K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE - 637 215
(Autonomous)

DEPARTMENT OF CIVIL ENIGNEERING

(REGULATIONS 2020)

M.E- STRUCTURAL ENGINEERING

Vision of the Institution

IV	We envision to achieve status as an excellent Educational Institution in the global knowledge hub, making self-learners, experts, ethical and responsible engineers, technologists, scientists, managers, administrators and entrepreneurs who will significantly contribute to research and environment friendly sustainable growth of the nation and the world.

Mission of the Institution

IM 1	To inculcate in the students self-learning abilities that enable them to become competitive and considerate engineers, technologists, scientists, managers, administrators and entrepreneurs by diligently imparting the best of education, nurturing environmental and social needs.
IM 2	To foster and maintain mutually beneficial partnership with global industries and Institutions through knowledge sharing, collaborative research and innovation.

Vision of the Department / Programme: (Structural Engineering)

DV	To impart knowledge and excellence in Civil Engineering and Technology with global perspectives to our students and to make them ethically strong engineers to create conducive environment.

Mission of the Department / Programme: (Structural Engineering)

DM 1	To promote innovative thinking in the minds of budding engineers and to make the department a centre of excellence in the field of Engineering.
DM 2	To provide knowledge base and moral autonomy to address regional, national and international needs in Civil Engineering.

Programme Educational Objectives (PEOs): (Structural Engineering)

The graduates of the programme will be able to	
PEO 1	Provide students to learn the detailed concepts of structural engineering for designing Civil Engineering structures.
PEO 2	Have successful career in different sectors of Structural Engineering Industry and technical institutes through life-long learning.
PEO 3	Independently analyze socio-industrial problems and provide feasible solutions through critical thinking and research.

Programme Outcomes (POs) of M.E. - Structural Engineering

Program Outcomes (POs)	
PO1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report / document
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
Program Specific Outcomes (PSOs)	
PSO1	Profound knowledge of Structural Engineering discipline, with an ability to evaluate, analyze and synthesize the existing and new knowledge in the field of structural design with wide applications.
PSO2	Critically analyze complex Structural Engineering problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.

	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 - 2020

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

SEMESTER - I

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	ST20111	Matrix Methods of Structural Analysis	3	0	0	3	30	70	100
2.	MA20132	Applied Mathematics for Structural Engineering	3	0	0	3	30	70	100
3.	ST20113	Advanced Concrete Structures	3	0	0	3	30	70	100
4.	ST20114	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.	ST20121	Advanced Structural Engineering Laboratory	0	0	3	2	50	50	100
8.	ST20122	Technical Presentation - I	0	2	0	1	50	50	100
		Total	**18**	**02**	**03**	**21**	**800**		

*End semester examination only in the second semester

SEMESTER - II

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
THEORY									
1.	ST20211	Theory of Elasticity and Plasticity	3	0	0	3	30	70	100
2.	ST20212	Advanced Steel Structures	3	0	0	3	30	70	100
3.	ST20213	Finite Element Method	3	0	0	3	30	70	100
4.	ST20214	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.	ST20221	Advanced Computing Laboratory	0	0	3	2	50	50	100
8.	ST20222	Technical Presentation - II	0	2	0	1	50	50	100
		Total	**18**	**02**	**03**	**21**	**800**		

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

SEMESTER - III

Sl.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.		Audit Course	2	0	0	0	50	50	100
PRACTICAL									
5.	ST20321	Project Work – Phase I	0	0	12	6	50	50	100
6.	ST20322	Practical Training*	0	0	20	1	50	50	100
		Total	**11**	**0**	**32**	**16**	**600**		

(* Four Weeks during vacation)

SEMESTER - IV

Sl.No.	Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CA	ES	Total
PRACTICAL									
1.	ST20421	Project Work – Phase II	0	0	30	12	50	50	100
		Total	**0**	**0**	**30**	**12**	**100**		

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

PROFESSIONAL ELECTIVES (SEMESTER – I)									
Sl.No.	**Course Code**	**Course Name**	**Hours/ Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**ES**	**Total**
THEORY									
1.	ST20161	Advanced Concrete Technology	3	0	0	3	30	70	100
2.	ST20162	Maintenance and Rehabilitation of Structures	3	0	0	3	30	70	100
3.	ST20163	Wind Analysis and Design of Structures	3	0	0	3	30	70	100
4.	ST20164	Optimization in Structural Design	3	0	0	3	30	70	100
5.	ST20165	Soil Structure Interaction	3	0	0	3	30	70	100
6.	ST20166	Storage Structures	3	0	0	3	30	70	100

PROFESSIONAL ELECTIVES (SEMESTER – II)									
Sl.No.	**Course Code**	**Course Name**	**Hours/ Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**ES**	**Total**
THEORY									
1.	ST20261	Chemistry of Cement and Concrete	3	0	0	3	30	70	100
2.	ST20262	Special Concrete	3	0	0	3	30	70	100
3.	ST20263	Design of Steel Concrete Composite Structures	3	0	0	3	30	70	100
4.	ST20264	Experimental Techniques and Instrumentation	3	0	0	3	30	70	100
5.	ST20265	Industrial Structures	3	0	0	3	30	70	100
6.	ST20266	Earthquake Resistant Structures	3	0	0	3	30	70	100

PROFESSIONAL ELECTIVES (SEMESTER – III)									
Sl.No.	**Course Code**	**Course Name**	**Hours/ Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**ES**	**Total**
THEORY									
1.	ST20361	Stability of Structures	3	0	0	3	30	70	100
2.	ST20362	Corrosion of Steel in Concrete	3	0	0	3	30	70	100
3.	ST20363	Aseismic Design of Structures	3	0	0	3	30	70	100
4.	ST20364	Design of Bridges	3	0	0	3	30	70	100
5.	ST20365	Design of Plate and Shell Structures	3	0	0	3	30	70	100
6.	ST20366	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**
THEORY									
1.	ST20OE1	Principles of Sustainable Development	3	0	0	3	30	70	100
2.	MA20302	Operations Research Techniques	3	0	0	3	30	70	100
3.	ST20OE3	Failure Analysis of structures	3	0	0	3	30	70	100
4.	ST20OE4	Prestressed Concrete structures	3	0	0	3	30	70	100
5.	ST20OE5	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**
THEORY									
1.	ST203A1	English for Research paper writing	2	0	0	0	50	50	100

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SEMESTER – I

		L	T	P	C
ST20111	**MATRIX METHODS OF STRUCTURAL ANALYSIS**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Illustrate the fundamentals in the analysis of structural members.*	*Understand*
CO2:	*Identify about the characteristics of structures by evaluation of its flexibility and stiffness matrices.*	*Apply*
CO3:	*Apply the transformation of system forces to element forces and element flexibility to system flexibility.*	*Apply*
CO4:	*Categorize about analysis of system through direct and element approach of flexibility method.*	*Analyze*
CO5:	*Examine structures by direct and element approach of stiffness method.*	*Analyze*

UNIT - I ENERGY CONCEPTS IN STRUCTURES [09]

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 [09]

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 [09]

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 [09]

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 [09]

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 (L= 45, T = 0) = 45 Periods

Reference Books :

1. Natarajan, C, and Revathi, P., Matrix Methods of structural Analysis: Theory and Problems, PHI leaning Pvt. Ltd., New Delhi, First Edition, 2014.
2. Bhavikati, S.S., Structural Analysis Vol.-I & II, Vikas Publishing House Pvt. Ltd., Fourth Edition, 2013.
3. Pandit, G.S, and Gupta, S.P., Structural Analysis Matrix Approach, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition, 2014.
4. Vazirani, V.N. and Ratwani, M.M., Advanced Theory of Structures and Matrix Methods of Analysis, Khanna Publishers, New Delhi, First Edition, 2008.

Course Faculty ` ***Module Coordinator*** ***Chairman BoS/CIVIL***

K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER – I

		L	T	P	C
MA20132	**APPLIED MATHEMATICS FOR STRUCTURAL ENGINEERING**	3	0	0	3

Course Outcomes : ***On successful completion of the course, the student will be able to*** **Cognitive Level**

CO1:	*Solutions to one dimensional wave and heat equations.*	*Evaluate*
CO2:	*Finding the solutions to elliptic and Poisson equations.*	*Apply*
CO3:	*Developing their skills in calculus of variations.*	*Understand*
CO4:	*Formulation of LPP and finding the optimal solutions.*	*Remember*
CO5:	*Interpreting multiple integration by using mapping function.*	*Evaluate*

UNIT – I ONE DIMENSIONAL WAVE AND HEAT EQUATIONS [09]

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 [09]

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 [09]

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 [09]

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

UNIT – V NUMERICAL INTEGRATION [09]

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

Total = 45 Periods

Reference Books :

1 Gupta, A.S., Calculus of Variations with Applications, Prentice Hall of India Pvt. Ltd., New Delhi, 2014

2 SankaraRao, K., Introduction to Partial Differential Equations, Prentice Hall of India Pvt. Ltd., New Delhi, 2015.

3 Andrews, L.C. and Shivamoggi, B.K., Integral Transforms for Engineers, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

4 P.K.Gupta and Manmohan Singh, Problems in Operation Research, S.Chand Publications, 2014.

Course Faculty ` **Module Coordinator** **Chairman BoS/*S & H***

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SEMESTER - I

ST20113	**ADVANCED CONCRETE STRUCTURES**	L	T	P	C
		3	0	0	3

Course Outcomes: On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Identify the design of beams, column and slabs with codal provisions.*	*Apply*
CO2:	*Develop the design of special RC elements.*	*Create*
CO3:	*Design flat slab and spandrel beams according to IS and ACI methods.*	*Create*
CO4:	*Illustrate the inelastic behavior of concrete structures.*	*Understand*
CO5:	*Interpret the quality control of concrete in field practice.*	*Understand*

NIT - I INTRODUCTION [09]

Review of limit state design of beams, slabs and column according to Indian standard (IS) codes. Calculation of deflection and crack width according to IS and American Concrete Institute (ACI) Codes.

UNIT - II DESIGN OF SPECIAL REINFORCED CONCRETE(RC) ELEMENTS [09]

Design of slender columns - Design of reinforced concrete 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 [09]

Design of flat 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 [09]

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

UNIT - V DETAILING AND FIELD PRACTICE [09]

Detailing for ductility - Fire resistance of structural members - Quality control of concrete.

Total = 45 Periods

References:

1 Krishna Raju, N., Advanced Reinforced Concrete Design, CBS Publishers & Distributors, New Delhi, Third Edition, 2016.

2 Varghese, P.C., Advanced Reinforced Concrete Design, Prentice Hall of India Private Limited, New Delhi, Second Edition, 2011.

3 Unnikrishna Pillai, S. and Devdas Menon., Reinforced Concrete Design, Tata McGraw-Hill Publishing Company Ltd., New Delhi, Third Edition, 2017.

4 Gambhir. M. L., Design of reinforced Concrete Structures, PHI Learning Pvt. Ltd., New Delhi, First Edition, 2014.

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K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - I

ST20114	**STRUCTURAL DYNAMICS**	L	T	P	C
		3	0	0	3

Course Outcomes: On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Identify the different degrees of freedom systems and damping.*	*Apply*
CO2:	*Analyses the formulation of structures by different methods of freedom systems.*	*Analyze*
CO3:	*Examine the dynamic response of multi degree of freedom by various methods.*	*Analyze*
CO4:	*Estimate the flexural vibration of beams.*	*Evaluate*
CO5:	*Design structures under dynamic loading conditions.*	*Create*

UNIT - I PRINCIPLES OF DYNAMICS [09]

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(MDOF) SYSTEMS [09]

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 [09]

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 [09]

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 [09]

Idealization of Multi– Storied Frames for Dynamic Loads– 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 – Indian Standard (IS) code Provisions – Wind Analysis – Gust Factor.

Total = 45 Periods

References :

1 Mario Paz William Leigh, Structural Dynamics, Kluwer Academic Press, Springer, Boston, Fifth Edition, 2004.

2 Anil .K. Chopra., Dynamics of Structures – Theory and applications to Earthquake Engineering, Pearson Education India, Third Edition, 2007.

3 Roy R. and Craig. Jr., Structural Dynamics - An Introduction to Computer Methods, John Wiley & Sons, New York, 1981.

4 Clough. R.W. and Penzien. J., Dynamics of Structures, CBS Publishers & Distributors, New Delhi, Second Edition, 2015.

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K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - I

		L	T	P	C
ST20121	**ADVANCED STRUCTURAL ENGINEERING LABORATORY**	0	0	3	2

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Interpret the method of testing of simply supported reinforced concrete beam for strength and deflection behavior.*	*Apply*
CO2:	*Examine the dynamic testing of steel elements.*	*Analyze*
CO3:	*Execute the method of testing of static cyclic testing of single bay two storied steel frames.*	*Apply*
CO4:	*Assimilate the quality of concrete and method of testing of concrete by Non-destructive test – rebound hammer & ultra-sonic pulse velocity test.*	*Analyze*
CO5:	*Perceive about the flow characteristics of self-compacting concrete.*	*Analyze*

List of Experiments:

1. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour.
2. Testing of simply supported steel beam for strength and deflection behaviour.
3. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.
4. Dynamic testing of cantilever steel beam
    a) To determine the damping 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.

Total = 45 Periods

References :

1 Dally, J.W, and Riley, W. F., Experimental Stress Analysis, Mc Graw-Hill, New Delhi, Third Edition, 1991.

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SEMESTER - I

		L	T	P	C
ST20122	**TECHNICAL PRESENTATION - I**	0	2	0	1

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Identify the area of interest of the student.*	*Apply*
CO2:	*Identify the thrust areas by referring journals, conference proceedings etc.*	*Apply*
CO3:	*Familiarize with literature collection.*	*Understand*
CO4:	*Demonstrate his/her own ideas in the current topic.*	*Understand*
CO5:	*Perceive about report writing and presentation.*	*Evaluate*

- The students have to refer the journals and conference proceedings and collect the literature.
- The student 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 Faculty ` ***Module Coordinator*** **Chairman BoS/*CIVIL***

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SEMESTER - II

ST20211	**THEORY OF ELASTICITY AND PLASTICITY**	L	T	P	C
		3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Illustrate the equilibrium and compatibility equations, plane stress & plane strain.*	*Understand*
CO2:	*Evaluate the two dimensional problems by Airy's stress function.*	*Evaluate*
CO3:	*Identify the membrane analogy and torsion of non-circular section.*	*Apply*
CO4:	*Analyze and calculate deflection of beams by using Energy theorems.*	*Analyse*
CO5:	*Determine the elastic and plastic problems in bending.*	*Evaluate*

UNIT - I PLANE STRESS AND PLANE STRAIN [09]

Basic concepts of deformation of bodies – Notations of stress and strain in three dimensional (3D) fields – Transformation of stress and strain in 3D field - Analysis of Stress and Strain - Stress-Strain Relationship - Equilibrium Equations - Compatibility Equations - Generalized Hooke's Law - Plane Stress and Plane strain Problems.

UNIT - II TWO DIMENSIONAL IN ELASTICITY [09]

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 [09]

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 PRINCIPLE [09]

Theorem of minimum potential energy and complementary energy – Bending of prismatic bars – Stress function – Beam of rectangular cross section – Beams of circular cross section.

UNIT - V PLASTICITY [09]

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

Total = 45 Periods

Reference Books :

1 Timoshenko, S, and Goodier, J.N., Theory of Elasticity, McGraw Hill (India) Private Limited, Noida, Third Edition, 2017.

2 Dr. Sadhu Singh, Theory of Elasticity, Khanna Publishers, New Delhi, Fourth Edition, 2003.

3 Dr. Sadhu Singh, Theory of Plasticity, Khanna Publishers, New Delhi, Fourth Edition, 2003.

4 Jane Helena, H., Theory of Elasticity and Plasticity, PHI Learning, New Delhi, First Edition, 2017.

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K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - II

		L	T	P	C
ST20212	**ADVANCED STEEL STRUCTURES**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Design members subjected to forces as per the standard code.*	*Create*
CO2:	*Classify different types of steel connections.*	*Evaluate*
CO3:	*Analyse and design transmission line towers and Chimneys.*	*Analyse*
CO4:	*Examine plastic analysis in continuous beams and portal frame.*	*Analyse*
CO5:	*Design light gauge steel elements*	*Create*

UNIT - I INTRODUCTION [09]

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 [09]

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 [09]

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 [09]

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 [09]

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 (L= 45, T = 0) = 45 Periods

Reference Books :

1 Negi. L.S., Design of steel Structures, Tata McGraw – Hill Education, New Delhi, Second Edition, 2017.

2 Subramanian. N., Design of Steel Structures, Oxford University Press, New Delhi, Fourth Edition, 2018.

3 Gambhir. M.L., Fundamentals of Structural Steel Design, McGraw Hill Education, New Delhi, First Edition, 2017.

4 Wei- Wen Yu., Design of Cold Formed Steel Structures, McGraw Hill Book Company, New York, Fifth Edition, 2019.

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K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER – II

		L	T	P	C
ST20213	**FINITE ELEMENT METHOD**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Illustrate basic concept of Finite Element Method, boundary and initial value problems.*	*Understand*
CO2:	*Examine about the finite element analysis of two dimensional problems.*	*Evaluate*
CO3:	*Compare Isoparametric elements and formulation of elements equations in one and two dimensions.*	*Analyze*
CO4:	*Illustrate field problems in higher order elements and analyze using mesh refinement and error evaluation.*	*Understand*
CO5:	*Inspect about the analysis of beams and rigid frames using two nodal beam elements.*	*Analyze*

UNIT - I 1D FINITE ELEMENT ANALYSIS [09]

Historical background – Weighted residual methods – Basic concepts of FEM – Variation formulation of Boundary value problems – 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 [09]

Basic Boundary Value Problems in 2 Dimensions – Triangular, Quadrilateral, higher order elements – Poisson and Laplace's equation – Weak Formulation – Element matrices and vectors.

UNIT - III ISO - PARAMETRIC FORMULATION [09]

Natural co-ordinate system – Lagrangian interpolation Polynomials – Iso-parametric - Elements – Formulation – Numerical integration – 1 D - 2 D triangular elements – Rectangular elements – Illustrative Examples.

UNIT - IV MESHING AND SOLUTION PROBLEMS [09]

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 ANALYSIS OF BEAMS AND RIGID FRAMES [09]

Introduction – Beam analysis using two Nodal elements – Analysis of Rigid Plane Frame using 2 Node Beam Elements – A three Dimensional rigid frame element – Timoshenko beam element.

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

Reference Books :

1 Zienkiewicz, O.C, and Taylor, R.L., Finite Element Methods, Butterworth-Heinemann, Oxford, Sixth Edition, 2005.

2 Bathe, K.J., Finite Element Procedure in Engineering Analysis, Prentice Hall Inc, New Jersey, First Edition, 1996.

3 Chandrupatla, T.R, and Belegundu, A.D., Introduction to Finite Element in Engineering, Prentice Hall, New Delhi, Fourth Edition, 2011.

4 Bhavikatti, S.S., Finite Element Analysis, New Age International Publishers, New Delhi, Third Edition, 2015.

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SEMESTER - II

		L	T	P	C
ST20214	**DESIGN OF SUBSTRUCTURES**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to	***Cognitive Level***
CO1: Demonstrate about the sub surface exploration.	*Understand*
CO2: Interpret different types of shallow foundations.	*Evaluate*
CO3: Inspect the design of pile foundation and application.	*Analyze*
CO4: Assess foundation to the miscellaneous structures.	*Evaluate*
CO5: Design different types of machine foundations based on guidelines.	*Create*

UNIT - I SUBSURFACE EXPLORATION [09]

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

UNIT - II SHALLOW FOUNDATIONS [09]

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 [09]

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 SPECIAL STRUCTURES [09]

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 [09]

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 (L= 45, T = 0) = 45 Periods

Reference Books :

1 Tomlinson, M.J., Foundation Design and Construction, Pearson India, Chennai, Seventh Edition, 2017.

2 Bowels, J. E., Foundation analysis and Design, McGraw Hill International Book Co, Fifth Edition, 2017.

3 Braja M. Das., Principles of Foundations Engineering, Cengage India Private limited, Noida, Eighth Edition, 2017.

4 Swami Saran., Analysis and Design of Substructures, CBS Publishers and Distributors Pvt. Ltd., New Delhi, Second Edition, 2018.

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K.S.R. COLLEGE OF ENGINEERING (Autonomous) **R 2020**

SEMESTER - II

		L	T	P	C
ST20221	**ADVANCED COMPUTING LABORATORY**	0	0	3	2

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Relate about Finite Element Model analysis and designing of RCC elements.*	*Remember*
CO2:	*Illustrate the design of pre-stressed concrete elements.*	*Evaluate*
CO3:	*Analyze steel member and bridge structure using FEM*	*Analyze*
CO4:	*Elaborate about response of dynamic analysis of structure.*	*Create*
CO5:	*Examine the retaining wall structures*	*Analyze*

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

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SEMESTER - II

		L	T	P	C
ST20222	**TECHNICAL PRESENTATION - II**	0	2	0	1

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Identify the area of interest of the student.*	*Apply*
CO2:	*Identify the thrust areas by referring journals, conference proceedings etc.*	*Apply*
CO3:	*Familiarize with literature collection.*	*Understand*
CO4:	*Demonstrate his/her own ideas in the current topic.*	*Understand*
CO5:	*Perceive about report writing and presentation.*	*Evaluate*

- 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

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SEMESTER - III

		L	T	P	C
ST20321	**PROJECT WORK - PHASE I**	0	0	12	6

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Identify current industry / research needs.*	*Apply*
CO2:	*Demonstrate experimental procedures.*	*Understand*
CO3:	*Collect the data from the literature surveys and able to frame the methodology.*	*Create*
CO4:	*Summarize the works carried out and can be compared with the Codal provisions.*	*Understand*
CO5:	*Apply the solutions for the results identified.*	*Apply*

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.

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SEMESTER - III

		L	T	P	C
ST20322	**PRACTICAL TRAINING**	0	0	20	1

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	Assess about the practical training related to Construction Engineering and Management.	*Evaluate*
CO2:	*Apply the industrial exposure through various industrial experiments.*	*Apply*
CO3:	*Augment the collective skills between theoretical knowledge and real time work.*	*Apply*
CO4:	*Identify the impact of health, safety and environmental solutions on productivity, quality and Society at large.*	*Apply*
CO5:	*Solve the solutions for the problems identified.*	*Create*

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

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SEMESTER - IV

		L	T	P	C
ST20421	**PROJECT WORK - PHASE II**	0	0	30	12

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Identify current industry / research needs.*	*Apply*
CO2:	*Demonstrate experimental procedures.*	*Understand*
CO3:	*Collect the data from the literature surveys and able to frame the methodology.*	*Create*
CO4:	*Summarize the works carried out and can be compared with the Codal provisions.*	*Understand*
CO5:	*Apply the solutions for the results identified.*	*Apply*

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 report covering background information , literature survey , problem statement, research discussion with conclusion and industry certificate (If applicable).
4. Phase II project report should be submitted at the end of the semester as per guidelines.
5. This project report should be evaluated jointly by external and internal examiners.

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SEMESTER - I

		L	T	P	C
ST20161	**ADVANCED CONCRETE TECHNOLOGY (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Demonstrate constituent materials of concrete, different types of cement, composition, properties, test of cement and properties of aggregates.*	*Understand*
CO2:	*Interpret the fresh, hardened and durability properties of concrete.*	*Understand*
CO3:	*Identify the principles of mix proportioning and Mix design.*	*Apply*
CO4:	*Summarize types of special concrete and their properties.*	*Understand*
CO5:	*Outline standards and specifications of various micro structural analysis Techniques*	*Understand*

UNIT - I CONCRETE MAKING MATERIALS [09]

Aggregates classification - Indian standard (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 [09]

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

UNIT - III MIX DESIGN [09]

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

UNIT - IV SPECIAL CONCRETE [09]

Light weight concrete - Heavy density 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 [09]

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

Reference Books:

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

2 Santhakumar, A.R., Concrete Technology, Oxford University Press, New Delhi, Second Edition, 2018.

3 Neville, A.M., Properties of Concrete, Pearson Education India, Chennai, Fifth Edition, 2012.

4 Gambir, M.L., Concrete Technology, McGraw Hill Education Private Limited, New Delhi, Fifth Edition, 2013.

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SEMESTER - I

		L	T	P	C
ST20162	**MAINTENANCE AND REHABILITATION OF STRUCTURES (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Illustrate the serviceability and durability of concrete with effects due to climate, temperature, chemicals, wear and erosion.*	*Understand*
CO2:	*Outline the importance of maintenance and inspection of structures with various repairing strategies.*	*Understand*
CO3:	*Summarize the types of materials for Repair.*	*Understand*
CO4:	*Demonstrate the various techniques for repair in concrete structures.*	*Understand*
CO5:	*Explain remedies for failures in structure due to design and construction errors.*	*Understand*

UNIT - I **INFLUENCE ON SERVICEABILITY AND DURABILITY** **[09]**

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** **[09]**

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** **[09]**

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** **[09]**

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** **[09]**

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 (L= 45, T = 0) = 45 Periods

Text Books :

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

2 Allen R.T, and Edwards S.C., Repair of Concrete Structures, Blakie and Sons, London, First Edition, 2011.

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

4 Dayaratnam, P. and Ramana Rao, N.V., Maintenance and Durability of Concrete Structures, University Press, Hyderabad, First Edition, 1997.

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SEMESTER - I

		L	T	P	C
ST20163	**WIND ANALYSIS AND DESIGN OF STRUCTURES (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Outline types of wind and their characteristics.*	*Understand*
CO2:	*Classify tunnels and inspect modeling requirements.*	*Understand*
CO3:	*Analyze the effect of wind on different structures*	*Analyze*
CO4:	*Choose various code provisions for the design of special structures for wind load.*	*Apply*
CO5:	*Design the Structures as cyclone resistant*	*Create*

UNIT - I INTRODUCTION [09]

Introduction, Types of wind – Characteristics of wind – Wind velocity, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects - Dynamic nature of wind – Pressure and suctions - Spectral studies, Gust factor.

UNIT - II WIND TUNNEL STUDIES [09]

Wind Tunnel Studies, Types of tunnels, Modelling requirements , Interpretation of Results, Aero-elastic models

UNIT - III EFFECT OF WIND ON STRUCTURES [09]

Classification of structures – Rigid and Flexible – Effect of wind on structures - Static and dynamic effects on Tall buildings – Chimneys.

UNIT - IV DESIGN OF SPECIAL STRUCTURES [09]

. Design of Structures for wind loading – as per IS, ASCE and NBC code provisions – design of Tall Buildings – Chimneys – Transmission towers – Industrial sheds

UNIT - V CYCLONE EFFECTS [09]

Cyclone effect on – low rise structures – sloped roof structures - Tall buildings. Effect of Cyclone on Claddings – Design of Cladding – use of Code Provisions in Cladding Design – Analytical Procedure and Modeling of Cladding.

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

Reference Books :

1 Peter Sachs, Wind Forces in Engineering, Pergamon Press, New York, Second Edition, 2013.

2 Cook. N.J., The Designer's Guide to Wind Loading of Building Structures: Static structures, Butterworths, First Edition, 2008.

3 John D. Holmes,Wind Loading of Structures, CRC Press, North America, Fourth Edition, 2021.

4 Kolousek.V, Pirner.M, Fischer.O and Naprstek.J, Wind Effects on Civil Engineering Structures, Elsevier Publications, California, First Edition, 1984.

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SEMESTER - I

		L	T	P	C
ST20164	**OPTIMIZATION IN STRUCTURAL DESIGN (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Explain the basic concepts in optimization techniques*	*Understand*
CO2:	*Analyze various methods of Linear and Non-Linear programming*	*Analyze*
CO3:	*Solve problems with degree of difficulty in geometric programming*	*Evaluate*
CO4:	*Describe the concept* of sub-optimization problems using classical and tabular methods.	*Create*
CO5:	*Apply various methods for optimal design of structural elements.*	*Apply*

UNIT - I BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES [09]

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 [09]

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 [09]

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 [09]

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 [09]

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

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

Reference Books :

1 Spunt, Optimization in Structural Design (Civil Engineering and Engineering Mechanics Services), Prentice-Hall, New Jersey, First Edition, 1971.

2 Rao, S.S., Optimization Theory and applications, Wiley Eastern Limited, New Delhi, First Edition, 1984.

3 Lucas Pun, Introduction to Optimization in Practice, John Wiley & Sons Inc., New Jersey, First Edition, 2001.

4 Iyengar. N.G.R and Gupta. S.K, Structural Design Optimization, Affiliated East West Press Ltd, New Delhi, First Edition, 1997.

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SEMESTER - I

		L	T	P	C
ST20165	**SOIL STRUCTURE INTERACTION (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Reproduce the concept of soil interaction, linear and non- linear behavior of soil.*	*Understand*
CO2:	Analysis infinite and Finite Length of beams with relation to their stiffness.	*Analyze*
CO3:	*Identify the elastic analysis of various plates.*	*Apply*
CO4:	*Assess the effects of elastic analysis of pile on the behaviour of a structure*	*Analyze*
CO5:	*Analyze the structure with soil-structure interaction effects by lumped mass model.*	*Analyze*

UNIT - I SOIL FOUNDATION INTERACTION [09]

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 [09]

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 [09]

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 [09]

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 [09]

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

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

Reference Books :

1 Selva Durai, A.P.S., Elastic Analysis of Soil Foundation Interaction, Elsevier Science Ltd, New York, First Edition, 2013.

2 Scott, R.F., Foundation Analysis, Prentice Hall, Englewood, First Edition, 2016.

3 ACI 336, Suggested Analysis and Design Procedures for Combined Footings and Mats, American Concrete Institute, New Delhi, First Edition, 2002.

4 Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley and Sons, New York, Second Edition, 2009.

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SEMESTER - I

		L	T	P	C
ST20166	**STORAGE STRUCTURES (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Use the techniques, skills and design principles of steel water tanks.*	*Apply*
CO2:	*Illustrate the design of concrete water tanks by using approximate and IS methods*	*Analyze*
CO3:	*Examine types of steel bunkers, silos and its design methodologies.*	*Analyze*
CO4:	*Analyze and design concrete bunkers and silos.*	*Analyze*
CO5:	*Design different types of foundations for material storage structures.*	*Create*

UNIT - I **STEEL WATER TANKS** **[09]**

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** **[09]**

Design of Circular tanks – Hinged and fixed at the base – IS method of calculating shear forces and moments – Hoop tension – Design of 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** **[09]**

Design of square bunker – Jansen's and Airy's theories – Indian Standard (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** **[09]**

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** **[09]**

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

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

Reference Books :

1 Rajagopalan, K., Storage Structures, A A. Balkema, Netherlands, First Edition, 1990.

2 Krishna Raju, N., Advanced Reinforced Concrete Design, CBS Publishers & Distributors, New Delhi, Third Edition, 2016.

3 Subramanian, N., Design of Reinforced Concrete Structures, Oxford publishers, Illustrated Edition, 2013.

4 Ram Chandra, Design of Steel Structures, Standard Book House, New Delhi, Nineteenth Edition, 2018.

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SEMESTER - II

		L	T	P	C
ST20261	**CHEMISTRY OF CEMENT AND CONCRETE (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Demonstrate the manufacture, components and specifications of Portland cement.*	*Understand*
CO2:	*Outline hydration, setting and hardening of Portland cement.*	*Understand*
CO3:	*Summarize about physicochemical and mechanical properties of Portland cement.*	*Understand*
CO4:	*Rephrase the Pozzolanic, Pozzolanic materials in concrete, Blast furnace slag.*	*Understand*
CO5:	*Relate Practical use, Production, Mix design criteria of Micro-silica as an addition in concrete.*	*Understand*

UNIT - I PORTLAND CEMENT [09]

Composition – Manufacture of Portland Cement clinker – Production of cement – components and their phase relationships – Constitutions and specifications of Portland Cement.

UNIT - II HYDRATION, SETTING AND HARDENING OF PORTLAND CEMENT [09]

Introduction – Hydration of Pure Clinker Minerals – Interaction in the Hydration of Clinker Minerals – Hydration of Portland Cement – Setting of Portland cement – Hydrated PC Paste – Strength of Hydrated Cement – PC Hydration at Elevated Temperature.

UNIT - III PHYSICOCHEMICAL AND MECHANICAL PROPERTIES OF PORTLAND CEMENT [09]

Introduction – Heat of Hydration – Setting Time – Strength – Instantaneous and Time-Dependant Strains Under Load – Drying Shrinkage – Durability.

UNIT - IV POZZOLANIC AND BLAST FURNACE SLAG CEMENT [09]

Introduction – Types of Pozzolanic Materials – Mixture of Pozzolanic Materials with lime – Cement Containing Pozzolanic Materials – Fresh, Mechanical, Transportation and Durability properties of concrete. Blast Furnace Slag – Processing – Composition – Slag activation – Hydration Modelling of GGBS cements – Hydraulic activity of slag – Portland Slag Cement and Blast furnace cement – Super-Sulfated cement.

UNIT - V MICRO-SILICA AS AN ADDITION [09]

Introduction – The Material – Effects on fresh concrete – Setting and Hardening of Concrete - Mechanical properties and Durability of Hardening Concrete – Practical Use of Micro-silica in concrete – Production of Micro-silica – Health and safety – standards and specifications – Mix design criteria .

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

Reference Books :

1 Ramachandran,V.S., Concrete Admixtures Handbook, William Andrew Publishers, New Delhi, Second Edition, 1996.

2 Santhakumar, A.R., Concrete Technology, Oxford University Press, India, Second Edition, 2018.

3 Neville, A.M., and Brooks, J.J., Concrete Technology, Pearson Education, New Delhi, Second Edition, 2010.

4 Lea's, Chemistry of Cement and concrete, Butter worth-Heinemann, Oxford, Fifth Edition, 2019.

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SEMESTER - II

		L	T	P	C
ST20262	**SPECIAL CONCRETE (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Explain the constituent materials of fibre reinforced concrete, properties of fibre, ferro cement and its applications.*	*Understand*
CO2:	*Illustrate workability, mixing procedure of light weight and high density concrete.*	*Understand*
CO3:	*Interpret the properties and durability of the high volume fly ash and slag concrete.*	*Understand*
CO4:	*Summarize types of polymer, mixing proportion and durability properties and its applications.*	*Understand*
CO5:	*Classify different types of concrete under special circumstances.*	*Understand*

UNIT - I FIBRE REINFORCED CONCRETE AND FERROCEMENT [09]

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 [09]

Light weight concrete – Light weight Aggregate concrete – Structural light weight concrete – Workability – Design of lightweight 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 [09]

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

UNIT - IV POLYMER MODIFIED MORTAR AND CONCRETE [09]

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 [09]

High Strength and High Performance Concrete – Self compacting concrete - Selfcuring concrete, Geopolymer concrete - Bacterial concrete - Nano materials in concrete.

Total = 45 Periods

Reference Books :

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

2 Gambir, M.L., Concrete Technology, Tata McGraw Hill Publishing Co. Ltd, New Delhi, Fifth Edition, 2017.

3 IS: 456-2000, Indian Standards Code of Practice for Plain and Reinforced Concrete.

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

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SEMESTER - II

		L	T	P	C
ST20263	**DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Discuss basic ideas on steel – concrete composite in construction*	*Create*
CO2:	*Identify the behavior of composite beams and columns*	*Apply*
CO3:	*Design composite beams, columns and trusses*	*Create*
CO4:	*Categorize the behavior of composite girder bridges.*	*Analyze*
CO5:	*Interpret knowledge from the case studies deals with composite construction.*	*Understand*

UNIT - I INTRODUCTION [09]

Introduction to Steel - Concrete Composite Construction - Theory of Composite Structures - Introduction to Steel - Concrete - Steel Sandwich Construction. Introduction - limit states of composite sections - shear connectors - type of shear connectors - degree of shear connection - partial and complete shear connections - strength of shear connectors - analysis and design of composite beams without profile sheet.

UNIT - II DESIGN OF COMPOSITE BEAMS [09]

Behavior of Composite Beams - Design of Composite Beams - propped condition - un propped condition - deflection of composite beams - beam with profile sheeted deck slab – design of partial shear connection.

UNIT - III DESIGN OF COMPOSITE SLABS [09]

Introduction - Behavior of Composite slabs - profiled sheeting - sheeting parallel to span - sheeting perpendicular to span - analysis and design of composite floor system.

UNIT - IV DESIGN OF COMPOSITE COLUMNS [09]

Behavior of Composite Column - Types of Composite columns - Design of encased columns - design of in-filled columns - axial, uni-axial and bi-axially loaded columns.

UNIT - V COMPOSITE BOX GIRDER BRIDGES AND CASE STUDIES [09]

Introduction - Behavior of Box Girder Bridges - Design Concepts. Temperature - shrinkage and creep - vibration of composite section - Cyclic behavior of composite section - case studies.

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

Reference Books :

1 Johnson R.P., Composite Structures of Steel and Concrete Beams, Slabs, Columns and Frames for Buildings, Wiley-Blackwell, Hoboken, Third Edition, 2004.

2 Narayanan, R., Steel-Concrete Composite Structures, CRC Press, Florida, First Edition, 2019.

3 Oehlers D.J. and Bradford M.A., Composite Steel and Concrete Structural Members, Fundamental behaviour, Pergamon, Oxford, First Edition, 2013.

4 Owens, G.W. and Knowles, P., Steel Designers Manual, Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, Oxford, Fifth Edition, 1993.

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SEMESTER - II

ST20264	**EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION (Professional Elective)**	L	T	P	C
		3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Explain various stress analysis methods and testing methods.*	*Understand*
CO2:	*Summarize characteristics of structural vibrations and acceleration measurements.*	*Understand*
CO3:	*Demonstrate on various testing methods and technologies in non-destructive structure and wind flow measures.*	*Understand*
CO4:	*Illustrate diagnosis of distress in structures, distress measurements and control.*	*Understand*
CO5:	*Demonstrate research techniques, standards and specifications.*	*Understand*

UNIT - I FORCES AND STRAIN MEASUREMENT [09]

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 [09]

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 NON-DESTRUCTIVE STRUCTURE AND WIND FLOW MEASURES [09]

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 [09]

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 [09]

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

Reference Books :

1 Dr.Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, Fourth Edition, 2009.

2 Dalley, J.W. and Riley, W.F., Experimental Stress Analysis, McGraw Hill Book Company, New York, Third Edition, 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, First Edition,1984.

4 Bray, D.E. and Stanley, R.K., Course Material on Non-destructive Evaluation, McGraw Hill Publishing Company, New York, First Edition,1989.

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SEMESTER - II

ST20265	**INDUSTRIAL STRUCTURES (Professional Elective)**	L	T	P	C
		3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Summarize basic concept of planning and requirements of industrial structures.*	*Understand*
CO2:	*Demonstrate Industrial building and industrial roofing structures.*	*Understand*
CO3:	*Evaluate design concepts of gantry girder with corbels and nibs.*	*Evaluate*
CO4:	*Analyze field problems in power plant structures.*	*Analyze*
CO5:	*Explain concept of power transmission structures.*	*Understand*

UNIT - I PLANNING AND FUNCTIONAL REQUIREMENTS [09]

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 [09]

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

UNIT - III MISCELLANEOUS STRUCTURES [09]

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

UNIT - IV POWERPLANT STRUCTURES [09]

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

UNIT - V POWER TRANSMISSION STRUCTURES [09]

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

Total = 45 Periods

Reference Books :

1 Srinivasalu, P. and Vaidyanathan, C.V., Handbook of Machine Foundations, Tata McGraw Hill, New Delhi, 2017.

2 Proc. of Advanced Course of Industrial Structures, Structural Engineering Research Centre, Chennai, 1982.

3 Varghese, P. C., Advanced Reinforced Concrete Design, PHI Learning, New Delhi, Second Edition, 2009.

4 Manohar, S.N., Tall Chimneys: Design and Construction, Tata Mc Graw Hill, New Delhi, First Edition, 1994.

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SEMESTER - II

		L	T	P	C
ST20266	**EARTHQUAKE RESISTANT STRUCTURES (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Interpret the performance and response of the structure during earthquake.*	*Understand*
CO2:	*Analyze the structures to resist earthquake forces by different methods.*	*Analyze*
CO3:	*Analyze the structures subjected to earthquake loading by different methods.*	*Analyze*
CO4:	*Apply ductile detailing of reinforced concrete and masonry buildings as per codal provisions.*	*Apply*
CO5:	*Determine concepts of the earthquake resistant design of masonry structures.*	*Evaluate*

UNIT - I INTRODUCTION [09]

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 Single degrees of freedom (SDOF) systems, Theory of seismic pickup, Numerical evaluation of dynamic response, Response spectra, Dynamics of MDOF systems.

UNIT - II CONCEPTS OF EARTHQUAKE RESISTANT DESIGN [09]

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 [09]

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 [09]

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 [09]

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 (L= 45, T = 0) = 45 Periods

Reference Books :

1 Mohiuddin Ali Khan., Earthquake-Resistant Structures, Design, Build, and Retrofit, Butterworth-Heinemann, Oxford, First Edition, 2013.

2 Pankaj Agarwal, and Manish Shrikhande., Earthquake Resistant Design of Structures, Prentice Hall of India, New Delhi, Fifth Edition, 2009.

3 Paulay, T. and Priestley, M.J.N., Seismic Design of Reinforced Concrete and Masonry buildings, John Wiley and Sons, New York, First Edition,1992.

4 Duggal, S.K., Earthquake Resistant Design of Structures, Oxford University Press, New Delhi, Second Edition, 2013.

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SEMESTER - III

ST20361	**STABILITY OF STRUCTURES (Professional Elective)**	L	T	P	C
		3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Estimate Stability of columns by analytical approaches*	*Evaluate*
CO2:	*Examine the theory of inelastic buckling.*	*Analyze*
CO3:	*Evaluate the behavior of portal frames and beam columns.*	*Evaluate*
CO4:	*Evaluate the torsional buckling of various sections.*	*Evaluate*
CO5:	*Inspect the buckling of thin plates* with stiffness by energy methods.	*Analyze*

UNIT - I STABILITY OF COLUMNS [09]

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 [09]

Approximate Methods- Rayleigh and Galerkin's methods – 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 [09]

Beam column behaviour – 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 woods charts.

UNIT - IV CONCEPT OF TORSIONAL BUCKLING [09]

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 [09]

Isotropic 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

Reference Books

1 Ashwini Kumar, Stability of Structures, Allied Publishers Limited, New Delhi, First Edition, 1998.

2 Stephen P. Timoshenko, and James M. Gere., Theory of Elastic Stability, Dover Publications, Mineola New York, Second Edition, 2012.

3 Chai Hong Yoo, and Lee Sung, C., Stability of Structures - Principles and Applications, Butterworth - Heinemann, Boston, First Edition, 2011.

4 Iyengar, N.G.R., Structural Stability of Columns and Plates, Ellis Horwood Ltd., First Edition, 1998.

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SEMESTER - III

		L	T	P	C
ST20362	**CORROSION OF STEEL IN CONCRETE (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Explain the basic principles of corrosion of steel in concrete.*	*Understand*
CO2:	*Illustrate different techniques on measurement of corrosion of steel in concrete.*	*Understand*
CO3:	*Demonstrate the in-situ corrosion monitoring systems in structures.*	*Understand*
CO4:	*Explain various methods of the corrosion prevention and* alternate reinforcing materials.	*Understand*
CO5:	*Demonstrate electro chemical corrosion protection in reinforced concrete.*	*understand*

UNIT - I PRINCIPLES AND THEORIES OF STEEL CORROSION IN CONCRETE [09]

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 [09]

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 INSITU CORROSION MONITORING OF STRUCTURES [09]

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 [09]

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 [09]

Electrochemical Chloride Removal - Electrochemical Re alkalization - Principles of Cathodic Protection by Impressed Current Method and Sacrificial Anode Type - Microscopic Study of Concrete and Steel Interface - Image techniques.

Total = 45 Periods

References :

1 Amir Poursaee, Corrosion of steel in concrete structures, Wood head Publishing, Sawston, Second Edition, 2016.

2 Bertolini, L, Elsener, B, Pedefrri, P, Redaelli, E. and Polder, R., Corrosion of Steel in Concrete, Wiley- VCH, New Jersey, Second Edition, 2014.

3 Vidivelli, B., Rehabilitation of Concrete Structures, Standard Publishers Distributors, New Delhi, First Edition, 2009.

4 Tonini, D.E, and Gaidis, J.M., Corrosion of Reinforcing Steel in Concrete, ASTM Special Technical Publications, 1980.

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SEMESTER - III

		L	T	P	C
ST20363	**ASEISMIC DESIGN OF STRUCTURES (Professional Elective)**	3	0	0	3

Course Outcomes: On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Illustrate the fundamental concept of earthquakes.*	*Understand*
CO2:	*Evaluate the response of structures to different types of dynamic loads.*	*Evaluate*
CO3:	*Identify the need for IS code specification for earthquake resistant design.*	*Apply*
CO4:	*Inspect the Seismic Analysis of Structure.*	*Analyze*
CO5:	*Develop the skills in software used for* analysis and design of buildings for earthquake.	*Create*

UNIT - I INTRODUCTION [09]

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 [09]

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 [09]

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 [09]

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 [09]

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

Reference Books:

1 Anil K. Chopra., Dynamics of Structures – Theory and Applications to Earthquake Engineering, Pearson, New Delhi, Fifth Edition, 2019.

2 Pankaj Agarwal, and Manish Shrikhande., Earthquake Resistant Design of Structures, Prentice Hall of India Pvt. Ltd., New Delhi, Fift Edition, 2011.

3 Duggal, S.K., Earthquake Resistant Design of Structures, Oxford University Press, New York, Second Edition, 2013.

4 Brebbia, C. A., Earthquake Resistant Engineering Structures, WIT Press, Southampton, First Edition, 2015.

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SEMESTER - III

		L	T	P	C
ST20364	**DESIGN OF BRIDGES (Professional Elective)**	3	0	0	3

Course Outcomes: On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Explain various types and Specifications of Bridge Structures.*	*Understand*
CO2:	*Analyze load Distribution and Design of Slabs in Bridge Structure.*	*Evaluate*
CO3:	*Design various types of long span girder Bridges.*	*Create*
CO4:	*Evaluate Various Load Calculation and Design of Prestressed Bridges.*	*Evaluate*
CO5:	*Design of Plate Girder bridges and types of bridge foundations.*	*Create*

UNIT - I INTRODUCTION [09]

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 [09]

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

UNIT - III LONG SPAN GIRDER BRIDGES [09]

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

UNIT - IV DESIGN OF PRESTRESSED BRIDGES [09]

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 Long Term Deflections.

UNIT - V DESIGN OF PLATE GIRDER BRIDGES, BEARINGS AND SUBSTRUCTURES [09]

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

Reference Books:

1 Johnson Victor, D., Essentials of Bridge Engineering, Oxford and IBH Publishing Co. Pvt.Ltd., New Delhi, Sixth Edition, 2019.
2 Jagadeesh, T.R. and Jayaram, M.A., Design of Bridge Structures, Prentice Hall of India Pvt. Ltd., New Delhi, Second Edition, 2009.
3 Krishnaraju,N., Design of Bridges, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Fifth Edition, 2019.
4 Ponnuswamy, S., Bridge Engineering, McGraw-Hill Education, New Delhi, Second Edition, 2008.

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SEMESTER – III

		L	T	P	C
ST20365	**DESIGN OF PLATE AND SHELL STRUCTURES (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Design types of folded plate structures by ACI and ASCE task committee method*	*Analyze*
CO2:	*Examine the structural action of different types of shells and its translation.*	*Analyze*
CO3:	*Design space frames with different nodes and its behaviour.*	*Create*
CO4:	*Analyze and design of space frames in construction.*	*Analyze*
CO5:	*Analyze and design grid floors.*	*Analyze*

UNIT – I DESIGN OF FOLDED PLATES **[09]**

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

UNIT - II THEORY OF SHELLS **[09]**

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 **[09]**

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

UNIT - IV ANALYSIS OF SPACE FRAMES **[09]**

Analysis of Space Frames - Formex Algebra, For Main and Detailed Design of Space Frames.

UNIT – V GRID FLOORS **[09]**

General Features-Analysis of Grid Floors-Design Examples.

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

Reference Books :

1 Timoshenko, S. and Woinowsky - Krieger S., Theory of Plates and Shells, McGraw Hill Education, New Delhi, Second Edition, 2017.
2 Ramasamy, G.S., Design and Construction of Concrete Shells Roofs, CBS Publishers, New Delhi, First Edition, 2005.
3 Chatterjee, B.K., Theory and Design of Concrete Shells, Chapman and Hall Press, New york, First Edition, 1988.
4 Farshad, M., Design and Analysis of shell structures, Springer, Netherlands, Second Edition, 1992.

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SEMESTER –III

		L	T	P	C
ST20366	**DESIGN OF TALL BUILDINGS (Professional Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Explain the modern concepts and evolution of high rise building structures.*	*Understand*
CO2:	*Evaluate lateral load resisting elements by different methods.*	*Evaluate*
CO3:	*Illustrate the behavior of shear walls and base isolation technique for earthquake resistance.*	*Understand*
CO4:	*Design of tall buildings by* various analysis methods.	*Create*
CO5:	*Identify software for analysis of tall buildings*	*Apply*

UNIT - I INTRODUCTION [09]

Design Philosophy, Materials -Modern concepts - Evolution of tall buildings – Classification of Buildings – Low-rise, medium-rise, high rise – Ordinary framed buildings & Shear-wall buildings –Behaviors of buildings under lateral loads like Wind loads, Earthquake loads & Blast loads – Basic structural & functional design requirements – Strength, and Stiffness & Stability.

UNIT - II LATERAL LOAD RESISTING ELEMENTS [09]

Frames, Shear walls & Tubes – Shear, Bending & combine modes of deformation – Structural behavior of Rigid frames – Simplified methods of analysis – Substitute frame method, Portal method, Cantilever method, Equivalent frame method – Structural behaviour of Shear walls – Approaches of analysis – Elastic continuum approach & Discrete approach — Structural behavior of Tubes –Actions.

UNIT - III BEHAVIOUR OF STRUCTURAL SYSTEMS [09]

Frame building, Shear wall building, Shear walls acting with frames, Single framed tubes – Other structural forms – Staggered Wall-beam system, Tube-in-tub system, Base isolation technique for earthquake resistance. Load distribution in a tall building – Load resisted by different shear walls & frames – Determinate & Indeterminate problems – Equivalent Stiffness method.

UNIT - IV ANALYSIS AND DESIGN [09]

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of structures as an integral unit, Analysis for member forces, drift and twist. Computerized 3D analysis. Design for differential movement, Creep and Shrinkage effects, Temperature Effects and Fire Resistance

UNIT - V MODERN METHODS [09]

Analysis of Tall buildings by Stiffness method – Available Software's for analysis of tall buildings.

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

Reference Books :

1 Bryan Stafford Smith and Alex Coull, Tall Building Structures: Analysis and Design, Wiley India Private Limited, New york, First Edition, 2011.

2 Bungale S. Taranath, Structural Analysis and Design of Tall Buildings: Steel and Composite Construction, CRC Press, New York, First Edition, 2011

3 Lin, T.Y. and Burry D.Stotes., Structural Concepts and Systems for Architects and Engineers, Van Nostrand Reinhold Co., New York, Second Edition, 1994.

4 Lynn S. Beedle, Advances in Tall Buildings, Van Nostrand Reinhold Co., New York, First Edition, 1986.

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SEMESTER - III

		L	T	P	C
ST20OE1	**PRINCIPLES OF SUSTAINABLE DEVELOPMENT (Open Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Explain the concepts of sustainable development.*	*Understand*
CO2:	*Illustrate the components and dimensions of sustainable development.*	*Understand*
CO3:	*Outline the frame work for achieving sustainability.*	*Understand*
CO4:	*Summarize policies and strategies for implementing sustainable development for socio economic programmes.*	*Understand*
CO5:	*Demonstrate the role of developed countries in sustainable development.*	*Understand*

UNIT - I CONCEPT OF SUSTAINABLE DEVELOPMENT [09]

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 [09]

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 [09]

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 [09]

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 [09]

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

Reference Books :

1 Ghosh Roy, M.K., Sustainable Development, Ane Books Pvt. Ltd., New Delhi, First Edition, 2011.

2 Abdul Kalam, A.P.J, and Srijan Pal Singh, Target 3 Billion: Innovative Solutions Towards Sustainable Development, Penguin Books India Pvt. Ltd., New Delhi, First Edition, 2011.

3 Brandon, P.S. and Patrizia Lombardi, Evaluating Sustainable Development: in the built Environment, Wiley-Blackwell, New Jersey, Second Edition, 2005.

4 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.

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SEMESTER – III

		L	T	P	C
MA20302	**OPERATIONS RESEARCH TECHNIQUES (Open Elective)**	3	0	0	3

Course Outcomes: ***On successful completion of the course, the student will be able to***		**Cognitive level**
CO1:	Solving the optimization techniques for decision making problem	*Understand*
CO2:	*Applying the concepts of Transportation and Assignment problems*	*Apply*
CO3:	*Evaluating the project scheduling by network analysis.*	*Evaluate*
CO4:	*Solving the Inventory models.*	*Understand*
CO5:	*Applying the concepts of scheduling and Replacement problems*	*Apply*

UNIT – I **LINEAR PROGRAMMING PROBLEM** **[09]**

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).

UNIT – II **TRANSPORTATION AND ASSIGNMENT PROBLEM** **[09]**

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 - Travelling Salesman problem.

UNIT – III **NETWORK MODELS** **[09]**

Network - Fulkerson's rule - construction of a network - critical path method (CPM) - optimistic, pessimistic and most likely time estimates - project scheduling by PERT analysis.

UNIT – IV **INVENTORY MODEL** **[09]**

Types of Inventory - Deterministic inventory models - EOQ and EBQ models with and without shortages - quantity discount model - Price breaks - probabilistic inventory model.

UNIT – V **REPLACEMENT MODELS** **[09]**

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 = 45 Periods

Reference Books:

1 Gupta,P.K. and Man Mohan, Problems in Operations Research, S. Chand and Co, New Delhi, Fourteenth Edition, 2016.

2 Hira and Gupta, Problems in Operations Research, S. Chand and Co, New Delhi, Twelfth Edition, 2015.

3 Jain, R.K., Operations Research Methods, SCI Technology Publishing, New Delhi, Third Edition, 2017.

4 Taha, H.A., Operation Research, Pearson Education, Carmel, Eleventh Edition, 2016.

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SEMESTER – III

		L	T	P	C
ST20OE3	**FAILURE ANALYSIS OF STRUCTURES (Open Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to ***Cognitive Level***

CO1:	*Classify types of failures, causes and mechanisms.*	*Understand*
CO2:	*Recognize the concepts of engineering materials and components fails.*	*Understand*
CO3:	*Analyze macro micro level failures and its safety.*	*Analyze*
CO4:	*Discuss the case studies of different structural systems.*	*Create*
CO5:	*Explain the concept of bridge maintenance techniques.*	*Understand*

UNIT - I INTRODUCTION [09]

Causes of failure – Types of failure – Why, What, How – Durability of materials – Landmark case – Performance and shape inadequacy – Statistics and reliability – Life cycle assessment.

UNIT - II STRUCTURAL FAILURE [09]

Structural failure – Material and load effects – Environment effect – Non structural and structural repairs – Biocidal treatment and use of preservations – Deterioration of wood.

UNIT - III MACRO MICRO FAILURES [09]

Macro micro level failures – Component and sub-system failures – Failure theories – Analytical methods – Cases and types of problem in components – Safety evaluation.

UNIT - IV STRUCTURAL SYSTEMS [09]

Introduction – Structural Systems – Case studies - Pin-jointed steel systems – Rigid jointed frames – Concrete walls – Arches – Reinforced concrete beams and frames – Shells – Repair of concrete bridge and water retaining structures.

UNIT - V BRIDGE MAINTENANCE TECHNIQUES [09]

Bridge maintenance techniques – The refurbishment of buildings - Legal responsibilities – Case studies – Definition of smartness – Sensors – Automatic and adaptive systems – Smart components.

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

Reference Books :

1 Rasnom, W.H., Building Failures, Diagnosis and Avoidance, E & F, N. SPON Ltd., Second Edition, 1987.
2 Moskvin, V., Concrete and Reinforced structures – Deterioration and protection, MIR Publications, Moscow, First Edition, 1983.
3 Kenneth, L. Carper., Forensic Engineering, CRC Press, New York Washington, Second Edition, 2000.
4 Raina, V.K., Concrete Bridge Practice Construction, Maintenance and Rehabilitation, Shroff Publishers, Second Edition, 2019.

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SEMESTER – III

		L	T	P	C
ST20OE4	**PRESTRESSED CONCRETE STRUCTURES (Open Elective)**	3	0	0	3

Course Outcomes : On successful completion of the course, the student will be able to		***Cognitive Level***
CO1:	*Apply the concepts of prestressing in a suitable way.*	*Apply*
CO2:	*Identify and the design the Prestressed Concrete Flexural Members as per IS: 1343.*	*Apply*
CO3:	*Analysis and design of Continuous Beams according to the real time applications.*	*Analyze*
CO4:	*Design Compression and Tension Members.*	*Create*
CO5:	*Analyze for Stresses and Ultimate Strength of Prestressed Composite Beams and Partial Prestressing.*	*Analyze*

UNIT - I PRINCIPLES OF PRESTRESSING [09]

Principles of Prestressing - Types and Systems of Prestressing, Need for High Strength Concrete and High Tensile Steel – Types of Tensioning - Analysis of Sections for Stresses by Stress Concept, Strength Concept and Load Balancing Concept – Short and long term Deflection – Losses in prestressing, Camber, Cable Layouts.

UNIT - II DESIGN OF FLEXURAL MEMBERS [09]

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

UNIT - III DESIGN OF CONTINUOUS BEAMS [09]

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 [09]

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 [09]

Composite Beams - Analysis and Design, Ultimate Strength - their Applications. Partial Prestressing– its Advantages and Applications. Case studies: Bunkers – Electric poles – Circular prestressing – Railway slabs.

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

Reference Books :

1 Pandit, G. S. and Gupta, S. P., Prestressed concrete, CBS Publishers and Distributors Private Limited, New Delhi, First Edition, 2019.
2 Krishna Raju, N., Prestressed concrete, McGraw Hill Education Private Limited, Uttar Pradesh, Sixth Edition, 2018.
3 Dayaratnam, P., Prestressed Concrete Structures, Oxford and IBH, New Delhi, First Edition, 2013.
4 IS 1343:2012, Code of Practice for Prestressed Concrete, Bureau of Indian Standards, New Delhi, First Edition, 2012.

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SEMESTER - III

		L	T	P	C
ST20OE5	**SMART MATERIALS AND SMART STRUCTURES (Open Elective)**	**3**	**0**	**0**	**3**

Course Outcomes : On successful completion of the course, the student will be able to		**Cognitive Level**
CO1:	Explain about the instrumented structure functions and response in modern engineering.	Understand
CO2:	Examine the strain measuring techniques using strain gauges.	Analyze
CO3:	Choose sensors according to their applications in structures	Apply
CO4:	Classify the actuator materials based on their applications	Analyze
CO5:	Explain about data acquisition system and control system.	Understand

UNIT - I INTRODUCTION [09]

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

UNIT - II MEASURING TECHNIQUES [09]

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

UNIT - III SENSORS [09]

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 [09]

Actuator techniques - Actuator and actuator materials - Piezoelectric and electro structure 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 [09]

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

Reference Books :

1 Srinivasan, A. V., Michael Mc Farland D., Smart Structures Analysis and Design, Cambridge University Press, England, South Asian Edition, 2010.

2 Peter L. Reece., Smart Materials and Structures: New Research, Nova Science Publishers Inc., New York, First Edition, 2007.

3 Gustav Gautschi., Piezoelectric Sensorics, Springer, New York, Second Edition, 2006.

4 https://nptel.ac.in/content/storage2/courses/112104040/pdf/lecture34.pdf.

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SEMESTER - III

ST203A1	**ENGLISH FOR RESEARCH PAPER WRITING (Audit Course)**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

Course Outcomes : On successful completion of the course, the student will be able to **Cognitive Level**

CO1:	Know how to improve the writing skills and level of readability	Understand
CO2:	Learn about what to write in each section	Analyze
CO3:	Improve skills needed when writing a title	Understand
CO4:	Ensure the good quality of paper at very first time submission	Apply
CO5:	Prioritize the useful phrases for Research Paper writing	Apply

UNIT - I [06]

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

UNIT - II [06]

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 [06]

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 [06]

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 [06]

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

Total (L= 0, T = 30) = 30 Periods

Reference Books :

1 Goldbort, Writing for Science, Yale University Press, First Edition, 2006.

2 Day R, How to write and publish a scientific paper, Cambridge University Press, First Edition, 2006.

3 Adrian Wallwork, English for Writing Research Papers, Springer New York, Dordrecht Heidelberg London, First Edition, 2011.

4 Sarah Freeman, Written Communication in English, Orient Black Swan, Hyderabad, First Edition, 2015.

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