	K.S.R. COLLEGE OF ENGINEERING (Autonomous) (Approved by AICTE& Affiliated to Anna University) K.S.R. Kalvi Nagar, Tiruchengode – 637 215	CURRICULUM PG R - 2018

Department	Civil Engineering
Programme	M.E – Structural Engineering

SEMESTER – I

SI.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	ST18111	Matrix Methods of Structural Analysis	3	0	0	3	30	70	100
2.	MA18132	Applied Mathematics for Structural Engineering	3	0	0	3	30	70	100
3.	ST18113	Advanced Concrete Structures	3	0	0	3	30	70	100
4.	ST18114	Structural Dynamics	3	0	0	3	30	70	100
5.		Professional Elective - I	3	0	0	3	30	70	100
6.		Professional Elective - II	3	0	0	3	30	70	100
PRACTICAL									
7.	ST18121	Advanced Structural Engineering Laboratory	0	0	3	2	50	50	100
8.	ST18122	Technical Presentation - I	0	2	0	1	50	50	100
		Total	18	02	03	21		800	

SEMESTER - II

SI.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	ST18211	Theory of Elasticity and Plasticity	3	0	0	3	30	70	100
2.	ST18212	Advanced Steel Structures	3	0	0	3	30	70	100
3.	ST18213	Finite Element Method	3	0	0	3	30	70	100
4.	ST18214	Design of Sub Structures	3	0	0	3	30	70	100
5.		Professional Elective - III	3	0	0	3	30	70	100
6.		Professional Elective - IV	3	0	0	3	30	70	100
PRACTICAL									
7.	ST18221	Advanced Computing Laboratory	0	0	3	2	50	50	100
8.	ST18222	Technical Presentation - II	0	2	0	1	50	50	100
		Total	18	02	03	21		800	

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Department	Civil Engineering
Programme	M.E – Structural Engineering

SEMESTER – III

SI.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.		Professional Elective - V	3	0	0	3	30	70	100
2.		Professional Elective - VI	3	0	0	3	30	70	100
3.		Open Elective	3	0	0	3	30	70	100
4.	ST183A1	Audit Course	2	0	0	0	50	50	100
PRACTICAL									
5.	ST18321	Project Work – Phase I	0	0	12	6	50	50	100
6.	ST18322	Practical Training*	0	0	20	1	50	50	100
		Total	11	0	32	16		600	

(* Four Weeks during vacation)

SEMESTER - IV

SI.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
PRACTICAL									
1.	ST18421	Project Work – Phase II	0	0	30	12	50	50	100
		Total	0	0	30	12		100	

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Department	Civil Engineering	
Programme	M.E – Structural Engineering	
	List of Electives	

ELECTIVES (SEMESTER – I)								
Sl.No.	**Course Code**	**Course Name**	**Hours/ Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**ES**	**Total**
1.	CN18191	Advanced Concrete Technology (Common to ST & CN)	3	0	0	3	30	70	100
2.	ST18192	Maintenance and Rehabilitation of Structures (Common to ST & CN)	3	0	0	3	30	70	100
3.	CN18193	Research Methodology and Intellectual Property Rights (Common to ST & CN)	3	0	0	3	30	70	100
4.	ST18164	Optimization in Structural Design	3	0	0	3	30	70	100
5.	ST18165	Soil Structure Interaction	3	0	0	3	30	70	100
6.	ST18166	Storage Structures	3	0	0	3	30	70	100

ELECTIVES (SEMESTER – II)								
Sl.No.	**Course Code**	**Course Name**	**Hours/ Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**ES**	**Total**
1.	CN18291	Chemistry of Cement and Concrete (Common to ST & CN)	3	0	0	3	30	70	100
2.	ST18292	Special Concrete (Common to ST & CN)	3	0	0	3	30	70	100
3.	ST18263	Design of Steel Concrete Composite Structures	3	0	0	3	30	70	100
4.	ST18264	Experimental Techniques and Instrumentation	3	0	0	3	30	70	100
5.	ST18265	Industrial Structures	3	0	0	3	30	70	100
6.	ST18266	Earthquake Resistant Structures	3	0	0	3	30	70	100

		ELECTIVES (SEMESTER – III)							
Sl.No.	**Course Code**	**Course Name**	**Hours/ Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**ES**	**Total**
1.	ST18361	Stability of Structures	3	0	0	3	30	70	100
2.	ST18362	Corrosion of Steel in Concrete	3	0	0	3	30	70	100
3.	ST18363	Aseismic Design of Structures	3	0	0	3	30	70	100
4.	ST18364	Design of Bridges	3	0	0	3	30	70	100
5.	ST18365	Design of Plate and Shell Structures	3	0	0	3	30	70	100
6.	ST18366	Design of Tall Buildings	3	0	0	3	30	70	100

		LIST OF OPEN ELECTIVES (SEMESTER – III)							
Sl.No.	**Course Code**	**Course Name**	**Hours/ Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**ES**	**Total**
1.	ST18OE1	Principles of Sustainable Development	3	0	0	3	30	70	100
2.	MA18302	Operations Research Techniques	3	0	0	3	30	70	100
3.	ST18OE3	Bridge Maintenance Management	3	0	0	3	30	70	100
4.	ST18OE4	Prestressed Concrete	3	0	0	3	30	70	100
5.	ST18OE5	Smart Materials and Smart Structures	3	0	0	3	30	70	100

		AUDIT COURSE (SEMESTER – III)							
Sl.No.	**Course Code**	**Course Name**	**Hours/ Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**ES**	**Total**
1.	ST183A1	English for Research paper writing (Common to ST & CN)	2	0	0	0	50	50	100

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SEMESTER - I

ST18111	MATRIX METHODS OF STRUCTURAL ANALYSIS	L	T	P	C
		3	0	0	3

Objectives:

* *To study the energy concepts in structures and strain energy in systems and in elements.*
* *To learn the knowledge about the characteristics and transformation of structures with stiffness and flexibility.*
* *To understand the analysis of stiffness and flexibility method of structures.*

UNIT - I   ENERGY CONCEPTS IN STRUCTURES   [9]

Introduction – Strain Energy – Symmetry of The Stiffness and Flexibility Matrices – Strain Energy in Terms of Stiffness and Flexibility Matrices – Stiffness and Flexibility Coefficients in Terms of Strain Energy – Additional properties of [a] and [k] – Another Interpretation of coefficients a_{ij} and k_{ij} – Betti's law – Applications of Betti's law: Forces not at the coordinates – Strain energy in systems and in Elements.

UNIT - II   CHARACTERSTICS OF STRUCTURES – STIFFNESS AND FLEXIBILITY   [9]

Introduction – Structure with Single Coordinate – Two Coordinates - Flexibility and Stiffness Matrices in Coordinates – Examples - Symmetric Nature of Matrices - Stiffness and Flexibility Matrices in Constrained Measurements - Stiffness and Flexibility of Systems and Elements - Computing Displacements and Forces form Virtual Work - Computing Stiffness and Flexibility Coefficients.

UNIT - III   TRANSFORMATION OF INFORMATION IN STRUTURES   [9]

Determinate- Indeterminate Structures - Transformation of System Forces to Element Forces - Element Flexibility to System Flexibility - System Displacement to Element Displacement - Element Stiffness to System Stiffness - Transformation of Forces and Displacements in General – Stiffness and Flexibility in General –Normal Coordinates and Orthogonal Transformation - Principle of Contragradience.

UNIT - IV   FLEXIBILITY METHOD   [9]

Statically Determinate Structures – Indeterminate Structures - Choice of Redundant Leading to ILL and Well-Conditioned Matrices- Transformation to One Set of Redundant to Another – Internal Forces due to Thermal Expansion and Lack of Fit - Reducing the Size of Flexibility Matrix - Application to Pin-Jointed Plane Truss-Continuous Beams – Frames-Grids.

UNIT - V   STIFFNESS METHOD   [9]

Introduction - Development of Stiffness Method - Stiffness Matrix for Structures with zero Force at some Coordinates - Analogy between Flexibility and Stiffness - Lack of Fit - Stiffness Matrix with Rigid Motions-Application of Stiffness Approach to Pin Jointed Plane Trusses-Continuous Beams-Frames - Grids-Space Trusses and Frames-Introduction Only - Static Condensation Technique - Choice of Method - Stiffness or Flexibility.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

* *Know the structures with energy concepts.*
* *Gain the knowledge about the characteristics of structures by evaluation of its flexibility and stiffness matrices.*
* *Learn the transformation of system forces to element forces and element flexibility to system flexibility.*
* *Impart knowledge about analysis of system through direct and element approach of flexibility method.*
* *Analysis of structures by direct and element approach of stiffness method.*

Reference Books :

1   Natarajan C, Revathi P, "Matrix Methods of structural Analysis: Theory and Problems", PHI leaning Pvt. Ltd.,2014
2   Bhavikati, S.S, Structural Analysis Vol.-I & II. Vikas Publishing House pvt ltd, 2009
3   Pandit G.S. and Gupta S.P., "Structural Analysis-A Matrix Approach", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014
4   Vazirani, V.N, Ratwani, M.M, "Advanced Theory of Structures and Matrix Methods of Analysis", Khanna Publishers, 2008.
5   William McGuire, Richard H. Gallagher, Ronald D. Ziemian "Matrix Structural Analysis" 2014

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SEMESTER - I

MA18132	APPLIED MATHEMATICS FOR STRUCTURAL ENGINEERING	L	T	P	C
		3	0	0	3

Objectives:
- *To apply concept of one dimensional wave and heat equations using Laplace and Fourier transform methods respectively.*
- *To improve their ability in solving elliptic and Poisson equations.*
- *To equip themselves familiar with calculus of variations, linear programming problems and the basics of numerical integration by using mapping function.*

UNIT - I   ONE DIMENSIONAL WAVE AND HEAT EQUATIONS   [9]

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

UNIT - II   ELLIPTIC EQUATION   [9]

Fourier Transform method for solving Laplace equation transforms in a half plane, in an infinite strip and in a semi-infinite strip – Properties of harmonic functions – Solution of Poisson equation.

UNIT - III   CALCULUS OF VARIATIONS   [9]

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

UNIT - IV   LINEAR PROGRAMMING PROBLEMS   [9]

Formulation – Graphical Solution – Simplex Method – Big M method – Transportation and Assignment Problems.

UNIT - V   NUMERICAL INTEGRATION   [9]

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

Total   = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Solve one dimensional wave and heat equations.*
- *Extend their knowledge in elliptic and Poisson equations.*
- *Develop their skills in calculus of variations.*
- *Know about linear programming problems.*
- *Interpret multiple integration by using mapping function.*

Reference Books :

1   Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 2015.
2   Rajasekaran.S, "Numerical Methods in Science and Engineering A Practical Approach", A.H.Wheeler and Company Private Limited, 2016.
3   Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 2014.
4   Andrews, L.C. and Shivamoggi, B.K., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
5   P.K.Gupta and Manmohan Singh, "Problems in Operation research", S.Chand Publications, 2014.

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SEMESTER - I

ST18113	ADVANCED CONCRETE STRUCTURES	L	T	P	C
		3	0	0	3

Objectives:

* *To study the behavior, analysis and design of special RC structures.*
* *To learn the knowledge about slabs and behavior of concrete structures.*
* *To understand the field practice and quality control of concrete.*

UNIT - I   OVER ALL REVIEW   [9]

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

UNIT - II   DESIGN OF SPECIAL RC ELEMENTS   [9]

Design of slender columns-design of RC walls-ordinary and shear walls, strut and tie method of analysis for corbels and deep beams, design of corbels, deep beams and grid floors.

UNIT - III   FLAT SLABS AND FLATE PLATES   [9]

Design of slabs and flat plates according to IS & ACI methods- design of shear reinforcement –design of spandrel beams-yield line theory and hiller - borg strip method of design of slabs

UNIT - IV   INELASTIC BEHAVIOR OF CONCRETE STRUCTURES   [9]

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

UNIT - V   DETAILING AND FIELD PRACTICE   [9]

Detailing for ductility- fire resistance of structural members-quality of control of concrete.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

* *Gain the knowledge about basic overall review of design of beams, column & slabs with codal provisions.*
* *Students will be able to solve design of special RC elements.*
* *Gain the knowledge about design of flat slab and spandrel beams according to IS & ACI methods.*
* *Acquire knowledge about behavior of concrete structures.*
* *Learn the quality of control of concrete.*

Reference Books :

1   Unnikrishna Pillai, S., Devdas Menon, Reinforced Concrete Design, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2011.
2   Krishna Raju, N., "Advanced Reinforced Concrete Design", CBS Publishers &Distributors, New Delhi, 2013
3   Gambhir. M. L, "Design of reinforced Concrete Structures", Prentice Hall India , 2008.
4   Varghese, P.C., Advanced Reinforced Concrete Design, Prentice Hall of India, Pvt.Ltd, New Delhi,2005
5   Purusothaman.P, " Reinforced Concrete structural Elements: Behavier, Analysis and Design" Mc- Graw Hill Education, 1990,

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SEMESTER - I

	L	T	P	C
ST18114 **STRUCTURAL DYNAMICS**	3	0	0	3

Objectives:
- *To know about the different degrees of freedom systems*
- *To gain knowledge on different methods to analyses the freedom systems*
- *To acquire knowledge to relate the dynamic loads to the structures.*

UNIT - I   PRINCIPLES OF DYNAMICS   [9]

Formulation of Equations of Motion by Different Methods, Single Degree of Freedom Systems, Free and Forced Response, Effect of Damping.

UNIT - II   MULTIDEGREE OF FREEDOM SYSTEMS   [9]

Formulation of Structure, Property Matrices- Eigen Value Problems – Methods- Dunkerly's Method– Holzer Method – stodola Method-Rayleigh's Method - Rayleigh- Ritz Method-Mode shapes- Ortho normality of Modes.

UNIT - III   DYNAMIC RESPONSE OF MDOF SYSTEMS   [9]

Mode Superposition Techniques - Problems on Two Degree of Freedom for Building Frames - Numerical Integration Techniques - New Marks Method-Linear Acceleration Method – Problems – Numerical Evaluation of Duhamel's Integral.

UNIT - IV   CONTINUOUS SYSTEMS   [9]

Modeling–Free and Forced Vibrations of Bars – Flexural Vibration of Simple Beams - Modes and Frequencies - orthogonality Properties of Normal Modes of Continuous Systems.

UNIT - V   DESIGN OF STRUCTURES SUBJECTED TO DYNAMIC LOADS   [9]

Idealization of Multi-Storied Frames for Dynamic Analysis- Machine Foundations – Analysis for Blast Loading – Earthquake Response – Elastic Rebound Theory – Deterministic Analysis of Earthquake response – Lumped SDOF system – Design of Earthquake Response – Design of Earthquake Resistant Structures – IS code Provisions- Wind Analysis - Gust Factor

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Gain knowledge to infer the different degrees of freedom systems.*
- *Acquire knowledge to analyses the different methods of freedom systems.*
- *Gain knowledge to interpolate the linear methods to MDOF systems.*
- *Interpret the flexural vibration of beams.*
- *Acquire knowledge to relate the dynamic loads to the structures.*

Reference Books :

1   Mario Paz, "Structural Dynamics", Academic Press, 2004.
2   Anil .K.Chopra, "Dynamics of Structures", Prentice Hall of India, EEE Edition, 2000.
3   Roy R.Craig. Jr., "Structural Dynamics - An Introduction to Computer Methods", John Wiley & Sons, 1981.
4   Clough. R.W and Penzien.J., "Dynamics of Structures" , McGraw Hill, 1995.
5   Anderson. R.A., "Fundamentals of Vibration", Amerind Publishing Co., 2000.

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<u>**SEMESTER - I**</u>

		L	T	P	C
ST18121	**ADVANCED STRUCTURAL ENGINEERING LABORATORY**	0	0	3	2

Objectives:

- *To learn the principles and procedures of testing and deflection behavior of beam & column.*
- *To learn the behavior of materials to the applied cyclic load of frames.*
- *To understand about quality of concrete of existing elements.*

List of Experiments:
1. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behavior.
2. Testing of simply supported steel beam for strength and deflection behavior.
3. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.
4. Dynamic testing of cantilever steel beam
    a) To determine the damping co-efficient from free vibrations
    b) To evaluate the mode shapes
5. Static cyclic testing of single bay two storied steel frames and evaluate
    a) Drift of the frame
    b) Stiffness of the frame
    c) Energy dissipation capacity of the frame
6. Determination of in-situ strength and quality of concrete using
    a) Rebound hammer and
    b) Ultrasonic pulse velocity tester
7. Flow characteristics of self-compacting concrete.

LABORATORY EQUIPMENTS REQUIREMENTS
1. Strong Floor
2. Loading Frame
3. Hydraulic Jack
4. Load Cell
5. Proving Ring
6. Electrical Strain Gauge with indicator
7. Rebound Hammer
8. Ultrasonic Pulse Velocity Tester
9. Dial Gauges
10. Vibration Exciter
11. Vibration Meter.
12. Slump Equipment for SCC

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Learn about the method of testing of simply supported reinforced concrete beam for strength and deflection behavior.*
- *Know about the method of testing of static cyclic testing of single bay two storied steel frames.*
- *Examine the dynamic testing of steel elements.*
- *Learn about the method of testing of reinforced concrete column subjected to concentric and eccentric loading.*
- *Know about the method of testing of concrete by Nondestructive test – rebound hammer & ultra-sonic pulse velocity test.*

References book:

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

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SEMESTER - I

		L	T	P	C
ST18122	**TECHNICAL PRESENTATION - I**	0	2	0	1

Objective: *To prepare students to gain confidence in technical presentation and report preparation.*

- The students have to refer the journals and conference proceedings and collect the literature.

- The students can select a course oriented topic.

- The students have to collect at least 30 research papers published in the last decades.

- Using OHP / Power Point, the student has to make presentation for 20 minutes followed by 10 minutes discussion.

- The student has to make five presentations in the semester.

- The student has to write a technical report for about 30 - 50 pages (Title page, One page Abstract, Review of Research paper under various sub - headings, concluding remarks and list of references).

- The technical report has to be submitted to the course coordinator one week before the final presentation.

Total : 30 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Recognize the area of interest of the student.*
- *Identify the thrust area by referring journals, conference proceedings etc.*
- *Familiarize with literature collection.*
- *Gain knowledge on current topic.*
- *Know about report writing and presentation.*

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SEMESTER - II

		L	T	P	C
ST18211	**THEORY OF ELASTICITY AND PLASTICITY**	3	0	0	3

Objectives:
- *To gain knowledge about the equilibrium and compatibility equations, plane stress & plane strain.*
- *To analyze, calculate deflection of beams by using Energy theorems.*
- *To know about elastic plastic problems in bending, fracture mechanics.*

UNIT - I   PLANE STRESS AND PLANE STRAIN   [9]

Analysis of Stress and Strain, Stress-Strain Relationship - Equilibrium Equations - Compatibility Equations - Generalized Hook's Law- Plane Stress and Plane strain Problems.

UNIT - II   2D IN ELASTICITY   [9]

Two Dimensional Problems in Cartesian and Polar Co-ordinates for Simple Problems. - Airy's stress function – Bi - Harmonic Equation.

UNIT - III   TORSION OF NON CIRCULAR SECTION   [9]

Saint Venant's Principle - Methods of Analysis- Membrane Analogy-Torsion of thin Rectangular Section and Hollow thin walled sections.–Thick cylinder – Bending of Curved Bars

UNIT - IV   ENERGY METHODS   [9]

Principle of Virtual Work - Energy theorems - Rayleigh Ritz method - deflection of beams problems – Finite difference method application to elasticity problems.

UNIT - V   PLASTICITY   [9]

Physical Assumptions – Yield Criteria – Failure Theories – Plastic Stress Strain Relationship – Elastic Plastic Problems in Bending – Torsion and Thick Cylinder.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Gain knowledge about the two dimensional and three dimensional equilibrium equations,*
- *Identify Airy's stress function & Bi - harmonic equation.*
- *Learn about the membrane analogy and analysis of structures.*
- *Apply the energy methods to find the deflection of beams.*
- *Solve the elastic plastic problems in bending.*

Reference Books :

1   Timoshenko.S and Goodier .J .N., "Theory of Elasticity", McGraw Hill Book Co., New york, 2013
2   Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi.2003.
3   Sadhu singh., "Theory of Plasticity", Khanna Publishers, New Delhi.2003.
4   Jane Helena H., "Theory of Elasticity and Plasticity", PHI Learning Pvt. Ltd., 2017.

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<u>SEMESTER - II</u>

		L	T	P	C
ST18212	**ADVANCED STEEL STRUCTURES**	3	0	0	3

Objectives:
* *To study the behavior of members and design of connections.*
* *To analysis and design of steel towers.*
* *To study of plastic analysis of structures and the design of cold formed steel structure*

UNIT - I   GENERAL   [9]

Design of members subjected to lateral loads and axial loads – Analysis and design of Industrial Buildings and bents-Sway and non-sway frames-Design of purlins, Louver rails, Gable column and Gable wind girder-Analysis of Gable Frames check for deflection.

UNIT - II   DESIGN OF CONNECTIONS   [9]

Types of connections – Bold and welded connections - Design of Framed Connections-Seated Connections – Unstiffened and Stiffened seated Connections – Moment Resistant Connections

UNIT - III   ANALYSIS AND DESIGN OF STEEL TOWERS   [9]

Analysis and Design of Transmission Line Towers - Types of bracing patterns- Sag and Tension calculations. Design of Self-supporting Chimney (Lined and unlined)–Guyed Steel stacks- Stresses due to wind and earthquake force-Design of foundation along with load calculation-Gust Factor Method.

UNIT - IV   PLASTIC ANALYSIS OF STRUCTURES   [9]

Introduction - shape factor - moment redistribution - static, kinematic and uniqueness theorems- combined mechanism-analysis of single bay and two bay portal frames- methods of plastic moment distribution- effect of axial force and shear force on plastic moments- connection moments distributing connection-design of continuous beams.

UNIT - V   DESIGN OF LIGHT GAUGE STEEL STRUCTURES   [9]

Types of cross sections-local bucking and lateral bucking-concepts of effective width-design of compression and tension members, beams, deflection of beams and design of beam web. Combined stresses and connections, wall studs.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
* *Carryout the design of purlin, Gable column and Gable wind girder.*
* *Learn about various connections in the Bolted and welded connection.*
* *Discuss about design of Transmission Line Towers and chimney.*
* *Learn about plastic analysis in continuous beams and portal frame.*
* *Design of light gauge steel structures in civil Engineering field.*

Reference Books :

1   Subramaniam . N, "Design of Steel Structures Theory & Practice", Oxford University Press, 2011.

2   Bavikatti .S.S, "Design of Steel Structures by Limit State Method", International Publishing House Pvt. Ltd, 2012

3   Negi.L.S, "Design of steel Structures",Tata McGraw – Hill Education, 1997

4   Jayagopal.L.S & Tensing.D, "Design of steel Structures", Vikas Publishing, 2015.

5   Wie Wen Yu. ,"Design of Cold Formed SteelStructures",McGrawHillBookCompany,NewYork,2015.

6   Gambhir.M.L, " Fumdamentals of Structural Steel Design", McGraw – Hill Education, Pvt.Ltd.2013.

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SEMESTER - II

	L	T	P	C
ST18213 **FINITE ELEMENT METHOD**	3	0	0	3

Objectives:

- *To analysis the structures by using finite element method to know 1D, 2D and 3D modeling for plain stress, strain analysis.*
- *To define about the refinement methods and mesh generation.*
- *To analysis and model using the recent softwares.*

UNIT - I   1D FINITE ELEMENT ANALYSIS   [9]

Historical background – Weighted residual methods – Basic concepts of FEM – Variation formulation of B.V.P. – Ritz method – Finite element modeling – Element equations – Linear and quadratic shape functions – Bar, beam elements – Applications to heat transfer.

UNIT - II   FINITE ELEMENT ANALYSIS OF 2D PROBLEMS   [9]

Basic Boundary Value Problems in 2 Dimensions – Triangular, Quadrilateral, higher order elements – Poisson and Laplace's equation – Weak Formulation – Element matrices and vectors – Application to solid mechanics, heat transfer, fluid mechanics.

UNIT - III   ISO-PARAMETRIC FORMULATION   [9]

Natural co-ordinate system – Lagrangian interpolation Polynomials – Isoparametric, elements – Formulation – Numerical integration – ID- IID triangular elements – Rectangular elements – illustrative Examples.

UNIT - IV   MESHING AND SOLUTION PROBLEMS   [9]

Higher Order Elements – P and H Methods of Mesh Refinement – ill conditioned elements – Discretization errors – Auto and Adaptive mesh generation techniques - Error evaluation.

UNIT - V   SOFTWARE APPLICATIONS   [9]

Preprocessing - Mesh generation – Region and block representation, generation of node numbers, mesh plotting- Post Processing – Types of data available – Displaying results graphically – Listing nodal and element solution data.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

- *Describe about basic concept of FEM, boundary and initial value problems.*
- *Examine about the finite element analysis of two dimensional problems and its applications.*
- *Compare Isoperimetric elements and formulation of elements equations in one and two dimensions.*
- *Illustrate field problems in higher order elements and analyze using mesh refinement and error evaluation.*
- *Compare and contrast about modeling and analyzing using recent FEM software.*

Reference Books :

1   Chandrupatla, T.R., and Belegundu, A.D., "Introduction to Finite Element in Engineering", Third Edition, Prentice Hall, India, 2003.

2   C. S. Krishnamoorthy, " Finite Element Analysis: Theory and Programming", Tata McGraw-Hill Education, 2010.

3   O.C.Zienkiewicz and R.L.Taylor, , Finite Element Methods, Mc Graw Hill , 2000.

4   K.J.Bathe , "Finite Element Procedure in Engineering Analysis" Prentice Hall Inc., 1996.

5   S.S.Rao, "The Finite Element Method in Engineering", Pergaman Press, 2003.

6   S.Moaveni, Finite Element Analysis : Theory and Application with ANSYS, Prentice Hall Inc., 1999.

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SEMESTER - II

		L	T	P	C
ST18214	**DESIGN OF SUBSTRUCTURES**	3	0	0	3

Objectives:
- *To create awareness among students about the importance of soil data.*
- *To know and design various types of sub structures.*
- *To acquire adequate knowledge of design foundation for different types of structures.*

UNIT - I   SUBSURFACE EXPLORATION   [9]

Purpose - Programme and Procedures – Interpretation of bore logs, soil data and exploration reports.

UNIT - II   SHALLOW FOUNDATIONS   [9]

Types of foundations and their specific applications – depth of foundation – bearing capacity and Settlement estimates – structural design of isolated footings strip, rectangular and trapezoidal combined footings – strap – balanced footings – raft foundation – Approximate flexible method of raft design - Compensated foundations.

UNIT - III   DEEP FOUNDATIONS   [9]

Types of Piles and their applications - Load capacity - Settlements - Group action – Testing of piles –Design of piles and pile caps – Lateral load capacity of piles.

UNIT - IV   FOUNDATIONS FOR BRIDGES AND OTHER MISCELLANEOUS STRUCTURES   [9]

Drilled shaft foundations and caissons for bridges - Foundations for transmission line towers – Chimneys – Silos – Structural Design of supports for foundation excavations – Design of Anchors.

UNIT - V   MACHINE FOUNDATIONS   [9]

Types - General requirements and design criteria - General analysis of machine foundations- soil system - Stiffness and damping parameters - Tests for design parameters - Guidelines for design of reciprocating engines, impact type machines, rotary type machines, framed foundations.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Gain knowledge about the sub surface exploration.*
- *The design of different types of shallow foundations.*
- *Know about the design of pile foundation and application.*
- *Impart knowledge about foundation to the miscellaneous structures.*
- *Identify about the guidelines to the machine foundations.*

Reference Books :

1. Thomlinson, M.J, 'Foundation Design and Construction', Pearson Education/prentice Hall, 2003.
2. J.E.Bowels, 'Foundation analysis and Design', McGraw Hill International Book Co.
3. Braja M. Das, 'Principles of Foundations Engineering', Cengage Learning, 2015.
4. Swami Saran, 'Analysis and Design of Substructures', Oxford & IBH Publishing Company Private Limited, 2008.
5. Bowels J. E, 'Foundation Analysis and Design', McGraw-Hill International Book Co, 2001.
6. Varghese. P.C, " Design of Reinforced Concrete foundations", PHI Learning Pvt.Ltd ,2010.

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SEMESTER - II

		L	T	P	C
ST18221	**ADVANCED COMPUTING LABORATORY**	0	0	3	2

Objectives:
- *To gain skill working with ANSYS civil systems and learn to analysis different elements and structures through FEM analysis*
- *To gain knowledge about the analysis of prestressed concrete elements.*
- *To analyse the retaining walls and structures subjected to seismic loads.*

List of Experiments:

1. FEM – ANSYS Civil – Preprocessing: Element Type, Material/ Geometric properties, Modeling, Mesh Generation – Solution: Loads, Constraints – Post Processing

2. FEM Analysis of RCC Beam – Column – Slab – Plane frame – Space frame.

3. Analysis of Pre-stressed concrete elements.

4. Buckling analysis of steel member.

5. FEM Analysis of Bridge Structure.

6. Dynamic Analysis of Structure Subjected to Seismic Load.

7. Analysis of Retaining wall in Geotechnical module.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

- *Relate about FEM analysis and designing of RCC elements.*
- *Illustrate the design of pre-stressed concrete elements.*
- *Solve steel member and bridge structure using FEM analysis.*
- *Investigation about response of dynamic analysis of structure.*
- *Examine the analyze retaining wall structures.*

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<u>**SEMESTER - II**</u>

		L	T	P	C
ST18222	**TECHNICAL PRESENTATION - II**	0	2	0	1

Objective: *To prepare students to gain confidence in technical presentation and report preparation.*

- The students have to refer the journals and conference proceedings and collect the literature.

- The students can select a course oriented topic.

- The students have to collect at least 30 research papers published in the last decades.

- Using OHP / Power Point, the student has to make presentation for 20 minutes followed by 10 minutes discussion.

- The student has to make five presentations in the semester.

- The student has to write a technical report for about 30 - 50 pages (Title page, One page Abstract, Review of Research paper under various sub - headings, concluding remarks and list of references).

- The technical report has to be submitted to the course coordinator one week before the final presentation.

Total : 30 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Recognize the area of interest of the student.*
- *Identify the thrust area by referring journals, conference proceedings etc.*
- *Familiarize with literature collection.*
- *Gain knowledge on current topic.*
- *Acquire idea on report writing and presentation related to the area.*

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<u>**SEMESTER - I**</u>

		L	T	P	C
CN18191	**ADVANCED CONCRETE TECHNOLOGY (ELECTIVE)** (Common to ST & CN)	3	0	0	3

Objectives:
- *To study the properties of materials, tests, admixtures for concrete and concreting under special circumstances.*
- *To gain knowledge about mix design and special types concrete and their effects on concrete properties*
- *To know different applications in construction field and tests on concrete.*

UNIT - I   CONCRETE MAKING MATERIALS   [9]

Aggregates classification, IS Specifications, Properties, Grading, Methods of combining aggregates, specified grading, Testing of aggregates. Cement, Grade of cement, Chemical composition, Testing of cement, Hydration of cement, Structure of hydrated cement, special cements, Water, Chemical admixtures, Mineral admixtures.

UNIT - II   PROPERTIES OF CONCRETE   [9]

Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and Shrinkage, Variability of concrete strength, Durability of concrete

UNIT - III   MIX DESIGN   [9]

Principles of concrete mix design, Methods of concrete mix design, Testing of concrete, Statistical quality control- sampling and acceptance criteria.

UNIT - IV   SPECIAL CONCRETE   [9]

Light weight concrete, Heavy weight concrete, Fly ash concrete, Fibre reinforced concrete, Sulphur infiltrated Concrete, Polymer Concrete, Super plasticized concrete, Hyper plasticized concrete, High performance concrete, High performance fibre reinforced concrete, self-compacting concrete.

UNIT - V   MICROSTRUCTURAL ANALYSIS   [9]

X- Ray Diffration, Differential Thermal Analysis, Thermo gravimetry Analysis, Atomic Absorption Spectroscopy, Conduction Calorimetry, Potentiometric Methods, X-Ray Fluorescence Analysis, Neutron Activation Analysis, Mossbauer Spectroscopy, Nuclear UV Absorption Spectroscopy, Electron Microscopy, Surface Area, Helium Pycnometry, Microhardness, Mercury Porosimetry, other Techniques and Standards and Specifications.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Acquire knowledge on constituent materials of concrete, different types of cement, composition and properties and tests of cement and properties of aggregates.*
- *Gain knowledge about concrete and their effects on concrete properties and study the mineral admixtures.*
- *Know the principles of mix proportioning and Mix design is to be studied for different methods.*
- *Gain knowledge about types of special concrete*
- *Identify different types of concretes and their properties and its applications in construction field.*

Reference Books :

1   M.S. Shetty, "Concrete Technology", S. Chand and Company Ltd. Delhi, 2014.
2   A.R. Santhakumar, "Concrete Technology", Oxford University Press, 2006.
3   A.M. Neville, "Properties of Concrete", Prentice Hall, London, 2012,
4   M.L. Gambir, "Concrete Technology", Tata McGraw Hill, Publishing Co. Ltd, New Delhi, 2006.

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SEMESTER - I

ST18192	MAINTENANCE AND REHABILITATION OF STRUCTURES (ELECTIVE) (Common to ST & CN)	L	T	P	C
		3	0	0	3

Objectives:

- *To get the knowledge on quality of concrete, durability aspects, causes of deterioration, assessment of distressed structures, repairing of structures and demolition procedures.*
- *To emphasize the importance of maintenance and inspection of structures and to divulge fundamental knowledge on various repairing strategies*
- *To impart a broad knowledge in the area of repair and rehabilitation of structures.*

UNIT - I   INFLUENCE ON SERVICEABILITY AND DURABILITY   [9]

Effects due to climate, Temperature, Chemicals, Wear and Erosion, Design and Construction Errors, Corrosion Mechanism, Effects of Cover Thickness and Cracking, Methods of Corrosion Protection, Corrosion Inhibitors, Corrosion Resistant Steels, Coatings, Cathodic Protection.

UNIT - II   MAINTENANCE AND REPAIR STRATEGIES   [9]

Definitions: Maintenance, Repair and Rehabilitation, Facts of Maintenance - Importance of Maintenance - Preventive Measures on Various Aspects Inspection, Assessment Procedure for Evaluating a Damaged Structure Causes of Deterioration - Testing Techniques.

UNIT - III   MATERIALS FOR REPAIR   [9]

Special Concretes and Mortar, Concrete Chemicals, Special Elements for Accelerated Strength Gain, Expansive Cement, Polymer Concrete, Sulphur Infiltrated Concrete, Ferro Cement, Fiber Reinforced Concrete.

UNIT - IV   TECHNIQUES FOR REPAIR   [9]

Rust Eliminators and Polymers Coating for Rebar's During Repair Foamed Concrete, mortar and Dry Pack, Vacuum Concrete, Gunite and Shotcrete, Epoxy Injection, Mortar Repair for Cracks, Shoring and Underpinning.

UNIT - V   REHABILITATION OF STRUCTURES   [9]

Repairs to overcome low member strength, Deflection, Cracking, Chemical Disruption, Weathering Wear, Fire, Leakage, Marine Exposure. Engineered Demolition Techniques for Dilapidated Structures – Case Studies.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Identify the effects due to climate, temperature, chemicals, wear and erosion on structures.*
- *Know the strategies of maintenance and repair*
- *Gain knowledge about the best Materials and Techniques for Repair.*
- *Demonstrate the various types of distress in concrete structures.*
- *Analyze and provide remedies for failures in structure due to design and construction errors.*

Reference Books :

1   Shetty.M.S., "Concrete Technology - Theory and Practice", S.Chand and Company, New Delhi, 2018.

2   Allen R.T. and Edwards S.C., "Repair of Concrete Structures", Blakie and Sons, UK, 2011.

3   Palaniappan.N., "Estate Management, Anna Institute of Management", Chennai, 1992.

4   Santhakumar. A.R., "Training Course Notes on Damage Assessment and Repair in Low Cost Housing", "RHDC-NBO", Anna University, July, 1992.

5   Denison Campbell-Allen and Harold Roper., "Concrete Structures", Materials, Maintenance and Repair, Longman Scientific and Technical UK, 1991.

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SEMESTER - I

CN18193	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS (ELECTIVE)	L	T	P	C
	(Common to ST & CN)	3	0	0	3

Objectives:
- *To impart scientific, statistical and analytical knowledge for carrying out research work effectively.*
- *To gain essential knowledge to do innovations in engineering.*
- *To understand olden days inventions and discoveries.*

UNIT - I RESEARCH CONCEPTS [9]

Concepts, meaning, objectives, motivation, types of research, approaches, research (Descriptive research, Conceptual, Theoretical, Applied & Experimental). **Formulation of Research Task** – Literature Review, Importance & Methods, Sources, quantification of Cause Effect Relations, Discussions, Field Study, Critical Analysis of Generated Facts, Hypothetical proposals for future development and testing, selection of Research task

UNIT - II MATHEMATICAL MODELING AND SIMULATION [9]

Concepts of modeling, Classification of Mathematical Models, Modeling with Ordinary differential Equations, Difference Equations, Partial Differential equations, Graphs, Simulation, Process of formulation of Model based on Simulation

UNIT - III EXPERIMENTAL MODELING [9]

Definition of Experimental Design, Examples and Single factor Experiments, Guidelines for designing experiments. Process Optimization and Designed experiments, Methods for study of response surface, determining optimum combination of factors, Taguchi approach to parameter design

UNIT - IV ANALYSIS OF RESULTS AND REPORT WRITING [9]

Parametric and Non-parametric, descriptive and Inferential data, types of data, collection of data (normal distribution, calculation of correlation coefficient), processing, analysis, error analysis, different methods, analysis of variance, significance of variance, analysis of covariance, multiple regression, testing linearity and non-linearity of model.
Report Writing: Types of reports, layout of research report, interpretation of results, style manual, layout and format, style of writing, typing, references, tables, figures, conclusion, appendices.

UNIT - V INTELLECTUAL PROPERTY RIGHTS [9]

Administration of patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge case Studies, IPR and IITs.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Acquire a sound and fundamental understanding of the scientific, mathematical, and engineering principles underlying surveying.*
- *Analyze, interpret and apply research and research-related data.*
- *Recognize, analyze, and solve society problems and environment problems.*
- *Acquire an understanding of the responsibilities and ethics of research professionals.*
- *Recognize the need to prepare for life-long study and learning.*

Reference Books :
1. C.R. Kothari, Research Methodology Methods and Techniques, 2/e, Vishwa Prakashan, 2004.
2. Panneerselvam R, Research Methodology, PHI Learning Private Limited, 2014.
3. Douglas Montgomary, Design of Experiments, Statistical Consulting Services, 2004.
4. S.S.Rao, Optimization Theory and Application Wiley Eastern Ltd, New Delhi, 1996.

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SEMESTER - I

		L	T	P	C
ST18164	**OPTIMIZATION IN STRUCTURAL DESIGN** **(ELECTIVE)**	3	0	0	3

Objectives:
- *To study the elements of optimization techniques like linear, quadratic, dynamic and geometric programming.*
- *To bring knowledge about programming methods and optimization theorems.*
- *To study the underlying concepts of non- traditional optimization methods*

UNIT - I   BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES   [9]

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

UNIT - II   LINEAR AND NON-LINEAR PROGRAMMING   [9]

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

UNIT - III   GEOMETRIC PROGRAMMING   [9]

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

UNIT - IV   DYNAMIC PROGRAMMING   [9]

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

UNIT - V   STRUCTURAL APPLICATIONS   [9]

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

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Gain knowledge about the basic concepts in optimization.*
- *Gain knowledge about various optimization techniques for optimal design of structural elements.*
- *Learn the linear programming methods for plastic design of frames.*
- *Analyse the optimization theorems for trusses and frames.*
- *Gain knowledge about non- traditional optimization methods and its applications.*

Reference Books :

1   Spunt, "Optimization in Structural Design", Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey, 2005.
2   Iyengar.N.G.R and Gupta. S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997
3   Rao, S.S., "Optimization Theory and applications", Limited, New Delhi, 2004.
4   Richard Bronson, "Operation Research", Schaum's Outline series, Mac Graw Hill Book Co, Singapore, 1997.
5   Pun, "Introduction to Optimization in Practice", John Wiley Eastern Limited, New Delhi, 2001.
6   Uri Krish, "Optimum Structural Design", McGraw Hill Book Co. 1981

SEMESTER - I

		L	T	P	C
ST18165	**SOIL STRUCTURE INTERACTION** **(ELECTIVE)**	3	0	0	3

Objectives:
- *To understand the concept of interaction, linear and non-linear behavior of soil.*
- *To design and analysis of beams, slabs on elastic medium.*
- *To do the elastic analysis of piles, pile groups and laterally loaded pile.*

UNIT - I   SOIL FOUNDATION INTERACTION   [9]

Introduction to Soil-Foundation Interaction Problems, Soil Behavior, Foundation Behavior, Interface Behavior, Scope of Soil Foundation Interaction. Analysis, Soil Response Models, Winkler, Elastic Continuum, Two Parameter Elastic Models, Elastic Plastic Behavior, Time Dependent Behavior.

UNIT - II   BEAM ON ELASTIC FOUNDATION- SOIL MODELS   [9]

Infinite Beam, Two Parameters, Isotropic Elastic Half Space, Analysis of Beams of Finite Length, Classification of Finite Beams in Relation to their Stiffness.

UNIT - III   PLATE ON ELASTIC MEDIUM   [9]

Infinite Plate, Winkler, Two Parameters, Isotropic Elastic Medium, Thin and Thick Plates, Analysis of Finite Plates, Rectangular and Circular Plates, Numerical Analysis of Finite Plates, Simple Solutions.

UNIT - IV   ELASTIC ANALYSIS OF PILE   [9]

Elastic Analysis of Single Pile, Theoretical Solutions for Settlement and Load Distributions, Analysis of Pile Group, Interaction Analysis, Load Distribution in Groups with Rigid Cap.

UNIT - V   LATERALLY LOADED PILE   [9]

Load Deflection Prediction for Laterally Loaded Piles, Sub grade Reaction and Elastic Analysis, Interaction Analysis, Pile Raft System, Solutions through Influence Charts.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Reproduce the concept of interaction, linear and non- linear behavior of soil.*
- *Design beams and slabs using Winkler foundation model.*
- *Identify the elastic analysis of various plates.*
- *Assess the effects of differential settlement on the behavior of a structure.*
- *Determine the effects of structural stiffness and rigidity on the loads carried by foundations and earth pressures acting on structures.*

Reference Books :

1. Selva Durai. A.P.S., "Elastic Analysis of Soil Foundation Interaction", Elsevier, 2013.
2. Poulos. H.G., and Davis, E.H., "Pile Foundation Analysis and Design", John Wiley, 1980.
3. Scott, R.F., "Foundation Analysis", Prentice Hall, 1984.
4. Structure Soil Interaction - State of Art Report, Institution of Structural Engineers, 1997.
5. ACI 336, "Suggested Analysis and Design Procedures for Combined Footings and Mats", American Concrete Institute, Delhi, 1994.

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SEMESTER - I

	L	T	P	C
ST18166 STORAGE STRUCTURES (ELECTIVE)	3	0	0	3

Objectives:
- *To impart the principals involved in the design of steel and concrete water tanks.*
- *To design the material storage structures as per the codal provisions.*
- *To educate the students to design the foundation for different storage structures.*

UNIT - I   STEEL WATER TANKS   [9]

Design of rectangular riveted steel water tank – Tee covers – Plates – Stays –Longitudinal and transverse beams – Design of staging – Base plates – Foundation and anchor bolts – Design of pressed steel water tank Design of stays – Joints – Design of hemispherical bottom water tank – side plates – Bottom plates – joints – Ring girder Design of staging and foundation.

UNIT - II   CONCRETE WATER TANKS   [9]

Design of Circular tanks – Hinged and fixed at the base – IS method of calculating shear forces and moments – Hoop tension – Design of intze tank – Dome – Ring girders – Conical dome – Staging – Bracings – Raft foundation – Design of rectangular tanks – Approximate methods and IS methods – Design of underground tanks – Design of base slab and side wall – Check for uplift.

UNIT - III   STEEL BUNKERS AND SILOS   [9]

Design of square bunker – Jansen's and Airy's theories – IS Codal provisions – Design of side plates – Stiffeners – Hooper – Longitudinal beams – Design of cylindrical silo – Side plates – Ring girder – stiffeners.

UNIT - IV   CONCRETE BUNKERS AND SILOS   [9]

Design of square bunker – Side Walls – Hopper bottom – Top and bottom edge beams – Design of cylindrical silo – Wall portion – Design of conical hopper – Ring beam at junction.

UNIT - V   FOUNDATION   [9]

Design of various types of foundation like isolated, combined and raft foundation for a water tanks, bunkers and silos.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Use the techniques, skills and advanced modern engineering design principles of steel water tanks.*
- *Know the fundamentals for the design of concrete water tanks.*
- *Get in depth knowledge on types of steel bunkers, silos and its design methodologies.*
- *Acquire an exposure to analyze and design concrete bunkers and silos.*
- *Design different types of foundations for material storage structures.*

Reference Books :

1 Rajagopalan K., "Storage Structures", Tata McGraw Hill, New Delhi, 2004.
2 Krishna Raju N., "Advanced Reinforced Concrete Design", CBS Publishers and Distributors, New Delhi, 2016.
3 N.Subramanian Designs Reinforced Concrete Structures" Oxford publishers, 2013.
4 Ram Chandra, "Design of Steel Structures", Vol – II, Standard Book house, 2016.

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<u>**SEMESTER - II**</u>

CN18291	**CHEMISTRY OF CEMENT AND CONCRETE**	L	T	P	C
	(ELECTIVE)	3	0	0	3
	(Common to ST & CN)				

Objectives:

- *To learn about the chemical combination in cement.*
- *To acquire knowledge in hydration process of pozzolanic and portland cement.*
- *To gain knowledge on types of cement and their application on concrete.*

UNIT - I   POZZOLANA CEMENT   [9]

Definition- classifications- Pozzolanic activity and its influencing factors- Lime – Pozzolana reaction and products formation- Applications.

UNIT - II   PORTLAND CEMENT   [9]

Definition- Raw materials and their physical – chemical characteristics- manufacturing process- cement making kilns viz, Rotary and shaft kiln- Refractory used in Rotary kiln- reactions occurred in different zones of rotary kiln- Hydration of cement- Setting and hardening of Portland cement- Heat of Hydration- Action of acid & sulphate water on cement- Flash set and False set of cement- Alkali – Aggregate reaction in Portland cement -Applications.

UNIT - III   SPECIAL CEMENTS   [9]

Rapid hardening Portland cement- Quick setting cement- White Portland Cement, coloured cement- Sulphate resisting cement- Low heat Portland cement- Oil – well cement- Waterproofed Portland cement- Hydrophobic cement- sorel cement- Blended Cement- Macro defect Free (MDF) Cement- Refractory Cement- Cement paints.

UNIT - IV   HIGH ALUMINA CEMENT   [9]

Introduction to refractory cement- Raw Materials used classification and composition of HAC- manufacturing process-Mineralogical phases of HAC- Hydration of HAC on the basis of $CaO-Al_2O_3-H_2O$ Phase diagram- Strength Development-HAC castables and uses.

UNIT - V   CONCRETE   [9]

Introduction- Admixture- Gap Grade concrete- continuous grade concrete- light, normal and heavy concrete-properties of concrete- installation technique of concrete- uses of various concretes.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

- *Gain knowledge on reactions due to pozzolana cement.*
- *Acquire knowledge to effects of Portland cement.*
- *Know about the special types of cement.*
- *Gain Knowledge about the effects of using high alumina cement.*
- *Acquire knowledge about the impact of cement on concrete.*

Reference Books :

1   V.S. Ramachandran., "Concrete Admixtures Handbook", Second Edition, Standard Publishers Distributors, (1705), Nai sarak, Delhi (1996).

2   A.R.Santhakumar ;"Concrete Technology", Oxford University Press,(2007)

3   http://nptel.ac.in/courses/105102012/9

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SEMESTER - II

		L	T	P	C
ST18292	**SPECIAL CONCRETE** **(ELECTIVE)** (Common to ST & CN)	3	0	0	3

Objectives:

- *To study the special concreting techniques, quality control of concrete construction and their future trends in special concretes.*
- *To understand the Advanced engineering knowledge and capabilities pertaining to the specification, production, properties, testing and application of concrete as a construction material.*
- *To know the different types of concretes and their properties and its applications in construction field and special types of concrete.*

UNIT - I   FIBRE REINFORCED CONCRETE AND FERROCEMENT   [9]

Fibre reinforced concrete - types of fibre – properties of fibres – factors affecting the properties of FRC – Workability – mixing - application. Different types of fibre reinforced concrete – current development in FRC. Ferrocement – Casting Techniques – Applications

UNIT - II   LIGHT WEIGHT CONCRETE AND HIGH DENSITY CONCRETE   [9]

Light weight concrete – light-weight Aggregate concrete – Structural light-weight concrete – workability – Design of light-weight Aggregate concrete Mix – mixing procedure – Aerated concrete – No-fines concrete. High density concrete – Types of radiation Hazards – Use of Concrete for radiation shielding

UNIT - III   HIGH VOLUME FLY ASH AND SLAG CONCRETE   [9]

Introduction – High volume fly ash & slag concrete - Mechanism of hydration – Mix proposition – properties of Fresh & Hardened Concrete. Durability Aspects of High Volume fly Ash Concrete and slag concrete

UNIT - IV   POLYMER MODIFIED MORTAR AND CONCRETE   [9]

Introduction – Application- General principle – Latex modification, Re dispersible polymer   powders – Water Soluble Polymers – liquid Resins – Monomers. Latex Modified Systems – Materials – Mix Proportioning – Mixing – Placing & Curing - Types of polymer concrete, Durability properties – Applications

UNIT - V   CONCRETE UNDER SPECIAL CIRCUMSTANCES   [9]

High Strength and High Performance Concrete – Self compacting concrete, self curing concrete, Geopolymer concrete, Bacterial concrete, Nano materials in concrete

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

- *Acquire knowledge on constituent materials of concrete, different types of cement, composition and properties and tests of cement and properties of aggregates.*

- *Gain knowledge about chemical and admixtures of concrete and their effects on concrete properties and study the mineral admixtures.*

- *Knowledge of principles of mix proportioning, mix design types and Mix design is to be studied for different methods.*

- *Determination of compressive and flexural strength of fresh concrete and hardened concrete, Young's modulus and durability test are to be studied.*

- *Significant different types of concretes and their properties and its applications in construction field and special types of concrete.*

Reference Books :

1   M.S.Shetty, "Concrete Technology", S.Chand and Company Ltd. Delhi, 2011.

2   A.M.Neville, "Properties of Concrete", Prentice Hall, 2012, London.

3   IS: 456-2007: "Indian Standards Code of Practice for Plain and Reinforced Concrete".

4   M.L.Gambir, "Concrete Technology", Tata McGraw Hill, Publishing Co. Ltd, New Delhi, 2006.

5   http://nptel.ac.in/syllabus/105102012/

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SEMESTER - II

ST18263	**DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES**	**L**	**T**	**P**	**C**
	(ELECTIVE)	**3**	**0**	**0**	**3**

Objectives:
- *To know the design of structural steel members subjected to tensile, compressive and bending loads*
- *To understand the design of structural systems such as roof trusses, gantry girders.*
- *To gain knowledge about seismic behavior of composite structures.*

UNIT - I   INTRODUCTION   [9]

Introduction to Steel - Concrete Composite Construction - Theory of Composite Structures - Introduction to Steel - Concrete - Steel Sandwich Construction

UNIT - II   DESIGN OF COMPOSITE MEMBERS   [9]

Behavior of Composite Beams - Columns - Design of Composite Beams - Steel - Concrete Composite Columns - Design of Composite Trusses

UNIT - III   DESIGN OF CONNECTIONS   [9]

Types of Connections - Design of Connections in the Composite Structures - Shear Connections - Design of Connections in Composite Trusses.

UNIT - IV   COMPOSITE BOX GIRDER BRIDGES   [9]

Introduction - Behavior of Box Girder Bridges - Design Concepts.

UNIT - V   CASE STUDIES AND SEISMIC BEHAVIOR   [9]

Case Studies on Steel - Concrete Composite Construction In Buildings - Seismic Behavior of Composite Structures.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Knowledge about the concept of structural steel members and tension splice.*
- *Design of compression members and column bases*
- *Design of laterally supported and unsupported beams.*
- *Gain knowledge about design of purlin & gantry girder*
- *Design of plate girder & understand the concept of light gauge steel section*

Reference Books :

1   Johnson. R.P., "Composite structures of steel and concrete", Blackwell Scientific Publications (Second Edition), UK, 1994.
2   Owens. G.W. and Knowels. P., "Steel Designers Manual", (Fifth edition), Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 1992.
3   Workshop on Steel Concrete Composite Structures, Conducted at Anna University, 2000.
4   IS 11384 - 1985, Code of Practice for Steel concrete Composite structures.

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SEMESTER II

		L	T	P	C
ST18264	**EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION (ELECTIVE)**	3	0	0	3

Objectives:

- *To learn the principles of measurements of static and dynamic response of structures and carry out the analysis of results*
- *To understand the testing methods of concrete*
- *To have a knowledge on the advanced types of equipment used in lab and field.*

UNIT - I   FORCES AND STRAIN MEASUREMENT   [9]

Choice of Experimental Stress Analysis Methods, Errors in Measurements - Strain Gauge, principle, types, performance and uses. Photo Elasticity - Principle and Applications - Hydraulic Jacks and Pressure Gauges – Electronic Load Cells – Design of Load Cell, Proving Rings – Calibration of Testing Machines – Long-Term Monitoring – Vibrating Wire Sensors– Fibre Optic Sensors.

UNIT - II   VIBRATION AND TEMPERATURE MEASUREMENTS   [9]

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for Velocity and Acceleration Measurements. Vibration Meter – Seismographs – Vibration Analyzer – Display and Recording of Signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital Data Acquisition Systems. – Thermo Couple Gauge.

UNIT - III   NONDESTRUCTIVE STRUCTURE & WIND FLOW MEASURES   [9]

Load Testing on Structures, Buildings, Bridges & Towers- Rebound Hammer – Acoustics Emission – Ultrasonic Testing Principles & Application – Holography – Use of Laser for Structural Testing – Brittle Coating, Advanced NDT Methods –Ultrasonic Pulse Echo, Impact Echo, Impulse Radar Techniques GECOR, Ground Penetrating Radar (GPR). Principles of Pressure and Flow Measurements – Pressure Transducers – Wind Tunnel and its use in Structural Analysis – Structural Modeling – Direct and Indirect Model Analysis.

UNIT - IV   DISTRESS MEASUREMENTS AND CONTROL   [9]

Diagnosis of Distress in Structures – Crack Observation and Measurements– Corrosion of Reinforcement in Concrete – Half cell, Construction and use – Damage Assessment – Controlled Blasting for Demolition – Techniques for Residual Stress Measurements – Permeability Measurements.

UNIT - V   RESEARCH TECHNIQUES, STANDARDS AND SPECIFICATIONS   [9]

X- Ray Diffration, Differential Thermal Analysis, Thermo gravimetry Analysis, Atomic Absorption Spectroscopy, Conduction Calorimetry, Potentiometric Methods, X-Ray Fluorescence Analysis, Neutron Activation Analysis, Mossbauer Spectroscopy, Nuclear UV Absorption Spectroscopy, Electron Microscopy, Surface Area, Helium Pycnometry, Microhardness, Mercury Porosimetry, other Techniques and Standards and Specifications.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

- *Gain knowledge on various stress analysis methods and testing methods.*
- *Acquire skills related to vibration and temperature measurements.*
- *Gain knowledge on various testing methods and technologies.*
- *Learn to diagnosis of distress in structures and distress measurements and control.*
- *Gain inspiration for lifelong learning towards applying research techniques, standards and specifications.*

Reference Books :

1   Sadhu Singh. "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1989.
2   Dalley .J.W and Riley.W.F., "Experimental Stress Analysis", Mc Graw Hill Book Company, N.Y. 1991.
3   Srinath.L.S, Raghavan.M.R, Lingaiah.K, Gargesha.G, Pant.B and Ramachandra.K., "Experimental Stress Analysis", Tata McGraw Hill Company, New Delhi, 1984.
4   Sirohi.R.S., Radhakrishna.H.C., "Mechanical Measurements", New Age International (P) Ltd. 1997.
5   Bray.D.E. and Stanley.R.K., "Course Material on Non-destructive Evaluation",Mc Graw Hill Publishing Company,New York, 1989.

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SEMESTER - II

ST18265	INDUSTRIAL STRUCTURES (ELECTIVE)	L	T	P	C
		3	0	0	3

Objectives:
* *To Study the Requirements of Industrial Structures.*
* *To Study the Planning of Industrial Structures.*
* *To Study the Design of Industrial Structures.*

UNIT - I   PLANNING AND FUNCTIONAL REQUIREMENTS   [9]

Classification of Industries and Industrial Structures - Planning for Layout Requirements Regarding Lighting, Ventilation and Fire Safety - Protection against Noise and Vibration - Guidelines from Factories Act.

UNIT - II   ROOF FOR INDUSTRIAL BUILDINGS   [9]

Roofs for Industrial Buildings - Steel and RC - Folded Plates and Shell Roofs.

UNIT - III   MISCELLANEOUS STRUCTURES   [9]

Gantry Girders - Design of Corbels and Nibs - Machine Foundations.

UNIT - IV   POWERPLANT STRUCTURES   [9]

Bunkers and Silos - Chimneys and Cooling Towers - High Pressure Boilers and Piping Design - Nuclear Containment Structures

UNIT - V   POWER TRANSMISSION STRUCTURES   [9]

Cables - Transmission Line Towers - Substation Structures - Tower Foundations - Testing Towers

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
* *Gain knowledge about basic concept of planning and requirements of industrial structures.*
* *Learn about in Industrial building and industrial roofing structures*
* *Analyze field problems in power plant structures.*
* *Gain knowledge about basic concept of power transmission structures.*
* *Know the design concepts of corbels and nibs.*

Reference Books :

1   Proc. of Advanced Course of Industrial Structures, Structural Engineering Research Centre, 1982.
2   P.Srinivasaluand C.V.Vaidyanathan, handbook of Machine Foundations, Tata McGraw Hill, 1976.
3   Varghese. P. C. "Advanced RCC Design", 2nd Edition, PHI Learning, 2009.
4   Manohar.S.N., "Tall Chimneys - Design and Construction", Tata McGraw Hill, 1994.
5   Santhakumar.A.R. and Murthy.S.S. "Transmission Line Structures", Tata Mc Graw Hill, 1992.
6   Dunham.V, "Planning of Industrial Structures", Mc-Graw Hill Book Co. 2002.

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SEMESTER - II

		L	T	P	C
ST18266 | **EARTHQUAKE RESISTANT STRUCTURES**
(ELECTIVE) | 3 | 0 | 0 | 3 |

Objectives:

- To learn the causes of earthquake and effects of ground motion and modeling of structures. Study the response spectra and structural dynamics of MDOF systems.
- To discover the different analysis and design approaches like equivalent lateral force method and inelastic time history analysis.
- To be trained in the ductile detailing of reinforced concrete structures as per IS 4326 and IS 13920.

UNIT - I   INTRODUCTION   [9]

Earthquake Ground Motion: Engineering seismology, Seismic zoning map of India, Strong motion studies in India, Strong motion characteristics, Evaluation of seismic design parameters.
Structural Dynamics: Initiation into structural dynamics, Dynamics of SDOF systems, Theory of seismic pickup, Numerical evaluation of dynamic response, Response spectra, Dynamics of MDOF systems.

UNIT - II   CONCEPTS OF EARTHQUAKE RESISTANT DESIGN   [9]

Basic elements of earthquake resistant design, Identification of seismic damages in RCC buildings, Effect of structural irregularities on performance of RCC buildings during earthquakes, earthquake resistant building architecture.

UNIT - III   SEISMIC ANALYSIS AND MODELING OF RCC STRUCTURES   [9]

Code based procedure for determination of design lateral loads, Infill walls, Seismic analysis procedure as per IS 1893 code, Equivalent static force method, Response spectrum method, Time history analysis, Mathematical modelling of multi-storey RCC buildings.

UNIT - IV   EARTHQUAKE RESISTANT DESIGN OF RCC STRUCTURES   [9]

Ductility considerations, Earthquake resistant design of multi-storey RCC buildings and shear walls based on IS 13920 code, Capacity based design.

UNIT - V   EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES   [9]

Identification of damages and non-damages in masonry buildings, Elastic properties of structural masonry, Lateral load analysis of masonry buildings, Seismic analysis and design of one-storey and two-storey masonry buildings.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

- *Classify the concepts of structural dynamics of MDOF systems for analysis of structures.*
- *Model and analyse the structures to resist earthquake forces by different methods.*
- *Design the various structural elements resisting earthquake forces as per IS Codes.*
- *Practice ductile detailing of reinforced concrete and masonry buildings as per codal provisions.*
- *Can know about earthquake resistant of Masonry structures.*

Reference Books :

1   Bruce A Bolt, "Earthquakes", W H Freeman and Company, New York, 2004.
2   C. A. Brebbia, "Earthquake Resistant Engineering Structures", WIT Press, 2011.
3   Mohiuddin Ali Khan "Earthquake-Resistant Structures: Design", Build and Retrofit‖, Elsevier Science & Technology, 2012.
4   Pankaj Agarwal 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.

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SEMESTER - III

		L	T	P	C
ST18361	**STABILITY OF STRUCTURES** **(ELECTIVE)**	3	0	0	3

Objectives:
- *To gain the concept of buckling and analysis of structural elements.*
- *To learn the concept of buckling of plates.*
- *To study the behaviour of inelastic buckling.*

UNIT - I   STABILITY OF COLUMNS   [9]

Concept of elastic structural stability – Analytical approaches to stability – Characteristics of stability analysis – Elastic buckling of columns- Equilibrium, Energy and Imperfection approaches – Non-Prismatic columns- Built up columns- Orthogonality of buckling modes- Effect of shear on buckling load – Large deflection theory.

UNIT - II   METHOD OF ANALYSIS AND INELASTIC BUCKLING   [9]

Approximate Methods- Rayleigh and Galerkin'smethods – Numerical methods- Finite Difference and Finite Element – Analysis of columns- Experimental study of column Behaviour- South well plot – Column curves – Derivation of column design formula – Effective length of columns – Inelastic behaviour – Tangent modulus and double modulus Theory.

UNIT - III   BEAM COLUMNS AND FRAMES   [9]

Beam column behavior – Standard case- Continuous columns and beam columns – Column on elastic foundation – Buckling of frames – Single story portal frames with and without side sway – Classical and stiffness methods – Approximate Evaluation of critical Loads in multistoried Frames- Use of Wood's charts.

UNIT - IV   CONCEPT OF TORSIONAL BUCKLING   [9]

Lateral buckling of beams – Energy method – Application to symmetric and simply symmetric I beams – Simply supported and cantilever beams – Narrow rectangular cross sections – Torsional buckling – Uniform and Non-Uniform torsion on open cross section – Flexural torsional buckling – Equilibrium and energy approach.

UNIT - V   BUCKLING OF THIN PLATES   [9]

Isotrophic rectangular plates – Governing differential equations – Simply supported on all edges – Use of energy methods – Plates with stiffeners – Concept of numerical techniques.

Total (L: 45 T: 0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Gain knowledge about basic concept of Stability of columns.*
- *Know the theory of inelastic buckling.*
- *Recall the concept of portal frames and beam columns.*
- *Learn about the torsional buckling of various sections.*
- *Gain knowledge about the buckling of thin plates.*

Reference Books :

1   Ashwini Kumar, "Stability of Structures", Allied Publishers Ltd, 2003.

2   Timoshenko, James M. Gere Mineola, "Theory of elastic stability" N.Y Dover Publications, 2009.

3   NGR Iyengar, Stephen P "Structural Stability of columns and Plates" Affiliated East-West press Pvt. Ltd., 1996.

4   Chai Hong Yoo, Sung Lee, "Stability of Structures - Principles and Applications" Butterworth-Heinemann, Elsevier, 2011.

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<u>SEMESTER – III</u>

		L	T	P	C
ST18362	**CORROSION OF STEEL IN CONCRETE** **(ELECTIVE)**	3	0	0	3

Objectives:
- *To know the basic principles of occurrence of corrosion.*
- *To study the Corrosion and Remedial Measures of Steel in Concrete.*
- *To apply the testing methods for corrosion of steel.*

UNIT - I   PRINCIPLES AND THEORIES OF STEEL CORROSION IN CONCRETE   [9]

Types of Corrosion of Rebars– Chloride Induced Corrosion of Steel in Concrete, Carbonation of Concrete and its Effect on Corrosion of Steel, Influence of Stray Current on Corrosion of Reinforcing Steel in Concrete – Corrosion of Steel in Prestress Concrete.

UNIT - II   MEASUREMENT OF CORROSION OF STEEL IN CONCRETE   [9]

Half-Cell Potential Measurement, Potential Mapping to Identity Anodic and Cathodic Sites, Linear Polarization Technique, Electrochemical Impedance Spectroscopy, Weight Loss Measurements, Micro-Cell Corrosion Study, Galvanostatic Pulse – Measurements – Custom Sweep and Resistance Test.

UNIT - III   IN-SITU CORROSION MONITORING OF STRUCTURES   [9]

Embeddable Electrodes and Sensors for Reinforced Concrete Structures - Use of Portable Equipment's and Instruments for Corrosion Monitoring - Interpretation of Test Results

UNIT - IV   CORROSION CONTROL   [9]

Anodic and Cathodic Protection, Corrosion Inhibitors, Anodic, Cathodic and Mixed Inhibitors, Inhibitor Efficiency, Corrosion Protection by Surface Coatings to Steel and Concrete, Determination of Coating Performance, Alternate Reinforcing Materials.

UNIT - V   ELECTRO CHEMICAL CORROSION PROTECTION IN REINFORCED CONCRETE   [9]

Electrochemical Chloride Removal, Electrochemical Realkalization, Principles of Cathodic Protection by Impressed Current Method, and Sacrificial Anode Type, Microscopic Study of Concrete and Steel Interface, Image Techniques.

Total (L : 45 T : 0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Gain Knowledge about the Principles of Steel Corrosion in Concrete.*
- *Analyze the Polarization and Spectroscopy of Steel Corrosion.*
- *Know about the Corrosion Monitoring of Structures.*
- *Relate the Corrosion Prevention Methods.*
- *Apply the Electro Chemical Corrosion Protection in Reinforced Concrete*

Reference Books :

1   Raupach. M, Elsener.B, Polder.R,Miety.J, "Corrosion of Reinforcement in Concrete Mechanisms, Monitoring, Inhibitors and Rehabilitation Techniques", Wood Head Publishing Ltd, Cambridge, 2007
2   Refresher Course Material on "Corrosion of Steel in Concrete", C.E.C.R.I, Karaikudi.
3   Vidivelli.B. "Rehabilitation of Concrete Structures", Standard Publishers Distributors, 2009.

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SEMESTER - III

		L	T	P	C
ST18363	**ASEISMIC DESIGN OF STRUCTURES** **(ELECTIVE)**	3	0	0	3

Objectives:
- *To Study and Understand the Importance of the Aseismic Design of Structures and Earthquake Response of the Structure.*
- *To Understand the Codal Provision of IS 13920 and Behavior of RC Structure.*
- *To Impart the Knowledge about base Isolation Technique.*

UNIT - I   INTRODUCTION   [9]

Basic Seismology – General Features of Tectonics of Seismic Regions- Earthquake Terminology - Definitions -Earthquake History – Behavior of Buildings, Dams and Bridges in Past Earthquakes – Seismographs – Accelerographs – Types of Earthquake – Fault Rupture Parameters – Earthquake Ground Motion Characteristics – Deterministic and Probabilistic Approach – Response Spectra – Design Spectra.

UNIT - II   EARTHQUAKE RESPONSE   [9]

Earthquake Response to Elastic and Inelastic Buildings – Application to Response Spectrum Theory – Base Exited Motion - Ground Motion Parameters – Modal Response Contribution – Modal Participation Factor – Response History – Spectral Analysis – Multiple Support Excitation – Earthquake Response to Continuous Systems on Rigid Base – Approximate Methods for Lateral Load Analysis.

UNIT - III   IS CODE PROVISIONS   [9]

Design Criteria Strength, Deflection, Ductility and Energy Absorption – Cyclic Behaviour of Structures- Codal Provisions of Design of Buildings as per IS 1893 and IS 4326. Ductile Detailing of Structures as per IS 13920. Behaviour and Design of Masonry Structures as per IS 13827 and IS13828.

UNIT - IV   BEHAVIOUR OF RC STRUCTURES   [9]

Analysis and Design of Frames for Lateral Loads – Capacity Design – Shear Wall Frame System – Coupled Shear Wall – Design of Rectangular and Flanged Shear Walls – Ductile Detailing of Frames for Earthquake Forces.

UNIT - V   SPECIAL TOPICS   [9]

Modern Concepts – Base Isolation, Passive Control and Active Control Systems – Computer Analysis and Design of Buildings for Earthquake Loads using Software Packages like   ETABS, ANSYS, and SAP2000.

Total (L: 45 T: 0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Know the Difference between Static and Dynamic Analysis, Types of Dynamic Loads, Concept Damping.*
- *Evaluate the Response of Structures to Different Types of Dynamic Loads*
- *Analyze Earthquake Phenomenon and Codal Provisions.*
- *Carry out Seismic Analysis of Structure.*
- *Gain Knowledge about Modern Concepts Involved in Aseismic Design.*

Reference Books :

1   Chopra, Anil.K, "Dynamics of Structures – Theory and Applications to Earthquake Engineering", Prentice – Hall of India Pvt.Ltd., 2007.
2   Pankaj Agarwal, "Earthquake Resistant Design of Structures", Prentice – Hall of India Pvt.Ltd., 2006.
3   James *Ambrose,* Dimitry *Vergun.,* "Simplified Building Design for Wind and Earthquake Forces", John Wiley, 1997.
4   Glenn Berg., "Seismic, Design Codes and Procedures, Earthquake Engineering Research Institute", 1983.

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SEMESTER - III

		L	T	P	C
ST18364	**DESIGN OF BRIDGES** **(ELECTIVE)**	3	0	0	3

Objectives:
* *To study about the Classification, Specification and Design Considerations for Bridge Structures.*
* *To learn and understand the Design of Various Elements of the Bridge Structure.*
* *To gain the Knowledge about the Types of Bridge Foundation and Design of Foundations.*

UNIT - I   INTRODUCTION   [9]

Classification, Investigations and Planning, Choice of Type, I.R.C. Specifications for Road Bridges & Loads, Forces Acting on Bridges, General Design Considerations.

UNIT - II   SHORT SPAN BRIDGES   [9]

Load Distribution Theories, Analysis and Design of Slab Culverts, Tee Beam and Slab Bridges.

UNIT - III   LONG SPAN GIRDER BRIDGES   [9]

Design Principles of Continuous Bridges, Box Girder Bridges, Balanced Cantilever Bridges.

UNIT - IV   DESIGN OF PRESTRESSED BRIDGES   [9]

Flexural and Torsional parameters – Courbon's theory–Distribution Co-Efficiently Exact Analysis –Design of girder section –Maximum and Minimum Prestressing Forces – Eccentricity– Live Load and Dead Load Shear Forces – Cable Zone in Girder – Check for Stresses at Various Sections–Check for Diagonal Tension–Diaphragms–End Block– Short Term and LongTerm Deflections.

UNIT - V   DESIGN OF PLATE GIRDER BRIDGES, BEARINGS AND SUBSTRUCTURES   [9]

Design of Riveted and Welded Plate Girder Bridges for Highway and Railway Loading– Wind Effects – Main Section, Splicing, Curtailment, Stiffeners –Different Types of Bearings– Design of Bearings–Design of Masonry and Concrete Piers and Abutments – Types of Bridge Foundations– Design of Foundations.

Total (L : 45 T : 0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
* *Gain Knowledge on various types and Specifications of Bridge Structures.*
* *Learn to load Distribution and Design of Slabs in Bridge Structure.*
* *Learn to Design Principles of Bridges.*
* *Acquire Knowledge on Various Load Calculation and Design of Prestressed Bridges.*
* *Learn about Design of Plate Girder and Design of Foundation Structure.*

Reference Books :

1. Krishnaraju.N, "Design of Bridges" McGraw Hill Education; 6th edition, 2018.
2. Ponnuswamy. S, "Bridge Engineering", McGrawHill,2nd edition, 2008.
3. Johnson Victor.D, "Essentials of Bridge Engineering", Oxford and IBH Publishing Co.Pvt.Ltd,6th edition,2018.
4. Jagadeesh.T.R, Jayaram.M.A, "Design of Bridge Structures",Prentice Hall of India Pvt . Ltd. 2nd edition, 2009.
5. Raina.V.K, "Concrete Bridge Practice", Shroff Pub & Dist. Pvt. Ltd, 2007.

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SEMESTER - III

		L	T	P	C
ST18365	**DESIGN OF PLATE AND SHELL STRUCTURES (ELECTIVE)**	3	0	0	3

Objectives:
- *To study the Structural Behavior and Types of Folded Plates, Shells by Different Methods.*
- *To Design and Analyse the Different Structures of Space Frames.*
- *To gain Knowledge on Analysis of Grid Floors in Construction.*

UNIT - I   DESIGNOF FOLDED PLATES   **[9]**

Folded Plate Structures-Structural Behaviour – Types- Design by ACI- ASCE Task Committee Method.

UNIT - II   THEORY OF SHELLS   **[9]**

Classification of Shells - Structural Action - Membrane Theory – Shells of Revolution and Shells of Translation - Examples - Limitations of membrane theory.

UNIT - III   SPACE FRAME - DESIGN PHILOSOPHY   **[9]**

Space Frames - Configuration - Types of Nodes - General Principles of Design Philosophy – Behaviour.

UNIT - IV   ANALYSIS OF SPACE FRAMES   **[9]**

Analysis of Space Frames - Formex Algebra, FORMIAN - Detailed Design of Space Frames.

UNIT - V   GRID FLOORS   **[9]**

General Features-Analysis of Grid Floors-Design Examples.

Total (L: 45 T:0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Gain knowledge on Basic Concepts in Classification of Plates*
- *Learn the Structural Action of Different Types of Shells and its Translation.*
- *Carryout a Design and Analysis of Space Frames Starting from Conceptual Design, by Selecting Suitable Data's and its Elements.*
- *Develop an Intuitive Feeling about the Different Stages of Grid Floors, ie., Develop a Clear Understanding of Conceptual Design*
- *Carryout a Design Philosophy of Plates, Frames and Shells.*

Reference Books :

1   Timoshenko, S.Woinowsky-Krieger, S "Theory of Plates and Shells", McGraw Hill Education, 2nd edition, 2017
2   Ramasamy, G.S., Design and Construction of Concrete Shells Roofs, CBS Publishers, 1st edition, 2005.
3   Farshad, M. "Design and Analysis of shell structures", Springer, 2010
4   Subramanian, N. " Principles of Space Structures", A H Wheeler Publishing Co Ltd.2008,
5   Chatterjee,B.K., Theory and Design of Concrete Shells, Oxford and IBH publishing co,1988.
6   http://nptel.ac.in/courses/105105041/
7   https://mycourses.aalto.fi/course/view.php?id=8489 &section=1

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<u>SEMESTER – IV</u>

ST18366   **DESIGN OF TALL BUILDINGS**   L   T   P   C
                                   (ELECTIVE)   3   0   0   3

Objectives:
- *To study the Behavior Analysis and Design of Tall Structures.*
- *To identify About Different Types of Loads, Materials and Design Philosophy.*
- *To gain the Knowledge about the Stability of Tall Building.*

UNIT - I   DESIGN CRITERIA   [9]

Design Philosophy, Loading, Sequential Loading and Materials - High Performance Concrete and High Strength Concrete - Fiber Reinforced Concrete - Light Weight Concrete.

UNIT - II   LOADING AND MOVEMENT   [9]

Gravity Loading: Dead and Live Load, Methods of Live Load Reduction, Impact, Gravity Loading, Construction Load. Wind Loading: Static and Dynamic Approach, Analytical and Wind Tunnel Experimental Method. Earthquake Loading: Equivalent Lateral Force, Modal Analysis, Combinations of Loading Working Stress Design, Limit State Design, Plastic Design.

UNIT - III   BEHAVIOR OF VARIOUS STRUCTURAL SYSTEMS   [9]

Factors affecting Growth, Height and Structural Form. High Rise Behavior, Rigid Frames, Braced Frames, In filled Frames, Shear Walls, Coupled Shear Walls, Wall-Frames, Tubular, Cores, Futrigger - Braced and Hybrid Mega System – Buttress system.

UNIT - IV   ANALYSIS AND DESIGN   [9]

Modeling for Approximate Analysis, Accurate Analysis and Reduction Techniques, Analysis of Building as Total Structural System Considering Overall Integrity and Major Subsystem Interaction, Analysis for Member Forces, Drift and Twist, Computerized General Three Dimensional Analyses.

Structural Elements: Sectional Shapes, Properties and Resisting Capacity-Design, Deflection, Cracking, Prestressing –Shear flow, Design for Differential Movement-Creep and Shrinkage Effects-Temperature Effects and Fire Resistance

UNIT - V   STABILITY OF TALL BUILDINGS   [9]

Overall Buckling Analysis of Frames, Wall-Frames, Approximate Methods, Second Order Effects of Gravity of Loading, P-Delta Analysis, Simultaneous First-Order and P-Delta Analysis-Translational-Torsional Instability, out of Plumb Effects-Stiffness of Member in Stability-Effect of Foundation Rotation.

Total (L: 45 T:0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Discuss the Behavior of Tall Buildings due to Various Types of Loads.*
- *Categorize the Different Types of loads, materials and Design Philosophy.*
- *Describe the Maintenance and Modifications Structural Elements.*
- *Solve and Design Such Buildings by Approximate, Accurate and Simplified Methods.*
- *Outline the Stability of Tall Building.*

Reference Books :

1   Taranath.B.S, "Structural Analysis and Design of Tall Building", CRC Press, 2011.
2   Lin T.Y and Stotes Burry D, "Structural Concepts and systems for Architects and Engineers", John Wiley, 2007.
3   Bryan Stafford Smith and AlexCoull, "Tall Building Structures - Analysis and Design", John Wiley and Sons, Inc., 2007.
4   Gupta.Y.P,"Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities", New Age International Limited, 1995.

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SEMESTER – III

| ST18OE1 | **PRINCIPLES OF SUSTAINABLE DEVELOPMENT**
(OPEN ELECTIVE) | L
3 | T
0 | P
0 | C
3 |

Objectives:

- *To impart knowledge in the concepts and dimensions of sustainable development.*
- *To gain knowledge on the framework for achieving sustainability.*
- *To sustainable development of socio economic systems*

UNIT - I   CONCEPT OF SUSTAINABLE DEVELOPMENT   **[9]**

Environment and Development - Population poverty and Pollution – Global and Local environmental issues – Resource Degradation-Greenhouse gases – Desertification-Industrialization – Social insecurity, Globalization and environment. History and emergence of the concept of sustainable development-Objectives of Sustainable Development.

UNIT - II   COMPONENTS AND DIMENSIONS OF SUSTAINABLE DEVELOPMENT   **[9]**

Components of Sustainability – Complexity of growth and equity – Social economic and environmental dimensions of sustainable development – Environment – Biodiversity – Natural resources – Ecosystem integrity – Clean air and water – Carrying capacity – Equity, Quality of Life, Prevention, Precaution – Preservation and Public Participation Structural and functional linking of developmental dimensions.

UNIT - III   FRAMEWORK FOR ACHIEVING SUSTAINABILITY   **[9]**

Operational guidelines – Interconnected prerequisites for sustainable development Empowerment of Women, children, Youth, Indigenous People, Non-Governmental Organizations Local Authorities, Business and industry – Science and Technology for sustainable development – Performance indicators of sustainability and assessment mechanism – Constraints and barriers for sustainable development.

UNIT - IV   SUSTAINABLE DEVELOPMENT OF SOCIO ECONOMIC SYSTEMS   **[9]**

Demographic dynamics of sustainability – Policies for Socio - Economic Development – Strategies for Implementing Eco-Development program Sustainable development through trade – Economic growth – Action plan for implementing sustainable development – Urbanization and sustainable Cities – Sustainable Energy and Agriculture – Sustainable livelihoods.

UNIT - V   SUSTAINABLE DEVELOPMENT AND INTERNATIONAL RESPONSE   **[9]**

Role of developed countries in the development of developing countries – International summits – Stockholm to Johannesburg – Rio principles – Agenda- Conventions – Agreements – Tokyo Declaration – Doubling statement – Tran boundary issues integrated approach for resources protection and management

Total (L : 45 T : 0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

- *Describe the concepts of sustainable development.*
- *Define the components and dimensions of sustainable development.*
- *Outline the Frame work for achieving sustainability.*
- *State the policies and strategies for implementing sustainable development for Socio economic programmes.*
- *Examine the role of developed countries in sustainable development.*

Reference Books :

1. Sayer J. and Campbell, B., The Science of Sustainable Development: Local Livelihoods and the Global environment - Biological conservation restoration & Sustainability, Cambridge university Press, London, 2003.
2. M.K. Ghosh Roy and Timberlake, Sustainable Development, Ane Books Pvt. Ltd, 2011.
3. Peter Brandon, Patrizia Lombardi, Evaluating Sustainable Development, Wiley-Blackwell, 2005.
4. APJ Abdul Kalam and Srijan Pal Singh, Target 3 Billion: Innovative Solutions Towards Sustainable Development, Penguin India, 2011

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<u>**SEMESTER - III**</u>

MA18302	**OPERATIONS RESEARCH TECHNIQUES**	L	T	P	C
	(OPEN ELECTIVE)	3	0	0	3

Objectives:
- *To learn about the optimization techniques for decision making problem in engineering fields.*
- *To understand concepts of Transportation, Assignment problems and to study the concepts of project scheduling by network analysis.*
- *To enumerate the concepts in stock control models, scheduling and Replacement problems.*

UNIT - I	LINEAR PROGRAMMING PROBLEM	[9]

Introduction - Scope and role of OR - Phases of OR - Limitations of OR - Linear programming problem - Formulation of linear programming problem - Optimum solution by graphical method - Simplex method (using slack variables only).

UNIT - II	TRANSPORTATION AND ASSIGNMENT PROBLEMS	[9]

Transportation Models (Minimizing and Maximizing Cases) - Balanced and Unbalanced cases - Initial Basic feasible solution by North West Corner Rule, Least cost and Vogel's approximation methods. Check for optimality by Modified method. Assignment Models (Minimizing and Maximizing Cases) - Balanced and Unbalanced Cases - Solution by Hungarian method.

UNIT - III	NETWORK ANALYSIS	[9]

Network - Fulkerson's rule - Construction of a network - Critical path method (CPM) - Programme Evaluation and Review Techniques (PERT) - Project scheduling by PERT analysis.

UNIT - IV	INVENTORY CONTROL THEORY	[9]

Types of Inventory - Deterministic inventory models - Purchase and manufacturing models with and without shortages - Quantity discount model - Price breaks (up to 3 price breaks).

UNIT - V	REPLACEMENT PROBLEMS	[9]

Replacement of items that deteriorate with time - Value of money changing with time - Not changing with time - Optimum replacement policy - Individual and group replacement.

Total (L: 45 T: 0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Develop the decision making during the uncertain situations by linear programming approach.*
- *Minimize the Transportation and Assignment cost to maximize the profit in industries.*
- *Develop the network techniques in project scheduling.*
- *Study the importance of stock controlling to maximize the profit.*
- *Apply the Replacement methods.*

Reference Books :
1. P.K. Gupta and Man Mohan "Problems in Operations Research", S. Chand and Co, 14th edition, 2016.
2. Hira and Gupta "Problems in Operations Research", S. Chand and Co, 13th edition, 2015.
3. Taha H.A, "Operation Research", Pearson Education 11th edition, 2016.

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<u>SEMESTER – III</u>

ST18OE3   **BRIDGE MAINTENANCE MANAGEMENT**   L   T   P   C
                    (OPEN ELECTIVE)   3   0   0   3

Objectives:
- *To introduce the philosophy underlying bridge maintenance management*
- *To study the salient features of bridge deterioration.*
- *To know the causes of bridge deterioration, the stress monitoring in bridge structures*

UNIT - I   UNIT I - INTRODUCTION   **[9]**

Bridge maintenance management - The system - Inspection - Inspection equipment- Planning - condition rating.

UNIT - II   ASSESSMENT AND EVALUATION   **[9]**

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

UNIT - III   NON DESTRUCTIVE TESTING   **[9]**

Concrete Elements - Corrosion analysis equipment's - Resistivity measurements - Rebar locators - Ultrasonic testing - Rebound hammer - carbonation test – Permeability Testing - Internal fracture tester - Impulse radar - Infrared thermography - Endoscopy -Impact echo - Radiography - Coring - Steel elements - Masonry elements.

UNIT - IV   BRIDGE DETERIORATION   **[9]**

Basic Theory - Discount rate - Traffic disruption - Future development – Maintenance strategy - Performance profiles - Whole life assessment.

UNIT - V   STRESSS MEASUREMENTS AND BRIDGE MONITORING   **[9]**

In - situ residual stresses - Stress relief principle - Indirect stress management – Live load stresses - Monitoring - Scour sensing - Load cells - Displacement transducers -Traffic monitoring.

Total (L : 45 T : 0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- *Study testing assessment and monitoring of bridge structures.*
- *Know the stress monitoring in bridge structures.*
- *Gain knowledge about the stress measurements.*
- *Study non - destructive testing.*
- *Learn about the deterioration of bridges.*

Reference Books :

1   M. J. Ryall and J. E. Harding G. A. R. Parke 'Bridge Management: Inspection, Maintenance, Assessment and Repair'' published by Springer science First Edition (Reprinted), 1994.

2   Airong Chen, Dan M. Frangopol, " Bridge Maintenance, Safety, Management and Life Extension CRC Press / Balkema, 2014

3   Proc. Third "International Conference on Bridge Management" F & N Spon, London. 1996.

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SEMESTER – III

		L	T	P	C
ST18OE4	**PRESTRESSED CONCRETE** **(OPEN ELECTIVE)**	3	0	0	3

Objectives:

- *To Impart Knowledge on the Basic Principles, Losses of Prestressed Concrete Structures.*
- *To Impart the Design Philosophy of Flexural Members, Continuous Beams*
- *To Impart the Design Philosophy of Prestressed Water Tanks, Pipes, Piles, Composite Beams etc.*

UNIT - I   PRINCIPLES OF PRESTRESSING   [9]

Principles of Prestressing - Types and Systems of Prestressing, Need for High Strength Concrete and High Tensile Steel - Analysis of Sections for Stresses by Stress Concept, Strength Concept and Load Balancing Concept - Analysis Methods Losses, Deflection (Short-Long Term), Camber, Cable Layouts.

UNIT - II   DESIGN OF FLEXURAL MEMBERS   [9]

Behaviour of Flexural Members - Determination of Ultimate Flexural Strength – IS: 1343Codal Provisions - Design of Flexural Members, Design for Combined Bending, Shear and Torsion, Design of Anchorage Zone.

UNIT - III   DESIGN OF CONTINUOUS BEAMS   [9]

Analysis and Design of Continuous Beams - Methods of Achieving Continuity – Concept of Linear Transformations, Concordant Cable Profile and Cap Cables.

UNIT - IV   DESIGN OF TENSION AND COMPRESSION MEMBERS   [9]

Design of Tension Members - Application in the Design of Prestressed Pipes and Prestressed Concrete Cylindrical Water Tanks - Design of Compression Members – Application in the Design of Columns and Piles.

UNIT - V   DESIGN OF COMPOSITE MEMBERS   [9]

Composite Beams - Analysis and Design, Ultimate Strength - their Applications. Partial Prestressing– its Advantages and Applications.

Total (L: 45 T:0) = 45 Periods

- ***Course Outcomes: On Completion of this course, the student will be able to***
- *Learn the Principles and Analysis, requirements of Pre-Stressed Concrete.*
- *Learn to Design the Prestressed Concrete Flexural Members as per IS1343.*
- *Gain Knowledge the about Analysis Principle of Continuous Beams and Apply in the Design of Prestressed Concrete Continuous Beams*
- *Know about the Design of Compression and Tension Members.*
- *Analyze for Stresses and Ultimate Strength of Prestressed Composite Beams and Partial Prestressing.*

Reference Books :

1   Krishna Raju, N., "Prestressed Concrete", Tata McGraw Hill Publishing Company, Ltd., 6th edition, 2018.
2   DevadasMenon, Sengupta, A.K,"Prestressed Concrete Structure (Web Course)", NPTEL Course Notes, 2008.
3   Sinha, N. C, Roy S K, "Fundamentals of Prestressed Concrete", S Chand & Co, 3rd edition, 2011.
4   Praveen Nagarajan., "Prestressed Concrete Design", Pearson Publisher, 1st edition, 2013.
5   Edward G Nawy, "Prestressed Concrete", A Fundamental Approach, 5th edition, Prentice Hall, Upper Saddle river, 2009.
6   S. Ramamrutham , " Prestressed Concrete",DhanpatRai Publishing Company (P) Ltd,5th edition, 2013.
7   http://nptel.ac.in/courses/105106117/

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<u>**SEMESTER – III**</u>

| **ST18OE5** | **SMART MATERIALS AND SMART STRUCTURES** (OPEN ELECTIVE) | L 3 | T 0 | P 0 | C 3 |

Objectives:
- *To learn the usage of smart materials in instrumented structures.*
- *To impart knowledge in measuring techniques and sensors.*
- *To gain knowledge in actuators and data acquisition systems for linear and nonlinear analysis.*

UNIT - I   INTRODUCTION   [9]

Introduction to smart materials and structures - instrumented structures functions and response – sensing systems - self-diagnosis - signal processing consideration - actuation systems and effectors.

UNIT - II   MEASURING TECHNIQUES   [9]

Strain measuring techniques using electrical strain gauges, types – resistance – capacitance – inductance –Wheatstone bridges – pressure transducers – load cells – temperature compensation – strain rosettes.

UNIT - III   SENSORS   [9]

Sensing technology – Types of sensors – Physical measurement using piezo electric strain measurement –Inductively read transducers – LVDT – Fibre optic techniques - Chemical and bio-chemical sensing in structural assessment – Absorptive chemical sensors – spectroscopes – Fibre optic chemical sensing systems and Distributed measurement.

UNIT - IV   ACTUATORS   [9]

Actuator techniques – Actuator and actuator materials – Piezoelectric and electro strictive material –Mange to stricture material – shape memory alloys – Electro rheological fluids – Electromagnetic actuation – Role of actuators and actuator materials.

UNIT - V   SIGNAL PROCESSING AND CONTROL SYSTEMS   [9]

Data acquisition and processing – Signal processing and control for smart structures – Sensors as geometrical Processors – Signal processing – Control system – Linear and nonlinear.

Total (L : 45 T : 0) = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to
- Gain knowledge about the instrumented structures functions and response in modern engineering
- Examine the strain measuring techniques using strain gauges.
- Design sensors using piezoelectric and fiber optic systems.
- Acquire knowledge to characterize the actuator materials based on their applications.
- Learn about data acquisition system and also acquire knowledge to design control system.

Reference Books :

1　A.V.Srinivasan., "Smart Structures", (South asian edition) Cambridge University Press, 2009.
2　Peter.L.Reece., "Smart Materials and Structures": New Research, Nova Science Publishers Inc, 2007.
3　Mukesh V., Gandhi, B. S. Thompson, "Smart Materials and Structures", Springer, 1992.
4　Gustav Gautschi., G.Gautschi., "Piezoelectric Sensorics": 2nd Edition, Springer, 2006.

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SEMESTER - III

ST183A1	**ENGLISH FOR RESEARCH PAPER WRITING** (Common to ST & CN)	L	T	P	C
		2	0	0	0

Objectives:
- *Understand that how to improve your writing skills and level of readability.*
- *Learn about what to write in each section.*
- *Understand the skills needed when writing a title.*
- *Ensure the good quality of paper at very first -time submission.*

UNIT - I   **[6]**

Planning and Preparations, Word order, Breaking up long sentences, Structuring, Paragraphs and Sentences, Being concise and removing redundancy, Avoiding Ambiguity and vagueness.

UNIT - II   **[6]**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing Paraphrasing and plagiarism, Sections of a paper, abstracts, Introduction, Review of the Literature, methods, results, discussions, conclusions, the final check.

UNIT - III   **[6]**

Key skills are needed when writing a title, key skills are needed when writing an abstract, key skills are needed when writing an introduction, skills needed when writing a review of literature.

UNIT - IV   **[6]**

Skills are needed when writing the methods, skills needed when writing the results, skills are needed when writing the discussion, skills are needed when writing the conclusions.

UNIT - V   **[6]**

Useful phrases, how to ensure paper is as good as it could possibly the first time submission.

Total = 30 Periods

Course Outcomes : On Completion of this course, the student will be able to
- *Know how to improve your writing skills and level of readability.*
- *Learn about what to write in each section.*
- *Improved skills needed when writing a title, abstract and introduction.*
- *Improved skills needed when writing methods, results and discussion.*
- *Ensure the good quality of paper at very first time submission.*

Reference Books :

1   Goldbort R (2006) Writing for Science, Yale University Press (available on google books)
2   Day R (2006) How to write and publish a scientific paper, Cambridge University Press
3   Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book
4   Adrian Wallwork, English for Writing Research Papers, Springer New York ,Dordrecht Heidelberg London, 2011

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<u>**SEMESTER - III**</u>

		L	T	P	C
ST18321	**PROJECT WORK - PHASE I**	0	0	12	6

Objective: To know about needs of the industry and research and provide solutions / suggestions related to Structural Engineering.

1. Every student shall have a supervisor who is the member of the faculty of the institution. Selection of faculty supervisor has to be completed within the first two weeks from the day of beginning of third semester.

2. The students should make discussion with his supervisor for selecting topic.

3. In consultation with supervisor, student has to collect research papers and journals.

4. Preferably it can be an experimental work or it can be a case study.

5. A detailed study of the collected literatures to be carried out.

6. The methodology should be framed and works carried out based on the framed methodology.

7. Phase - I project report should be submitted at the end of the semester as per guidelines.

8. This project report should be evaluated jointly by external and internal examiners.

Course Outcomes: On Completion of this course, the student will be able to
- *Identify current industry / research needs.*
- *Acquire knowledge on the experimental projects.*
- *Collect the data from the literature surveys and able to frame the methodology.*
- *Summarize the works carried out and can be compared with the Codal provisions.*
- *Apply the solutions for the results identified.*

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SEMESTER - III

		L	T	P	C
ST18322	**PRACTICAL TRAINING**	0	0	20	1

Objective: *To prepare students to gain confidence in solving practical issues related to Structural Engineering.*

1. The faculty allotted for practical training will act as supervisor.

2. The student shall finally produce a comprehensive report covering back field information, field survey, methodology implemented, results and discussions with conclusion.

3. This practical training report shall be submitted for evaluation.

4. The knowledge gained in practical training shall be assessed in presentation.

5. The practical training report should be evaluated by internal examiner.

Course Outcomes: On Completion of this course, the student will be able to
- Gain knowledge about the practical training related to Structural Engineering.
- *Determine the industrial exposure through various industrial experiments.*
- *Enhance the collective skills between theoretical knowledge and real time work.*
- *Enhancement knowledge on the impact of health, safety and environmental solutions on productivity, quality and society at large.*
- *Apply the solutions for the problems identified.*

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SEMESTER - IV

	L	T	P	C
ST18421 **PROJECT WORK – PHASE II**	0	0	30	12

Objective: *To know about needs of the industry and research and provide solutions / suggestions related to Structural Engineering.*

1. The supervisor allotted for project phase I will continue to supervise project phase II.

2. As per methodology suggested in phase I, the project can be implemented.

3. Outcome of implementation can be studied and each student shall finally produce a comprehensive report covering back ground information, literature survey, methodology, results and discussions with conclusion.

4. This final report shall be in type written form as specified in the guidelines.

5. The project report should be evaluated jointly by external and internal examiners

Course Outcomes: On Completion of this course, the student will be able to
- *Identify current industry/research needs.*
- *Acquire knowledge on the experimental projects.*
- *Collect the data from the literature surveys and able to frame the methodology.*
- *Summarize the works carried out and can be compared with the Codal provisions.*
- *Apply the solutions for the results identified.*