUCTURAL FORM AND MODELLING FOR ANALYSIS

Structural form – braced frame structures –rigid frame structures – in filled frame structures – flat plate and flat slab structures – shear wall structures – wall frame structures – framed tube structures – outrigger braced structures – suspended structures – core structures – space structures – hybrid structures. Floor systems – reinforced concrete one way slabs and beams and slabs on beams or walls – one way pan joists and beams – one way slabs on beams and girders – two way flat plate – two way flat slab – waffle flat slabs – two way slab and beam. Floor systems – steel framing – one way beam system – two way beam system – three way beam system – composite steel – concrete floor systems.

9 Hours

UNIT IV

BRACED FRAME AND RIGID FRAME STRUCTURES

Types and behaviour of bracing – behaviour of braced bents – method of analysis – member force analysis – drift analysis, approximate analysis – use of large scale bracing. Rigid frame behaviour – approximate determination of member forces caused by gravity loading – horizontal loading – approximate drift analysis – flat plate structures – computer analysis of rigid frame – reduction of rigid frame – lumped girder frame – single – bay substitute frame.

9 Hours

UNIT V

SHEAR WALL AND TUBULAR STRUCTURES

Behaviour of shear wall structures-analysis of proportionate wall systems-non proportionate structures and its behaviour-effects of discontinuities at the base-stress analysis of shear walls. Structural behaviour of tubular structures-general three-dimensional structural analysis simplified two dimensional analyses for symmetrical tubular structures.

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

Overall buckling analysis of frames: approximate methods-overall buckling analysis of wall frames- second order effects of gravity loading- simultaneous first order and P-delta analysis-translational torsional instability calculations-effects of foundation rotation.

9 Hours

UNIT VI[$]

Application of software packages in the analysis of tall structures.

TOTAL: 45 Hours

Reference(s)

1. Bryan Stafford Smith and Alexcoull, Tall Building Structures, Analysis and Design, John Wiley and Sons, Inc., 2005.
2. Y. P. Gupta, Proceedings National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International Limited, Publishers, Nov. 1995.
3. S. B. Mehta, High Rise Buildings, M/S Skyline, 1978.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

4. Lynn S. Beedle, Advances in Tall Buildings, CBS Publishers and Distributors, Delhi, 1986.
5. Reinforced Concrete Design of Tall Buildings By B.S.Taranath CRC Press, 2010

15ST55 REPAIR AND REHABILITATION OF STRUCTURES

3 0 0 3

Course Objectives

- To emphasize the importance of maintenance and inspection of structures
- To impart fundamental knowledge on various repairing strategies

Course Outcomes (COs)

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

1. Demonstrate the various types of distress in concrete structures.
2. Identify the effects due to climate, temperature, chemicals, wear and erosion on structures.
3. Analyze the failures in structures due to design and construction errors.
4. Suggest methods and techniques for repairing/ strengthening concrete structures

UNIT I
INTRODUCTION

General Consideration - Distresses monitoring- Causes of distresses –Assessment procedure for evaluating a damaged structure - Quality assurance - Defects due to climate, chemicals, wear and erosion – Inspection - Structural appraisal – Economical appraisal.

9 Hours

UNIT II
BUILDING CRACKS

Causes - diagnosis - remedial measures - Thermal and Shrinkage cracks - unequal loading - Vegetation and trees - Chemical action - Foundation movements - Techniques for repair - Epoxy injection.

9 Hours

UNIT III
MOISTURE PENETRATION

Sources of dampness - Moisture movement from ground - Reasons for ineffective DPC - Roof leakage - Pitched roofs - Madras Terrace roofs - Leakage of Concrete slabs -Dampness in solid walls - condensation - hygroscopic salts- remedial treatments - Ferro cement overlay - Chemical coatings - Flexible and rigid coatings.

9 Hours

UNIT IV
REPAIRS TO STRUCTURES

Methods of repair -repairing, spalling and disintegration - Repairing of concrete floors and pavements. Steel Structures: Types and causes for deterioration - preventive measures - Repair procedure- Brittle fracture - Lamellar tearing - Defects in welded joints - Mechanism of corrosion - Design to protect against corrosion - Design and fabrication errors - Distress during erection. Masonry Structures: Discoloration and weakening of stones - Biocidal treatments - Preservation - Chemical preservatives - Brick masonry structures – Distresses and remedial measures – Definition of Structural Health Monitoring – Motivation for Structural health monitoring.

9 Hours

UNIT V
STRENGTHENING OF STRUCTURES

General principle - relieving loads - Strengthening super structures - plating-Conversion to composite construction - post stressing - Jacketing - bonded overlays- Reinforcement addition - strengthening the substructures – under pinning-Increasing the load capacity of footing- Repair of structures distressed due to earthquake- Design for rehabilitation.

9 Hours

UNIT VI[$]

Failures, repairs and rehabilitation of prestressed concrete members

Total: 45 Hours

Reference(s)

1. Dension, C. Alien and H. Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical, UK, 1991.
2. B. A. Richardson, Remedial Treatment of Buildings, Construction Press, London, 1980.
3. R. T. Alien and S. C. Edwards, Repair of Concrete Structures, Blakie and Sons, UK, 1987.
4. S. M. Johnson, Deterioration, Maintenance and Repair of Structures, McGraw-Hill Book Company, Newyork, 1965.
5. R. K. Guha, Maintenance and Repairs of Buildings, New Central Book Agency (P) Ltd, Calcutta, 1985.
6. R. N. Raikar, Learning from failures - Deficiencies in Design, Construction and Service,- R &D Centre (SDCPL), RaikarBhavan, Bombay, 1987.
7. SP25-84 – Hand Book on Causes and Prevention of Cracks on Buildings, Indian Standards Institution, New Delhi, 1984

15ST56 DESIGN OF PRESTRESSED CONCRETE STRUCTURES

3 0 0 3

Course Objectives

- To impart knowledge on the behaviour and design of Prestressed concrete structures.
- To impart knowledge on the making of various types of Prestressed concrete structures

Course Outcomes (COs)

1. Students will be able to design any Prestressed concrete girder completely.
2. Students will be able to design prestressed concrete composite beams and continuous beams.
3. Students will be able to design storage tanks, pipes and poles.

UNIT I

INTRODUCTION

Basic principles of Prestressing – Classification and types – Advantages over ordinary reinforced concrete – Materials – high strength concrete and high tensile steel - Methods of Prestressing – Freyssinet, Magne lBlaton, Lee M_c Call and Killick anchorage systems – Analysis of sections for stresses by stress concept, strength concept and load balancing concept – Losses of prestress

9 Hours

UNIT II

DESIGN FOR FLEXURE AND SHEAR

Basic assumptions for calculating flexural stresses - Permissible stresses in steel and concrete as per I.S.1343 Code – Design of sections of Type I and Type II post – tensioned and pre -tensioned beams - Check for strength limit state based on I.S.1343 Code – Layout of cables in post-tensioned beams – Location of wires in pre-tensioned beams – Design for shear based on I.S.1343 Code.

9 Hours

UNIT III

DEFLECTION AND DESIGN OF ANCHORAGE ZONE

Factors influencing deflections – Short term deflections of uncracked members – Prediction of long term deflections due to creep and shrinkage – Check for serviceability limit state of deflection. Determination of anchorage anchorage zone stresses in post – tensioned beams by Magnel's method, Guyon's method and I.S.1343 code – Design of anchorage zone reinforcement.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

UNIT IV
COMPOSITE BEAMS
Types of R.C.C. – P.S.C composite beams – Analysis and design of composite beams and Continuous Beams – Methods of achieving Continuity in continuous beams – Analysis for secondary moments –Concordant cable and linear transformation – Calculation of stresses – Principles of design.

9 Hours

UNIT V
MISCELLANEOUS STRUCTURES
Design of tanks, pipes, sleepers, tension and compression members – Use of non-prestressed reinforcement – Definition, methods of achieving, merits and demerits of partial Prestressing.

9 Hours

UNIT VI[$]
Complete design of a prestressed concrete girder – Use of software packages for the design of prestressed concrete structures.

Total: 45 Hours

Reference(s)

1. Krishna Raju, N., "Prestressed Concrete", Tata M_cGraw Hill Publishing Company, New Delhi, 2008.
2. Lin, T.Y. and Ned.H.Burns, "Design of Prestressed Concrete Structures", John Wiley & Sons, New York, 2009.
3. Rajagopalan, N., "Prestressed Concrete", Narosa Publishing House, New Delhi,2008
4. Mallik, S.K. and Gupta, A.P., "Prestressed Concrete", Oxford & IBH Publishing Co., Pvt.Ltd., India, 1992.
5. Arthur H.Nilson,"Design of Prestressed Concrete", John Wiley & Sons Inc, New York, 2004.
6. Dayaratnam, P., "Prestressed Concrete Structures", Oxford and IBH, New Delhi, 1982.
7. Sinha, N.C.and Roy, S.K., "Fundamentals of Prestressed Concrete", S.Chand& Co.,Ltd.,1994

15ST57 DESIGN OF BRIDGES

3 0 0 3

Course Objectives

- To impart knowledge on the design different types of reinforced concrete bridges, steel bridges and pre stressed concrete bridges.
- To impart knowledge on the design of pier, abutments and foundations for the bridges.

Course Outcomes (COs)

1. The students will be able to design different types of reinforced concrete bridges with bearings and substructures.
2. The students will be able to design steel trussed bridges and plate girder bridges.
3. The students will be able to design different types of pre-stressed concrete bridges.

UNIT I
SHORT SPAN R.C BRIDGES
Introduction - Definition and basic forms – Components of a bridge - Classification of bridges – IRC Loading Standards and specifications - Design of Reinforced Concrete Slab Bridge decks – Design of Tee Beam and Slab Bridge Deck – Dynamic response of bridge deck and codal provisions.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

UNIT II
LONG SPAN R.C BRIDGES
Design principles of Balanced Cantilever Bridges, Continuous girder Bridges, Rigid Frame Bridges, Arch bridges and Box culverts.

9 Hours

UNIT III
STEEL BRIDGES
General- Railway loadings- Dynamic effect-Railway culvert with steel beams-Design of Plate Girder Bridges and Steel Trussed bridges – Design principles of cable stayed and suspension bridges.

9 Hours

UNIT IV
PRESTRESSED CONCRETE BRIDGES
Introduction – Design of Post – tensioned prestressed Concrete Slab Bridge deck – Design of Post – tensioned prestressed Concrete Tee beam and Slab Bridge deck.

9 Hours

UNIT V
BEARINGS AND SUBSTRUCTURES
Bearings – Types of bearings – Design of bearings - Design of Piers and abutments - Foundations: Types of bridge foundations - Design of Pile Foundation and Well foundation - Caisson Foundation.

9 Hours

UNIT VI[$]
Application of software packages for the design of bridges.

Total: 45 Hours

Reference(s)

1. N. Krishna Raju, Design of Bridges, Oxford & IBH Publishing Company Pvt. Ltd, New Delhi. Fourth edition 2015.
2. T.R. Jagadeesh and M.A. Jayaram., “Design of Bridge Structures”, Prentice Hall of India Pvt.Ltd. Second edition 2014.
3. S.Ponnuswamy, Bridge Engineering, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second edition 2008.
4. D. Johnson Victor, Essentials of Bridge Engineering, Oxford and IBH Publishing Co., New Delhi, Sixth edition, 2014.
5. Raina V.K. "Concrete Bridge Practice", Tata McGraw Hill Publishing Company, New Delhi, 2007.
6. IRC: 6, 18, 21, 22, 24, 78 & 83.
7. SP: 16 (S & T) - 1980, Design Aids to I.S.456-1978.
8. I.S. 1343 – 1980, Indian Standard Code of Practice for prestressed concrete

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15ST58 DESIGN OF INDUSTRIAL STRUCTURES

3 0 0 3

Course Objectives:

- To enable the students to plan engineering, chemical and textile industries
- To familiarize them the design of folded plate and shell structures and other industrial structures.

Course Outcomes (COs):

1. The students will get in depth knowledge on types and layout of industrial structures.
2. They will be able to design steel industrial structures
3. They will be able to design RCC industrial structures and roofs

UNIT I
GENERAL
Classification of Industries and Industrial Structures – Specific requirements for Industries like Engineering, Textiles, Chemicals, etc. – Site layout and external facilities required.

9 Hours

UNIT II
FUNCTIONAL REQUIREMENTS
Nature and artificial lighting protection from the sun light – Services Electrical wiring fixtures – cable and pipe bridge – Electrical installation – substations – Effluent disposal – Heating and Ventilation – Air conditioning – Fire expanse and chutes – fire alarm, extinguishers and hydrants – Guidelines from factories act.

9 Hours

UNIT III
INDUSTRIAL STRUCTURES
Design and detailing of R.C. gable frames, corbels and nibs, bunkers, silos and Gantry girders – North light shell roofs and folded plates – Application of prefabrication techniques.

9 Hours

UNIT IV
POWER TRANSMISSION STRUCTURES
Cables –Transmission line towers – Substation Structures – Tower Foundation – Testing of tower.

9 Hours

UNIT V
POWER PLANT STRUCTURES
Types of power plants – Design of Turbo generator foundation – containment structures – Machine foundations – R.C.C chimney.

9 Hours

UNIT VI[$]
Application of software packages for the design of industrial structures.

Total: 45 Hours

Reference(s)

1. P. Dayaratnam, Design of Steel Structures, A.H. Wheeler & Co., Ltd., Allahabad, 2008.
2. S.N. Manokar, Tall Chimneys – Design and Construction, Tata McGraw Hill, 1986.
3. A.R. Santhakumar and S.S. Murthy, Transmission Line Structures, Tata McGraw Hill, 1992.
4. IS: 9178 Criteria for design of Steel bins for Storage of Bulk materials Part I – General Requirements and Assessment of Loads and Part II – Design Criteria.
5. IS: 3483 Code of Practice for Noise Reduction in Industrial Buildings.
6. IS: 6060 Code of Practice for Day lighting of Factory buildings.
7. IS: 4998 criteria for Design of Reinforced Concrete chimneys.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

8. SP: 32 Hand book on Functional Requirements of Industrial buildings (Lighting and Ventilation)
9. IS: 2974 Design and Construction of Machine Foundations.
10. IS: 4091 – Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles.

15ST59 PREFABRICATED STRUCTURES

3 0 0 3

Course Objectives:

- To impart Knowledge on pre-fabricated elements and the technologies used in fabrication and erection.
- To give an exposure on the applications of Pre – Engineered Buildings in construction.

Course Outcomes (COs):

1. Students will get in depth knowledge on types of prefabricated elements and their method of manufacture
2. They will be familiar with the hoisting technology of prefabricated structural components
3. They will be able to design pre-engineered steel building and guide their erection

UNIT I
GENERAL PRINCIPLES OF FABRICATION

Comparison with monolithic construction – Types of prefabrication – site and plant fabrication – Economy of prefabrication – Modular coordination – Standardization – Planning for Components of prefabricated structures – Disuniting of structures – Design of simple rectangular beams and I beams – Handling and erection stresses – Elimination of erection stresses – Beams, columns – Symmetrical frames.

10 Hours

UNIT II
PREFABRICATED ELEMENTS

Roof and floor panels, ribbed floor panels – wall panels – footings – Joints for different structural Connections – Effective sealing of joints for water proofing – Provisions for non – structural fastenings – Expansion joints in pre –cast construction. Designing and detailing of precast unit for factory structures – Purlins, Principal rafters, roof trusses, lattice girders, gable frames – Single span single storeyed frames – Single storeyed buildings – slabs, beams and columns.

11 Hours

UNIT III
PRODUCTION AND HOISTING TECHNOLOGY

Choice of production setup – Manufacturing methods – Stationary and mobile production – Planning of production setup – Storage of precast elements – Dimensional tolerances – Acceleration of concrete hardening. Equipment for hoisting and erection – Techniques for erection of different type of members like Beams, Slabs, Wall panels and Columns – Vacuum lifting pads.

9 Hours

UNIT IV
APPLICATIONS

Designing and detailing of precast unit for factory structures – Purlins, Principal rafters, roof trusses, lattice girders, gable frames – Single span single storeyed frames – Single storeyed buildings: slabs, beams and columns, Application of prestressed concrete in prefabrication.

9 Hours

UNIT V
PRE – ENGINEERED BUILDINGS

Introduction – Advantages – Pre Engineered Buildings Vs Conventional Steel Buildings – Design of Pre Engineered Buildings (PEB) - Applications

6 Hours

UNIT VI[$]

Complete design of a two storeyed residential building using pre-cast concrete components.

Total: 45 Hours

Reference(s)

1. L. Mokk, Prefabricated Concrete for Industrial and Public Structures, Publishing House of the Hungarian Academy of Sciences, Budapest, 2007.
2. T. Koncz, Manual of Precast Concrete Construction, Vol.I, II, III & IV, Berlin, 1971.
3. B. Lewicki, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam, London, New York, 1998.
4. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precast Concrete, Netherland BetorVerlag, 2009.
5. Hass, A.M. Precast concrete design and Applications, Applied Science Publishers, 1983.
6. Promyslow.V. Design and Erection of Reinforced Concrete Structures, MIR Publishers, Moscow 1980.

15ST60 ADVANCED STRUCTURAL ANALYSIS

3 0 0 3

Course Objectives

- To train the students to analyse structures for stresses and stress resultant using advanced methods
- To educate the students to analyse by flexibility and stiffness method for pin jointed trusses, continuous beams, grids and rigid jointed frames.

Course Outcomes (COs)

1. The students will be able to understand the fundamental concepts and modern methods of analysis related to pin jointed trusses, continuous beams, grids and rigid jointed frames.

UNIT I

REVIEW OF FUNDAMENTAL CONCEPTS

Determination of static and Kinematic Indeterminacies of two Dimensional portal frames, pin jointed trusses and hybrid frames Coordinates system – Degree of freedom –Determination of forces and displacements - Principles of superposition – Flexibility and Stiffness matrices – Force displacement relationships for axial force , force couple and torsional moments - Stiffness and flexibility matrices in Single, Two and n coordinates.

9 Hours

UNIT II

ENERGY CONCEPTS IN STRUCTURES AND TRANSFORMATION OF INFORMATION

Strain energy - Strain energy in terms of stiffness and flexibility matrices – Betti's Law and it's application -Transformation of System force to element forces – Transformation of Element Flexibility to System Flexibility – Transformation of System Displacement to Element Displacement – Transformation of Element Stiffness matrix to system stiffness matrix -Normal coordinates and orthogonal coordinates.

9 Hours

UNIT III

FLEXIBILITY METHOD

Flexibility method applied to Statically Determinate and Statically Indeterminate Structures:– Choice of redundant - ill and well-conditioned matrices – Automatic choice of redundant – Internal forces due to thermal expansion and lack of fit – Analysis of Two Dimensional and Three

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Dimensional Pin jointed trusses - Analysis of Two Dimensional portal and gable Frames, continuous beams, grids.

9 Hours

UNIT IV

STIFFNESS METHOD

Development of the stiffness method – Analogy between flexibility and stiffness methods – internal force due to thermal expansion - lack of fit – Application to pin jointed plane and space trusses, continuous beams, plane frames and grids.

9 Hours

UNIT V

SPECIAL TOPICS - MATRIX DISPLACEMENT METHODS:

Static condensation Technique – Substructure Technique -Transfer Matrix method – Symmetry & Anti symmetry of structures – Reanalysis Technique.

Direct Stiffness Method: Discrete system – Direct stiffness approach – Application to two and three dimensional pin-jointed trusses - plane frames – Grids – Three dimensional space frames- Introduction to software packages.

9 Hours

UNIT VI[$]

Application of software packages for the analysis of plane and space frames, space trusses and grids.

Total: 45 Hours

Reference(s)

1. F. M. Rubinstein, Matrix Computer Methods of Structural Analysis, Prentice Hall, 1986.
2. Dr.Devadasmenon " Advanced Structural Analysis", Narosa Publishing House, New Delhi, 2009
3. S. Rajasekaran, Computational methods of Structural mechanics, Prentice Hall, 2006.
4. McGuire and R. H. Gallagher, Matrix Structural Analysis, John Wiley, 1999
5. J. R. William Weaver and James M. Gere, Matrix Analysis of Framed Structures, CBS Publishers & Distributors, 2004
6. M. L. Gambhir Fundamentals of Structural Mechanics and Analysis, PHI Learning, New delhi,2011
7. C. K. Wang, Intermediate Structural Analysis, McGraw Hill International Editions, 1984

15ST61 OFFSHORE STRUCTURES

3 0 0 3

Course Objectives

- To impart Knowledge on forces due to ocean waves and their effects on coastal structures.
- To impart knowledge on the design of coastal structures

Course Outcomes (COs)

1. Students will gain knowledge on wave theories
2. Students will be able to analyse offshore structures
3. Students will be able to design offshore structures

UNIT I

WAVE THEORIES

Wave generation process, small and finite amplitude wave theories -Behavior of steel at elevated temperature; Fire Rating for Hydrocarbon fire; Design of structures for high temperature; Blast

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Mitigation-Blast walls; Collision of Boats and energy absorption; Platform survival capacity and Plastic design methods.

9 Hours

UNIT II

FORCES ON OFFSHORE STRUCTURES

Wind forces, wave forces on vertical, inclined cylinders, structures – Current forces and use of Morison equation.Wind Loads; Wave and Current Loads; Calculation based on Maximum base Shear and Overturning Moments; Design Wave heights and Spectral Definition; Hydrodynamic Coefficients and Marine growth; Fatigue Load Definition and Joint Probability distribution; Seismic Loads.

9 Hours

UNIT III

OFFSHORE AND SOIL STRUCTURE MODELING

Different types of offshore structures, foundation modelling, structural modelling.Route selection and Diameter / wall thickness calculations; Pipeline stability, free span calculations; Concrete coated pipelines and pipe-in-pipe insulated pipelines; Design using DNV 81 code.

9 Hours

UNIT IV

ANALYSIS OF OFFSHORE STRUCTURES

Static method of analysis, foundation analysis and dynamics of offshore modelling.Jacket concepts, redundant framing arrangement; Launch and Lift jackets; Simple Deck configurations for Lift and float-over installations; In-service and Pre-service Loads and analysis.

9 Hours

UNIT V

DESIGN OF OFFSHORE STRUCTURES

Design of platforms, helipads, Jacket tower and mooring cables and pipe lines-Principles of WSD and LRFD; Allowable stresses and Partial Safety Factors; Tubular Members, Slenderness effects; Column Buckling, Design for Hydrostatic pressure; Design for combined axial and bending stresses (API RP 2A guidelines).

9 Hours

UNIT VI[$]

Layout plan of a harbour and design of various components.

Total: 45 Hours

Reference(s)

1. D. V. Reddy and M. Arockiasamy, Offshore Structures, Vol. 1 and Vol.1, Krieger Publishing Company, Malabar, Florida, 1991.
2. S.K. Chakrabarti, Hydrodynamics of Offshore Structures, Computational Mechanics Publication, 1987.
3. APl Recommended Practice for Planning, Designing and constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.
4. R.L., Wiegel, Oceanographical Engineering, Prentice Hall Inc, Englewood Cliffs, N.J.2008.
5. B.C.A. Walker., Dynamic Analysis of Offshore Structures, New-nesButter worths, U.K.1979.
6. Thomas H.Dawson, Offshore Structural Engineering, Prentice Hall Inc Englewood Cliffs, N.J. 1983.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15ST62 ADVANCED CONCRETE TECHNOLOGY

3 0 0 3

Course Objectives

- To provide a good understanding of a range of topics within the field of concrete technology including constituent materials and mixture proportioning, properties of concrete in the fresh and hardened state, microstructure, volume changes and durability.
- The emphasis throughout the course is on understanding the key physical and chemical processes influencing the behaviour and performance of concrete in service.

Course Outcomes (COs)

1. Understand how the constituents and mix proportions of concrete influence its early age properties, Mechanical properties, volume changes and durability, via an appreciation of their influence on concrete micro structure.
2. Gain the ability to design and proportion concrete mixtures to a specified performance.
3. Become familiar with common problems affecting concrete in construction and their prevention.

UNIT I
CEMENT, AGGREGATES &ADMIXTURES

Cement-Composition and properties of Portland cement-tests on physical properties-hydration of cement-consistency-setting time-soundness-strength-cements of different types-composition-properties and uses with special emphasis for different constructional and weather condition-IS code Specifications for cement-Aggregates-classification-mechanical properties-deleterious substances in aggregates-bulking of sand-Alkali aggregate reaction-grading requirements-IS code specifications. Admixtures- Accelerators-Retarders- Water reducing agents-Plasticizers-Air entraining Agents – water proofing agents.

9 Hours

UNIT II
FRESH CONCRETE

Rheology of mortar and concrete – workability-Factors affecting workability-Tests for workability-segregation-Bleeding-Mixing of concrete-Compaction of concrete-Methods of compaction-Hardening of concrete-Factors affecting strength of concrete-Types of curing-Maturity of concrete-Shrinkage-creep of concrete- Factors affecting creep and shrinkage of concrete-Micro structure of concrete-micro cracking.

9 Hours

UNIT III
DURABILITY OF CONCRETE

Permeability-chemical attack-sulphate attack-Quality of water-marine atmosphere-Methods to improve durability-Thermal properties of concrete-Fire resistance-Reinforcement corrosion-Testing of hardened concrete-Compression test-Split tension test-Flexural test-Test for bond strength-Is code provisions-Factors affecting strength-Accelerated strength tests-Stress strain characteristics-Determination of modulus of elasticity-Electro dynamic method, Pulse Velocity method –In situ strength determination.

9 Hours

UNIT IV
CONCRETE MIX DESIGN

Basic consideration – Factors in the choice of mix proportions-Mix design methods-A.C.I method-I.S method- British method –Correction for moisture content- Bulk- Yield of concrete-Mix Design for light weight concrete- Design of High strength concrete and Self compacting concrete-EFNARC Specifications and Design of SCC mixes- Design of concrete mix using mineral admixtures- Design mix for pump ability and effect of super plasticizers in water reduction.

9Hours

UNIT V
SPECIAL CONCRETES
Method of Manufacture, properties and applications – Lightweight concrete-Aerated concrete- No fines concrete –Heavy weight concrete- Fibre reinforced concrete –Polymer concrete –High volume fly ash concrete-High performance concrete- Self compacting concrete- Concrete using waste material – Roller compacted concrete- Ready mixed concrete – Pumping of concrete.

9 Hours

UNIT VI[$]
Method of manufacture, Properties and use of Ultra High Strength Concrete.

Total: 45 Hours

Reference(s)
1. M.S. Shetty, Concrete Technology, S. Chand & Co., 2005
2. Raft Siddique, Spacial Structural Concrete, Galgotia Publication, 2000
3. Krishna Raju, Design of Concrete Mixes, C.B.S. Publication, 2002
4. M.L. Gambhir, concrete Technology, Dhanpatrai& Sons, 1992
5. A.M Neville, J.J.Brooks, Concrete Technology, Pearson Education, 2010
6. A.R. Shantha Kumar, Concrete Technology, Oxford University Press, 2007
7. P. Kumar Mehta, Paulo J.M. Monteiro Concrete: Microstructure, Properties and Materials, 3rd edition, MC Graw –Hill -2006

15ST63 EXPERIMENTAL STRESS ANALYSIS AND TECHNIQUES

3 0 0 3

Course Objectives
- To familiarize the students about the measurement of strain and effects of vibrations and wind blow.
- To make the students analyse the structure by non-destructive testing method and model analysis.

Course Outcomes (COs)
1. To measure strains in structural elements
2. To know the spot of stress concentration by photo elastic methods
3. They will be able to predict the behaviour of proto type structure by conducting model tests and analysis

UNIT I
STRAIN MEASUREMENT
Methods of Measurement -Calibration-Load calibration of testing machines-I.S. Code provisions - Measurement system- Mechanical, Optical and Acoustical extensometers -Strain measurement- Electrical resistance strain gauges- Principle, Types, Performance, Uses- Strain Rosettes- Wheatstone Bridge-Electronic load cells-Proving rings.

9 Hours

UNIT II
MEASUREMENT OF DISPLACEMENT VIBRATION &WIND FLOW
Measurement of vibration- Vibration galvanometers- Vibrometer-Characteristics of Structural vibration-Pressure gauges-Velocity transducers- Seismic transducers – Linear Variable Differential Transformer-Cathode ray oscilloscope – X Y Plotter- Wind Tunnels-Flow meters- Venturimeter- Digital Data Acquisition systems.

9 Hours

UNIT III
DISTRESS MEASUREMENT &CONTROL
Diagnosis of distress in structures-Cracks in structures-Formation of cracks- Types of cracks- Causes of cracks- Crack measurement- Monitoring and measurement of crack movement-

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Corrosion of reinforcement in RCC- Half-cell-Construction and use-Damage assessment-Controlled blasting for demolition-Photo elasticity-Two dimensional photo elasticity, Sources of light – photo elastic effects - stress optic law-Interpretation of fringe pattern- Compensation and separation techniques- Photo elastic materials. Introduction to three dimensional photo elasticity.

9 Hours

UNIT IV

NON-DESTRUCTIVE TESTING METHODS

Load testing on structures-In situ load testing-Ultimate load testing-Rebound hammer-Principle and Applications-Limitations-Ultrasonic testing- Principles and Applications- Brittle coating-Principle and Applications-Stress coat- All Temp- Comparison of brittle coatings- Evaluation of the coating - Introduction to Moiré techniques- Holography- ultrasonic C- Scan- Thermograph-Fiber – optic Sensors.

10 Hours

UNIT V

MODEL ANALYSIS

Model laws- Laws of similitude-Model materials- Model testing- Necessity for Model analysis-Advantages-Applications- Types of similitude- Scale effect in Models- Indirect model study-Direct model study-Limitations of model investigations- Structural problems that may demand model studies- Usage of influence lines in model studies.

8 Hours

UNIT VI[$]

Creation of models of strain gauges used in Wheatstone bridge-measurement of distress in structures-Ground penetrating radar.

Total: 45 Hours

Reference(s)

1. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 2006.
2. J. W. Dally and W. F. Riley, Experimental Stress Analysis, McGraw-Hill, Inc. New York, 1978
3. L. S. Srinath, Experimental Stress Analysis, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1984
4. C. S. Rangan, Instrumentation – Devices and Systems, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1983.

15ST64 SOFT COMPUTING IN STRUCTURAL ENGINEERING

3 0 0 3

Course Objectives

- To familiarize the students with non-traditional optimization techniques and computer applications
- To illustrate their applications to engineering problems

Course Outcomes (COs)

1. At the end of the course students will be able to apply the principle of Artificial intelligence, Genetic algorithm and Hybrid systems for the optimal design of structural elements

UNIT I

INTRODUCTION TO ARTIFICIAL INTELLIGENT SYSTEMS

Neural Networks – Fuzzy logic - genetic algorithm.

Neural Networks: Basic Concepts - Artificial Neural Network (ANN) Architecture - Learning Methods -Back Propagation Network (BPN)- Single layer ANN - Multilayer Perception -

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Learning Method of Effect of tuning parameters - New technologies - application to Structural Engineering.

10 Hours

UNIT II

ASSOCIATIVE MEMORY AND ADAPTIVE RESONANCE THEORY

Kosko's Discrete (Bi-directional Associative Memory) BAM - input normalization - Evolution Equation - vector quantization - simplified ART architecture - Architecture of ART1 and ART2 - Application to structural engineering problems.

10 Hours

UNIT III

FUZZY LOGIC

Fuzzy sets and relations - Predicate logic - Fuzzy quantifiers - Fuzzy Rule based systems - Defuzzification method - Application to controllers- Application to Structural Engineering problems.

10 Hours

UNIT IV

GENETIC ALGORITHMS

Basic concepts - incoding - Equation functions - genetic operators - reproduction - selection - cross over - mutation - convergence of GA - optimal design using GA - Application to structural engineering problems.

8 Hours

UNIT V

HYBRID SYSTEMS

Neuro - Fuzzy Hybrids - Fuzzy genetic hybrids - Neuro genetic hybrid - Fuzzy BPN - Fuzzy Art Map - Fuzzy controlled GA. **Support Vector Machines:** Support vector regression – Classifications.

7 Hours

UNIT VI[$]

Mathematical formation and designing of algorithm using various non-traditional optimization techniques and comparing it with classical optimization techniques.

Total: 45 Hours

Reference(s)

1. Rajasekaran S and VijayalakshmiPai G A, "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India, New Delhi, 2004.
2. Adeli H, and Hung S L, "Machine Learning, Neural Networks, Genetic Algorithms and Fuzzy Systems, John Wiley and Sons, New York, 1995.
3. Goldberg D E, "Genetic Algorithms in Search Optimization and Machine Learning", Addison Wesley, Rading Mass, USA, 1989.
4. Zadeh, Loffi A, "Fuzzy Sets", Information Control, Vol.8, pp.338-353, 1965.
5. Tsoukalas H L and Uhrig E R, "Fuzzy in Neural Approaches in Engineering", John Wiley and Sons, USA, 1997.
6. Gunn S R, “Support Vector Machines for Classification and Regression”, Technical report ISIS-I-98 - University of Southampton, 1998.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15ST65 FRACTURE MECHANICS

3 0 0 3

Course Objectives

- To give an outline of the total field of fracture mechanics
- To familiarize students with problems that can be solved with fracture mechanics concepts.

Course Outcomes (COs)

1. Students will gain knowledge on the Mechanics of Fractures.
2. They will be able apply it to solve engineering problems.
3. They will be able to do research on fracture mechanics.

UNIT I
INTRODUCTION

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.

9 Hours

UNIT II
LINEAR ELASTIC FRACTURE MECHANICS

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.

9 Hours

UNIT III
ELASTIC – PLASTIC FRACTURE MECHANICS

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.

9 Hours

UNIT IV
DYNAMIC AND TIME – DEPENDENT FRACTURE

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

9 Hours

UNIT V
APPLICATION TO STRUCTURES

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.

9 Hours

UNIT VI[$]

Fracture mechanics in R.C. Structures.

Total: 45 Hours

Reference(s)

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

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15ST66 SMART STUCTURES AND APPLICATIONS

3 0 0 3

Course Objectives

- To impart knowledge on smart materials and their properties
- To familiar the application of smart materials in structures

Course Outcomes (COs)

1. Students will be able to select appropriate smart materials and design smart structures.
2. understand the engineering principles in smart sensor, actuator and transducer technologies
3. appreciate and suggest improvement on the design, analysis, manufacturing and application issues involved in integrating smart materials

UNIT I
INTRODUCTION

Definition of smart structures – smart buildings and bridges. Piezoelectric Materials and Induced – Strain Actuation: Piezoelectric properties – Actuation of Structural components by Piezoelectric Crystals, Actuator – Structure Interaction –Axial Motion of Rods – Bending of Beams – Harmonic Excitation. Shape Memory Alloys: Experimental phenomenology – Influence of stress on the characteristic Temperatures – Constitutive modelling of the shape Memory Effect – Vibration Control through shape Memory Alloys – Multiplexing embedded NiTiNOL Actuators; Analysis and Design of control scheme and Test Specimens – Electrical Control System – Preliminary tests on steel beam with External Actuation – Composite beam with embedded fibre actuation – Composite beam with embedded NiTiNOL fibres – Application of shape Memory Alloys.

10 Hours

UNIT II
ELECTRORHEOLOGICAL AND MAGNETORHELOGICAL FLUIDS

Introduction – Mechanisms and Properties: Fluid composition and behaviour, Bingham Plastic and related models, Pre-yield response, post-yield flow and device geometry, other effects, Applications of ER and MR Fluids: Clutches, dampers, other applications.

8 Hours

UNIT III
VIBRATION ABSORBERS AND MISTUNING

Parallel damped vibration absorber: analysis – optimum case. Gyroscopic vibration Absorbers: analysis of Perissogyro vibration absorber – Experimental setup and observations – Active vibration absorbers. Mistuning: Vibration characteristics of mistuned systems – Nearly periodic simply supported beams – Circularly symmetric structures – Analytical approach.

9 Hours

UNIT IV
FIBRE OPTICS

Introduction – Total internal reflection – Fibre characteristics Fibre-Optic Strain Sensors: Strain measurement – Microbent and graded –index fibres – Extrinsic Fabry – Perot Sensors – Mach – zehnder- Interferometers – Bragg Grating Sensor – White light interferometry – Twisted and Braided Fibre Optic sensors – Optical fibres as load bearing elements – Additional applications: Crack detection –Integration of Fibre – Optic sensors and shape memory elements.

9 Hours

UNIT V
CONTROL OF STRUCTURES

Structures as controlled plants: Modelling Structures for control – Control strategies and limitations. Active structures in practice: Systems using SMA actuators – Systems using PZT sensors and actuators.

9 Hours

UNIT VI[$]

Conversion of an existing Conventional Residential building into a smart building

Total: 45 Hours

Reference(s)

1. Srinivasan, A.V. and Michael McFarland, D., "Smart Structures: Analysis and Design", Cambridge University Press, 2011.
2. Yoseph Bar Cohen, smart Structures and Materials 2003, The International Society for Optical Engineering 2003.
3. Brain Culshaw, Smart Structures and Materials Artech House, Boston, 1996.
4. Gandhi M.V. and Thompson, B.S., Smart Materials and Structures, Chapman and Hall 1992.

15ST67 HYDRAULIC STRUCTURES

3 0 0 3

Course Objectives

- To impart knowledge on the design of hydraulic structures
- Guide the students to control the use of water

Course Outcomes (COs)

1. To understand, and control for the benefit of society, the occurrence, movement and use of water
2. To design various types of dams, wells and R.C. storage structures
3. To modify the behaviour of water calls inevitably for a large investment of time, resources and effort

UNIT I

DESIGN OF GRAVITY DAMS

Classification of dams – choice of type of Dam –Selection of Dam Site – Site and subsurface investigations - Gravity dams: Forces acting on Gravity Dams – Reaction of Foundations – Shear stresses and Principal stresses – Stability Criteria of Gravity Dams – Elementary and Practical Profiles of Gravity Dam –Analysis of Gravity Dam.

9 Hours

UNIT II

ARCH AND BUTTRESS DAMS

Arch Dams: Classification – Principles of Design – Arch Dam Design methods: Cylindrical methods – Trial load method – Elastic analysis theory – Elastic shell theory – Finite element method. Buttress Dams: Types – Forces and stresses in Buttress Dams - Principles of Design.

9 Hours

UNIT III

EARTH DAMS

Components of Earth Dams and their functions – Classification of Earth Dams – Flow Net Analysis – Phreatic Line and its determination – Pore pressure – Slope Stability Analysis – Failure of Earth Dams: Hydraulic failures, Seepage failures, Structural failures and failure due to earthquakes – Design considerations in Earth Dams – Drainage system in Earth Dam – Construction of Earth Dam – Rock-fill Dams.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

UNIT IV

WELLS FOR IRRIGATION AND WATER SUPPLY

Types and Design of open wells in unconsolidated formations – Location and construction of open wells in alluvial formations – Types and Design of open wells in hard rock formations – Location and Design of wells with sanitary protection.

Tube Wells and their Designs:

Types of tube wells and their selection – Designs of well screen and gravel pack – Design of skimming wells – Construction of bored and driven tube wells – Rehabilitation of sick and failed tube wells.

9 Hours

UNIT V

DESIGN OF MISCELLANEOUS HYDRAULIC STRUCTURES

River intake well – Structural Design related to a water supply system – Structural Design connected with sewage treatment plants – Design of radial shutters for water regulation.

9 Hours

UNIT VI[$]

Design of all types of underground, on ground and overhead R.C. water tanks.

Total: 45 Hours

Reference(s)

1. Duggal, K.N. and Soni, J.P., 'Elements of Water Resources Engineering', New Age International (P) Ltd Publishers, 2011.
2. Mechael, A.M., and Khepar, S.D, 'Water Well and Pump Engineering', Tata McGraw Hill Publishing Company Limited, New Delhi, 2009.
3. Santhosh Kumar Garg, 'Irrigation Engineering and Hydraulic Structures', Khanna Publishers, 2014.

15ST68 SOIL–STRUCTURE INTERACTION

3 0 0 3

Course Objectives

- Identify situations where soil-structure interaction is likely to occur and assess its impact on the behaviour of a structure
- Assess the effects of differential settlement on the behaviour of a structure
- Determine the effect of structural stiffness and rigidity on the loads carried by foundations and earth pressures acting on retaining structures

Course Outcomes (COs)

1. The students will be able to understand the significance of soil-structure interaction in the case of different types of structures, including embedded and buried structures and how to take soil structure interaction into account in design.

UNIT-I

SOIL-FOUNDATION INTERACTION

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.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

UNIT II

BEAM ON ELASTIC FOUNDATION

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

9 Hours

UNIT III

PLATE ON ELASTIC MEDIUM

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.

9 Hours

UNIT IV

ELASTIC ANALYSIS OF PILES

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

9 Hours

UNIT V

LATERALLY LOADED PILES

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

9 Hours

UNIT VI[$]

Design of foundation using spring concept.

Total: 45 Hours

Reference(s)

1. Hemsley, J.A, Elastic Analysis of Raft Foundations, Thomas Telford, 2013.
2. McCarthy, D.F. Essentials of Soil Mechanics and Foundations, basic geotechnics (6th Edition), Prentice Hall, 2006.
3. Selvadurai, A.P.S., Elastic Analysis of Soil Foundation Interaction, Elsevier, 1979.
4. Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley, 1980. 5. Scott, R.F. Foundation Analysis, Prentice Hall, 1981.
5. Structure Soil Interaction - State of Art Report, Institution of structural Engineers, 1978.
6. ACI 336, Suggested Analysis and Design Procedures for Combined Footings and Mats, American Concrete Institute, Dehit, 1988.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

ONE CREDIT COURSES

15STXA DESIGN OF MULTI STOREYED STEEL BUILDING USING SOFTWARE

1 0 0 1

Course Objectives

- To introduce the fundamentals of software for analysing and designing the multi storey steel building
- To study the steel building accessories

Course Outcomes (COs)-

The students are expected to demonstrate the ability to:

1. Determine the load calculation and application details
2. Analyze and design the multi storey steel building by software packages as per Indian Standard
3. Evaluate the failures of steel structures under various scenarios

Connection

Bolted – Welded – Splice - Column base

Beams

Laterally restrained/Unrestrained beams - Plate girder - Gantry girder- Monorails

Roof

Truss deign (Tension & Compression member)-Rafter Design - Purlin design - Sag rod design

Column

Compression -Tension-Uniaxial-Biaxial bending

Loads

Wind – Seismic - Snow action on structures

Total: 20 hours