I. Vision and Mission of the Institute

Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of the industry, society, the nation and the world at large.

Mission

- Commitment to offer value-based education and enhancement of practical skills
- Continuous assessment of teaching and learning process through scholarly activities
- Enriching research and innovative activities in collaboration with industry and institute of repute
- Ensuring the academic process to uphold culture, ethics and social responsibility

II. Vision and Mission of the Department

Vision

To develop competent Civil Engineers to create infrastructure with technology in demand that leads to nation building

Mission

The Mission of the Department is to

- Provide holistic education to students to enhance technical knowledge and skills
- Indoctrinate augmented contents to meet the requirements of stakeholders
- Promote research and consultancy activities in collaboration with industries
- Foster ethical and moral values with leadership qualities

III. Program Educational Objectives (PEOs)

The Program Educational Objectives (PEOs) of the Structural Engineering represent major accomplishments that the graduates are expected to achieve after two years of graduation.

PEO1: Graduates will attain knowledge and skills in structural engineering that foster career and professional accomplishment in the public or private sector organizations

PEO2: Graduates will obtain commitment for solving complex real-life issues related to analysis, design and maintenance of structures under various environmental conditions.

PEO3: Graduates will possess competence on latest tools and techniques and professional responsibilities by performing quality research in institutions of international repute or in Research organizations or Academia

IV. Program Outcomes (POs)

PO1: Independently carry out research /investigation and development work to solve practical problems

PO2: Write and present a substantial technical report/document

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PO3: 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

PO4: Analyze and design the reinforced concrete structures and steel structures as per the codal provisions

PO5: Address the societal needs with an interdisciplinary approach through advanced courses and get exposed to the latest technologies to be industry ready

PO6: Engage in lifelong learning for updating oneself on structural engineering contemporary advancements.

V. PEO/PO Mapping

Following three levels of correlation should be used:

1: Low

2: Medium

3: High

PEO	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	2	3	3	3	3
PEO2	3	2	3	3	3	3
PEO3	3	2	3	3	3	3

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VI. MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

Year	SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6
I Year	SEM I	Advanced Mathematical Methods	✓	-	-	-	✓	✓
		Advanced Concrete Structures	✓	✓	✓	✓	✓	✓
		Theory of Elasticity and Plasticity	✓	✓	✓	✓	✓	✓
		Research Methodology & IPR	✓	✓	✓	-	✓	✓
	SEM II	Finite Element Analysis	✓	✓	-	✓	✓	✓
		Prestressed Concrete	✓	✓	✓	✓	✓	✓
		Advanced Steel Structures	✓	✓	✓	✓	✓	✓
		Advanced Structural Engineering Laboratory	✓	✓	✓	✓	✓	✓
		Technical Seminar	✓	✓	✓	-	✓	✓
II Year	SEM III	Aseismic Design of Structures	✓	✓	✓	✓	✓	✓
		Stability of structures	✓	✓	✓	✓	✓	✓
		Project Work (Phase-I)	✓	✓	✓	✓	✓	✓
	SEM IV	Project Work (Phase-II)	✓	✓	✓	✓	✓	✓
PE		Maintenance and Rehabilitation of Structures	✓	✓	✓	✓	✓	✓
		Prefabricated Structures	✓	✓	✓	✓	-	✓
		Offshore Structures	✓	✓	✓	-	✓	✓
		Matrix Methods for Structural Analysis	✓	✓	✓	✓	✓	✓
		Theory of Plates and shells	✓	✓	✓	✓	✓	✓
		Mechanics of Composite Materials	✓	✓	✓	✓	✓	✓
		Analysis and Design of Tall Building	✓	✓	✓	✓	✓	✓

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		Industrial Structures	✓	✓	✓	✓	✓	✓
		Experimental Techniques	✓	✓	✓	✓	✓	✓
		Wind and Cyclone Effects on Structures	✓	✓	✓	✓	✓	✓
		Nonlinear Analysis of Structures	✓	✓	✓	✓	✓	✓
		Design of Sub Structures	✓	✓	✓	✓	✓	✓
		Optimization of Structures	✓	✓	✓	-	✓	✓
		Design of Steel Concrete Composite Structures	✓	✓	✓	✓	✓	✓
		Design of Bridges	✓	✓	✓	✓	✓	✓
		Smart Materials and structures	✓	✓	✓	✓	✓	✓
		Computer Aided Analysis and Design	✓	✓	✓	✓	✓	✓
		Energy Efficient Buildings	✓	-	✓	-	✓	-
		Structural Health Monitoring	✓	✓	✓	✓	-	✓
		Advanced Concrete Technology	✓	✓	✓	✓	-	✓

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M.E. STRUCTURAL ENGINEERING

REGULATIONS – 2021

CHOICE BASED CREDIT SYSTEM

CURRICULUM FOR I TO IV SEMESTERS

SEMESTER I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P21MA101	Advanced Mathematical Methods	FC	3	1	0	4
2	P21ST101	Advanced Concrete Structures	PCC	3	0	0	3
3	P21ST102	Theory of Elasticity and Plasticity	PCC	3	0	0	3
4	P21RMC01	Research Methodology & IPR	RMC	3	0	0	3
5	-	Professional Elective I	PEC	3	0	0	3
6	-	Professional Elective II	PEC	3	0	0	3
			TOTAL	**18**	**1**	**0**	**19**

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P21ST201	Finite Element Analysis	PCC	3	0	0	3
2	P21ST202	Prestressed Concrete	PCC	3	0	0	3
3	P21ST203	Advanced Steel Structures	PCC	3	0	0	3
4	-	Professional Elective III	PEC	3	0	0	3
5	-	Professional Elective IV	PEC	3	0	0	3
PRACTICALS							
6	P21ST204	Advanced Structural Engineering Laboratory	PCC	0	0	4	2
7	P21ST205	Technical Seminar	EEC	0	0	4	2
			TOTAL	**15**	**0**	**8**	**19**

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SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P21ST301	Aseismic Design of Structures	PCC	3	0	0	3
2	P21ST302	Stability of structures	PCC	3	0	0	3
3	-	Professional Elective V	PEC	3	0	0	3
4	-	Professional Elective VI	PEC	3	0	0	3
PRACTICALS							
5	P21ST303	Project Work (Phase-I)	EEC	0	0	12	6
			TOTAL	**12**	**0**	**12**	**18**

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P21ST401	Project Work (Phase-II)	EEC	0	0	24	12
2	P21STI01	Industrial Training / Internship (4 weeks)	EEC	0	0	0	2
			TOTAL	**0**	**0**	**24**	**14**

LIST OF COURSES BASED ON ITS CATEGORY

FOUNDATION COURSES (FC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P21MA101	Advanced Mathematical Methods	FC	3	1	0	4

PROFESSIONAL CORE COURSES (PCC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P21ST101	Advanced Concrete Structures	PC	3	0	0	3
2	P21ST102	Theory of Elasticity and Plasticity	PC	3	0	0	3
3	P21ST201	Finite Element Analysis	PC	3	0	0	3
4	P21ST202	Prestressed Concrete	PC	3	0	0	3
5	P21ST203	Advanced Steel Structures	PC	3	0	0	3
6	P21ST204	Advanced Structural Engineering Laboratory	PC	0	0	4	2
7	P21ST301	Aseismic Design of Structures	PC	3	0	0	3

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8	P21ST302	Stability of Structures	PC	3	0	0	3

PROFESSIONAL ELECTIVES COURSES (PEC)

S.NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	P21STP01	Maintenance and Rehabilitation of Structures	3	0	0	3
2	P21STP02	Prefabricated Structures	3	0	0	3
3	P21STP03	Offshore Structures	3	0	0	3
4	P21STP04	Matrix Methods for Structural Analysis	3	0	0	3
5	P21STP05	Theory of Plates and shells	3	0	0	3
6	P21STP06	Mechanics of Composite Materials	3	0	0	3
7	P21STP07	Analysis and Design of Tall Building	3	0	0	3
8	P21STP08	Industrial Structures	3	0	0	3
9	P21STP09	Experimental Techniques	3	0	0	3
10	P21STP10	Wind and Cyclone Effects on Structures	3	0	0	3
11	P21STP11	Nonlinear Analysis of Structures	3	0	0	3
12	P21STP12	Design of Sub Structures	3	0	0	3
13	P21STP13	Optimization of Structures	3	0	0	3
14	P21STP14	Design of Steel Concrete Composite Structures	3	0	0	3
15	P21STP15	Design of Bridges	3	0	0	3
16	P21STP16	Smart Materials and structures	3	0	0	3
17	P21STP17	Computer Aided Analysis and Design	2	0	2	3
18	P21STP18	Energy Efficient Buildings	3	0	0	3
19	P21STP19	Structural Health Monitoring	3	0	0	3
20	P21STP20	Advanced Concrete Technology	3	0	0	3

RESEARCH METHODOLOGY & IPR COURSES (RMC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P21RMC01	Research Methodology & IPR	RMC	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P21ST302	Technical Seminar	EEC	0	0	4	2
2	P21ST303	Project Work (Phase-I)	EEC	0	0	12	6
3	P21ST401	Project Work (Phase-II)	EEC	0	0	24	12
4	P21STI01	Industrial Training / Internship (4 weeks)	EEC	0	0	0	2

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VIII. Scheme of Credit distribution – Summary

S.No	Stream	Credits/Semester				Credits	%	Suggested by AICTE
		I	II	III	IV			
1.	Foundation Courses (FC)	4	-	-	-	4	5.71	-
2.	Professional Core Courses (PCC)	6	11	6	-	23	32.86	-
3.	Professional Elective Courses (PEC)	6	6	6	-	18	25.72	-
4.	Research Methodology & IPR Courses (RMC)	3	-	-	-	3	4.29	-
5.	Employability Enhancement Courses (EEC)	-	2	6	14	22	31.42	-
Total		**19**	**19**	**18**	**14**	**70**	**100**	-

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SEMESTER I

P19MA101	ADVANCED MATHEMATICAL METHODS	Category: BS			
		L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To provide the student with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering
- It covers a broad spectrum of mathematical techniques such as Laplace Transform, Fourier Transform, Calculus of variations, conformal mapping and numerical methods.
- Application of these topics to the solution of problems in physics and engineering is stressed

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PATIAL DIFFERENTIAL EQUATIONS 9 + 3

Laplace transform: Definitions – Properties – Ttransform error function – Bessel's function – Dirac delta function – Unit step functions – Convolution theorem – Inverse Laplace transform: Complex inversion formula – Solutions to Partial differential equations: Heat equation – Wave equation

UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Fourier transform: Definitions – Properties – Transform of elementary functions – Dirac delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations: Heat equation – Wave equation – Laplace and Poisson's equations

UNIT III CALCULUS OF VARIATIONS 9 + 3

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

UNIT IV CONFORMAL MAPPING AND APPLICATIONS 9 + 3

Introduction to conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications – Fluid flow and heat flow problems

UNIT V NUMERICAL METHODS 9 + 3

Linear simultaneous equation – Gauss elimination – Gauss Jordan and Crouts method – Gauss Seidal iterative method – Gauss Jacobian method – Solutions of Algebraic and Transcendental equations – Newton method and Adams Method

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Total: 60 Periods

TEXT BOOKS:

1. Jain R.K, Iyengar, SRK, 'Advanced Engineering Mathematics', Fourth Edition, Alpha Science Publications, 2014
2. Gerald W. Recktenwald, 'Introduction to Numerical Methods, Pearson Publications (US)second edition, 2019

REFERENCES:

1. J Vasishtha A.K, Gupta R.K 'Integral Transforms', Krishna's Educational Publishers, 2016

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2. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015
3. NPTEL Web link: http://nptel.ac.in/courses/105105043/12

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Solve IVP and BVP's using Laplace Transform techniques	Apply
CO2	Apply Fourier Transforms to IVP and BVP in PDE's	Apply
CO3	Determine Maximizing and minimizing the functional that occurs in Engineering fields.	Apply
CO4	Construct conformal mapping and apply it in Engineering fields.	Apply
CO5	Solve Linear System of linear equations and nonlinear equations in practical engineering problems	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	2	1
CO2	3	-	-	-	2	1
CO3	3	-	-	-	2	1
CO4	3	-	-	-	2	1
CO5	3	-	-	-	2	1
CO	3	-	-	-	2	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER I

P21ST101	ADVANCED CONCRETE STRUCTURES	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To design special RC elements such as Corbels, Deep beams, Grid floors
- To design of flat slab and yield line-based design of RC elements
- To understand the ductile detailing beams and frames

UNIT I BASIC DESIGN CONCEPTS 9

Limit state method – Design of beams – Design of columns according to IS Codes. Short-term and long-term deflection of reinforced concrete beams – Estimation of crack width in reinforced concrete

UNIT II DESIGN OF SPECIAL RC ELEMENTS 9

Strut and tie method of analysis for corbels and deep beams – Design of corbels – Design of Deep beams – Design of Grid floors

UNIT III FLAT SLABS AND YIELD LINE BASED DESIGN 9

Design of flat slabs according to IS method – Check for shear – Design of spandrel beams – Yield line theory and Hillerborg's strip method of design of slabs

UNIT IV INELASTIC BEHAVIOUR OF CONCRETE BEAMS AND COLUMNS 9

Inelastic behaviour of concrete beams – Moment Rotation curves – Ductility definitions – Evaluation

UNIT V DUCTILE DETAILING 9

Concept of Ductility – Detailing for ductility – Design of beams, columns for ductility – Design of cast-in-situ joints in frames

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Gambhir.M.L., "Design of Reinforced Concrete Structures", Prentice Hall of India, New Delhi, 2012.
2. Varghese. P.C., "Advanced Reinforced Concrete Design", PHI Learning Pvt. Ltd., New Delhi, 2011.
3. Subramanian. N., "Design of Reinforced Concrete Structures", Oxford University Press, New Delhi, 2013.
4. Sinha.N.C. and Roy S.K., "Fundamentals of Reinforced Concrete", S.Chand and Company Limited, New Delhi, 2003.
5. Unnikrishna Pillai and Menon., "Reinforced concrete Design', Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2010.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Design the columns and examine short term and long-term deflection of beams	Apply
CO2	Design the deep beams, corbels, and slender columns	Apply
CO3	Design the flat slabs with various methods	Apply
CO4	Analyse inelastic behaviour of concrete beams and columns	Analyze
CO5	Design the ductility and cast-in-situ joints in frames	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	3
CO2	3	2	2	3	3	3
CO3	3	2	2	3	3	3
CO4	3	2	2	3	3	3
CO5	3	2	2	3	3	3
CO	3	2	2	3	3	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER I

P21ST102	THEORY OF ELASTICITY AND PLASTICITY	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand elastic properties of different types of materials
- To study 2D stress strain relationship of materials
- To gain knowledge on elastic plastic problems in bending

UNIT I ELASTICITY 9

Analysis of stress and strain – Equilibrium equations – Compatibility equations – Stress strain relationship – Generalized Hooke's law

UNIT II 2D STRESS STRAIN PROBLEMS 9

Plane stress and plane strain – Simple two-dimensional problems in Cartesian and Polar coordinate – Stress – Strain transformation – Stress invariants

UNIT III TORSION OF NON-CIRCULAR SECTION 9

Torsion of rectangular bars including hollow sections – Solution with St.Venant's approach and Prandtl's approach – Membrane analogy – Torsion of thin walled open and closed sections

UNIT IV ENERGY METHODS 9

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

UNIT V PLASTICITY 9

Physical Assumptions – Yield criteria – Plastic stress strain relationship – Elastic plastic problems in bending –Torsion and thick cylinder

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Ansel C Ugural and Saul.K. Fenster," Advanced Strength and Applied Elasticity", Fourth Edition, Prentice, (2010).
2. Sadhu Singh, "Theory of Elasticity", Dhanpat Rai sons Private Limited, New Delhi, (2004).
3. Chakrabarty.J, "Theory of Plasticity", Third Edition, Elsevier Butterworth Heinmann – UK, (2007).
4. Timoshenko S. and GoodierJ.N ."Theory of Elasticity", McGraw Hill Book Co., New York, 2010.
5. Sadd, M. H. "Elasticity theory", applications and numeric Academic Press, (2018).

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Analysis of stress strain relationship and compatibility equations	Analyze
CO2	Study plane stress and strain problems	Understand
CO3	Learn torsion on non- circular section	Understand
CO4	Gain sufficient knowledge in various energy theories	Understand
CO5	Analyze plastic stress strain relationship and elastic plastic problems	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	-	2
CO2	2	3	3	2	-	2
CO3	3	2	2	3	-	1
CO4	2	2	3	2	2	2
CO5	2	3	1	3	-	-
CO	2	3	3	3	2	2

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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SEMESTER I

P21RMC01	RESEARCH METHODOLOGY AND IPR	Category: RMC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge in problem formulation, analysis and solutions.
- To impart skills required for technical paper writing / presentation without violating professional ethics
- To familiarize knowledge on Patent drafting and filing patents

UNIT I RESEARCH PROBLEM FORMULATION 9

Meaning of research problem – Sources of research problem – Criteria characteristics of a good research problem – Errors in selecting a research problem – Scope and objectives of research problem. Approaches of investigation of solutions for research problem – data collection – analysis – interpretation – necessary instrumentations

UNIT II LITERATURE REVIEW AND DATA COLLECTION 9

Effective literature studies approaches – analysis – plagiarism and research ethics. Method of data collection, Types of data – Primary Data – Scales of measurement – Source and collection of data observation method – Secondary data

UNIT III TECHNICAL WRITING / PRESENTATION 9

Effective technical writing: How to write report – paper – developing a research proposal – format of research proposal – a presentation and assessment by a review committee

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 9

Nature of Intellectual Property: Patents – Designs – Trade and Copyright. Process of Patenting and Development – technological research – innovation, patenting – development – International Scenario – International cooperation on Intellectual Property – Procedure for grants of patents – Patenting under PCT

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 9

Patent Rights: Scope of Patent Rights – Licensing and transfer of technology – Patent information and databases – Geographical Indications – New Developments in IPR – Administration of Patent System – IPR of Biological Systems – Computer Software

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: –Periods Total: 45 Periods

REFERENCES:

1. Ranjit Kumar, "Research Methodology: A Step-by-Step Guidefor beginners" 2nd Edition, 2010.
2. Cooper, DR and Schindler, P S., "Business Research Methods", Tata McGraw Hill, 9th Edition, 2014.
3. Robert P. Merges, Peter S, Menell, Mark A. Lemley, "Intellectual Property" in New Technological age, 2016.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Formulate research problem	Apply
CO2	Carry out research analysis	Analyse
CO3	Develop research proposal	Evaluate
CO4	Draft process of patenting	Apply
CO5	File and publish patents in R & D.	Evaluate

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	2	2
CO2	3	3	2	-	2	2
CO3	3	3	2	-	2	2
CO4	3	3	2	-	2	2
CO5	3	3	2	-	2	2
CO	3	3	2	-	2	2
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P21ST201	FINITE ELEMENT ANALYSIS	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the basics of the Finite Element Technique
- To introduce the concepts of mathematical modeling of Engineering problems
- To appreciate the use of FEM to a range of Engineering problems

UNIT I INTRODUCTION 9

Basic concepts of Finite element Analysis - Introduction to Elasticity – steps in Finite Element Analysis – virtual work and variational principle - Galerkin Method – Finite Element Method: Displacement Approach – Stiffness Matrix and Boundary Conditions

UNIT II AXIAL DEFORMATION OF BAR AND SPRING ELEMENT 9

Natural Coordinates - Triangular Elements -Rectangular Elements - Lagrange and Serendipity Elements -Solid Elements - Isoparametric Formulation - Stiffness Matrix of Isoparametric Elements - Numerical Integration: One, Two and Three Dimensional - Examples

UNIT III ANALYSIS OF FRAMED STRUCTURES 9

Stiffness of Truss Member - Analysis of Truss -Stiffness of Beam Member- Analysis of Continuous Beam -Plane Frame Analysis -Analysis of Grid and Space Frame - Constant Strain Triangle -Linear Strain Triangle -Rectangular Elements - Numerical Evaluation of Element Stiffness -Computation of Stresses, Geometric Nonlinearity and Static Condensation - Axisymmetric Element -Finite Element Formulation of Axisymmetric Element -Finite Element Formulation for 3 Dimensional Elements

UNIT IV PLATES AND SHELLS 9

Introduction to Plate Bending Problems - Finite Element Analysis of Thin Plate -Finite Element Analysis of Thick Plate – Finite Element Analysis of Skew plate - Introduction to Finite Strip Method -Finite Element Analysis of Shell

UNIT V APPLICATIONS OF FEM 9

Finite Elements for Elastic Stability – Buckling of Truss Members, Beam-Column Members & Plate Bending elements –Finite element in Fluid Mechanics- Dynamic Analysis –Solution techniques to Dynamic Problem- Nonlinear, Vibration and Thermal Problems - Meshing and Solution Problems - Modeling and analysis using recent analysis software

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Bhavikatti.S.S, "Finite Element Analysis", New Age International Publishers, 2015.
2. Chandrupatla, R.T. and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2015.
3. Rao.S.S, "Finite Element Method in Engineering", Butterworth – Heinmann, UK, 2008
4. Logan D. L., A First Course in the Finite Element Method, Thomson Learning, 2012.
5. David Hutton,"Fundamentals of Finite Element Analysis", Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the energy principles and finite element concepts.	Understand
CO2	Formulate shape functions for various elements and determine the stresses and strains for 2D and 3D problems.	Analyze
CO3	Apply finite element method for the analysis of framed structures.	Apply
CO4	Analyze plates and shells using finite element method.	Analyze
CO5	Understand the applications of finite element method using recent analysis software.	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	3	1	1
CO2	2	2	-	3	1	1
CO3	2	2	-	3	1	1
CO4	2	2	-	3	1	1
CO5	2	2	-	3	1	1
CO	2	2	-	3	1	1
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P21ST202	PRESTRESSED CONCRETE	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the basic principles of prestressing
- To know the methods used for analysing prestressed concrete structures
- To design the various prestressed concrete structures

UNIT I PRINCIPLES OF PRESTRESSING 9

Basic concepts of prestressing – Types and systems of prestressing – Need for high strength materials – Analysis methods – Losses of prestress – Short and long-term deflection – Cable layouts

UNIT II DESIGN OF FLEXURAL MEMBERS 9

Behaviour of flexural members – Determination of ultimate flexural strength – Design of flexural members – Design for shear – Bond and torsion – End blocks

UNIT III DESIGN OF CONTINUOUS BEAMS 9

Analysis and design of continuous beams – Methods of achieving continuity – concept of linear transformations – Concordant cable profile and gap cables

UNIT IV DESIGN OF TENSION AND COMPRESSION MEMBERS 9

Design of tension members – Application and design of prestressed concrete pipes – Cylindrical water tanks – Design of compression members with and without flexure

UNIT V DESIGN OF COMPOSITE MEMBERS 9

Composite beams – Analysis and design – Ultimate strength – Composite members applications – Partial prestressing – Advantages and applications

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill Publishing Co., New Delhi, 2008
2. Rajagopalan.N, "Prestressed Concrete", Narosa Publications, New Delhi, 2008
3. Arthur H. Nilson, "Design of Prestressed Concrete", John Wiley and Sons Inc, New York, 2004.
4. Lin.T.Y., andBurns.H "Design of Prestressed Concrete Structures", John Wiley and Sons Inc, New York, 2009.
5. Sinha.N.C.and.Roy.S.K, "Fundamentals of Prestressed Concrete", S.Chand and Co., 1998

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Calculate the losses and analyze for deflection of prestressed concrete members	Analyze
CO2	Design the prestressed concrete members for flexure and shear as per the relevant design code	Apply
CO3	Analyze and design of continuous beams	Analyze
CO4	Design of prestressed concrete structures - sleepers, tanks, pipes and poles	Apply
CO5	Analyze and design of composite beams and students will have sufficient knowledge on partial pre-stressing	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	2	3	2	2
CO5	3	3	2	3	2	2
CO	3	3	2	3	2	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

		Category: PCC			
		L	T	P	C
P21ST203	ADVANCED STEEL STRUCTURE	3	0	0	3

COURSE OBJECTIVES:

- To study the behaviour of members and connections
- To analyse and design the Industrial buildings of roofs and chimneys
- To study the design of light gauge steel structure

UNIT I JOINTS IN STEEL CONSTRUCTION 9

Shear connections – Fin plate connection – End plate connection – Framed connections – Moment connections – Bolted end plate connection – Welded beam to column connection – Splices – Column base Connection

UNIT II LIGHT GAUGE STEEL DESIGN 9

Concepts – Local buckling and Effective width – Design of beams – Stiffened flange – Multiple stiffened flange – Unstiffened flange – Design of beams for lateral buckling – Design of columns – Design of members under combined stresses – Design of connections

UNIT III INDUSTRIAL MATERIAL HANDLING SYSTEMS 9

Types of cranes – Basic requirements for crane running beams – Design of Monorail – Gantry girder for under slung cranes – Gantry girders for overhead cranes – Plated and Braced Gantry girder

UNIT IV INDUSTRIAL APPURTENANCES 9

Self-supporting chimney – Chimney foundations – Guyed steel chimney – Design of silos – Design of Bunkers – Design of self-Standing towers

UNIT V INDUSTRIAL ROOF SYSTEMS 9

Components – Cladding – Purlins – Primary load carrying systems – Beams – Trusses – Frames – Loads and load combinations for design – Design of Purlins – Antisag rods – Planning and design of trusses – Planning and design of North light roof system – Planning and design of bracings – Panel bracing – Roof bracing

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. L.S. Jayagopal and D. Tensing "Advanced Design of Steel Structures" Vikas Publishing House, Delhi, 2019.
2. Salmon G, John E Johnson, Faris Malhas "Steel Structures: Design and Behavior; Emphasizing Load and Resistance Factor Design" Fifth Edition, Pearson Prentice Hall; 2009.
3. "Steel Construction Manual", 14th Edition, American Institute of Steel Construction.
4. Lynn S. Beedle, "Plastic Design of Steel Frames", John Wiley and Sons, 1990.
5. Subramanian.N, "Design of Steel Structures", Oxford University Press, 2014.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Study the behaviour of different connections in steel structures	Understand
CO2	Analyze and design light gauge steel members	Analyze
CO3	Understand the design concept of crane foundations, monorail, gantry girders	Understand
CO4	Analyze and design steel industrial appurtenances	Analyze
CO5	Design of industrial roof systems	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	3	-	2
CO2	3	-	3	2	-	2
CO3	3	3	-	3	1	2
CO4	3	3	-	2	-	2
CO5	3	-	-	2	1	2
CO	3	3	3	3	1	2

Correlation levels:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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SEMESTER II

P21ST204	ADVANCED STRUCTURAL ENGINEERING LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To provide the hands on experience in testing and quality control of concrete making materials to design concrete mixes for different ranges of strength and workability
- To train the students to handle non-destructive testing instruments and to analyze the data obtained for quality assessment of concrete
- To conduct flexure test on concrete specimens

LIST OF EXPERIMENTS

1. Concrete mix design for low, medium and high strength conventional concretes by IS method and ACI method. Calculation and Laboratory testing (with and without Superplasticizer).
2. Workability tests on fresh self-compacting concrete.
3. Non-destructive testing of concrete using rebound hammer and ultrasonic pulse velocity.
4. Rapidly Chloride Permeability Test.
5. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour.
6. Testing of simply supported steel beam for strength and deflection behaviour.
7. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Total: 60 Periods

LIST OF EQUIPMENTS

1. Strong Floor
2. Loading Frame
3. Hydraulic Jack
4. Load Cell
5. Proving Ring
6. Electrical Strain Gauge with indicator
7. Rebound Hammer
8. Ultrasonic Pulse Velocity Tester
9. Dial Gauges
10. Vibration Exciter
11. Vibration Meter
12. Slump Cone
13. L-Box
14. J-Ring
15. V-Funnel
16. Rapid Chloride Ion Permeability Test Apparatus

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REFERENCES:

1. Neville A.M, "Properties of Concrete", Pearson Education Ltd., England, 2011.
2. Santhakumar A.R., "Concrete Technology", Oxford University Press, New Delhi, 2007.
3. Krishnaraju, N, "Design of concrete mixes", Sehgal Educational Consultants & Publishers Pvt.Ltd., Faridabad, 1988.
4. IS: 10262-2009, Concrete Mix Proportioning, Guideline, BIS, New Delhi.

COURSE OUTCOMES

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Identify the functional role of ingredients of concrete and apply this knowledge to mix design philosophy	Remember
CO2	Design and develop the self-compacting concrete and its fresh properties	Apply
CO3	Apply engineering principles to understand behaviour of concrete structural elements	Apply
CO4	Understand the behaviour of steel structural elements	Remember
CO5	Conduct Non-Destructive Tests on existing concrete structures	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	-	2
CO2	3	3	3	2	-	2
CO3	3	3	2	3	3	2
CO4	3	2	3	3	3	3
CO5	3	2	-	-	2	-
CO	3	3	3	3	3	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P21ST205	TECHNICAL SEMINAR	Category: EEC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To work on a specific technical topic in Structural Engineering and acquire the skills of written and oral presentation.
- To acquire writing abilities for seminars and conferences

STRATEGY

The students will work for four hours per week guided by a group of staff members. They will be asked to give a presentation on any topic of their choice related to Structural Engineering and to engage in discussion with the audience. A brief copy of their presentation also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will defend their presentation. Evaluation will be based on the technical presentation and the report and also on the interaction shown during the seminar

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 30 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Face an audience and to tackle any problem during group discussion in the Interviews	Apply
CO2	Acquire writing abilities for seminars and conferences	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	2	2
CO2	3	3	2	-	2	2
CO	3	3	2	-	2	2
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER III

P21ST301	ASEISMIC DESIGN OF STRUCTURES	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the effect of earthquakes on structures
- To study the modern concepts used for earthquake resistant design
- To design the earthquake resistant Structures using softwares

UNIT I INTRODUCTION 9

Basic Seismology – General features of Tectonics of Seismic Regions – Earthquake Terminology – Definitions – Earthquake History – Behaviour of Buildings, Dams and Bridges in Earthquakes – Seismographs – Accelerographs – Theory of Vibrations – Damped and undamped system – Free and forced vibrations – SDOF and MDOF systems

UNIT II EARTHQUAKE RESPONSE 9

Earthquake Response to Elastic and Inelastic Buildings – Application to Response Spectrum Theory – Base exited motion - Ground motion parameters – Modal response contribution – Modal participation factor – Response history – Spectral analysis – Multiple support excitation – Earthquake response to continuous systems on rigid base

UNIT III EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES 9

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

UNIT IV EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES 9

Earthquake Resistant Design of R.C.C. Buildings – Material properties – Lateral load analysis – Capacity based Design and detailing – Rigid Frames – Shear walls

UNIT V ADVANCED TOPICS IN SEISMOLOGY 9

Advanced Concepts – Base Isolation, Passive Control and Active Control Systems – Computer Analysis and Design of Buildings for Earthquake Loads using Software Packages like Staad - pro & Etabs

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Anil.K.Chopra, "Dynamics of Structures" (Theory and Applications to Earthquake Engineering), Prentice Hall of India Private Limited, 2nd Edition, New Delhi, 2003
2. Clough R W and Penzien J, "Dynamics of structures", McGraw Hill
3. Jaykrishna, "Elements of Earthquake engineering", Saritha Prakasan, Naunchandi, Meerut
4. Pankaj Agarwal and Manish Shrikandhe, "Earthquake Resistant Design of Structures", PHI
5. Ambrose &Vergun, "Simplified Building Design for wind and Earthquake Forces", John Wiley, 1985

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain behavior of structures subjected to earthquake	Understand
CO2	Design various IS codal provisions for seismic structures	Apply
CO3	Design masonry and RC structures to the earthquake forces	Apply
CO4	Design and detailing of RCC framed and Shear wall Structures	Apply
CO5	Design buildings for seismic forces using various software packages.	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	3	2	2	2	2	2
CO3	3	2	2	2	2	2
CO4	3	2	2	2	2	2
CO5	3	2	2	2	2	2
CO	3	2	2	2	2	2
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER III

P21ST302	STABILITY OF STRUCTURES	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the basic concept of buckling
- To study about torsional and lateral buckling
- To design the various models in structural elements

UNIT I BUCKLING OF COLUMNS 9

Classification of buckling problems – Eigen value problem – Elastic and Inelastic Buckling – Governing equation for columns – Energy methods — Rayleigh Ritz –Galerkins approach - Non prismatic and built up columns – Numerical Techniques – Finite difference method – Effect of shear on buckling

UNIT II BUCKLING OF BEAM-COLUMNS AND FRAMES 9

Theory of beam column – Stability analysis of beam column with single – concentrated loads distributed load and end couples – Analysis of rigid jointed frames with and without sway – Use ofstability function to determine the critical load

UNIT III TORSIONAL AND LATERAL BUCKLING 9

Torsional buckling – Combined torsional and flexural buckling – Local buckling uniform and non uniform torsion on open section – Lateral buckling of beams –Pure bending of simply supported and cantilever beams

UNIT IV BUCKLING OF PLATES 9

Governing differential equation – Buckling of thin plates various edge conditions – Analysis by equilibrium and energy approach – Finite difference method

UNIT V INELASTIC BUCKLING 9

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

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Chajes A, "Principles of Structures Stability Theory", Prentice Hall, 1974.
2. Ashwini Kumar, "Stability Theory of Structures", Allied publishers Ltd., New Delhi, 2003.
3. Gambhir, "Stability Analysis and Design of Structures", Springer, New York, 2004.
4. Timoshenko.S.P, and Gere.J.M, "Theory of Elastic Stability", McGraw Hill Book Company, 1963
5. Manikaselvam V K, "Elements of Matrix and Stability Analysis of Structures", Khanna Publishers,1999

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the fundamental concepts of structural stability.	Understand
CO2	Analyze the beam column joints with single and multiple loads.	Analyze
CO3	Understand the torsional and lateral buckling of beams.	Understand
CO4	Analyze the buckling of plates with equilibrium and energy approach.	Analyze
CO5	Understand the buckling behaviour of plates	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	3	2	3
CO2	3	2	1	3	2	3
CO3	3	2	-	2	2	3
CO4	3	2	-	2	3	3
CO5	3	2	-	3	3	3
CO	3	2	1	3	2	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER III

P21ST303	PROJECT WORK (PHASE - I)	Category: EEC			
		L	T	P	C
		0	0	12	6

COURSE OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature
- To develop the methodology to solve the identified problem
- To train the students in preparing project reports and to face reviews and viva-voce examination

STRATEGY

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

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 180 Periods Total: 180 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Involve in individual and team work with good oral, written and Graphical communications	Apply
CO2	Apply the principles in structural Engineering	Apply
CO3	Gain practical professional experience in structural Engineering	Analyze
CO4	Investigate the leading problems related to structural Engineering	Evaluate
CO5	Develop the solution for the problem identified in structural Engineering	Create

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	2	3	3
CO	3	3	3	2	3	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER IV

P21ST401	PROJECT WORK (PHASE - II)	Category: EEC			
		L	T	P	C
		0	0	24	12

COURSE OBJECTIVES:

- To solve the identified problem based on the formulated methodology
- To develop skills to analyse and discuss the test results, and make conclusions

STRATEGY

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 360 Periods Total: 360 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Involve in individual and team work with good oral, written and Graphical communications	Apply
CO2	Apply the principles in Civil & Structural Engineering	Apply
CO3	Gain practical professional experience in Structural Engineering	Analyze
CO4	Investigate the leading problems related to structural Engineering	Evaluate
CO5	Develop the solution for the problem identified in structural Engineering	Create

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	3	3	2	3	3
CO	3	3	3	2	3	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P21STP01	MAINTENANCE AND REHABILITATION OF STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the maintenance and repair strategies of concrete structures
- To study about modern techniques of retrofitting
- To investigate the techniques for strengthening of existing structures

UNIT I MAINTENANCE AND REPAIR STRATEGIES 9

Maintenance, Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance, Various aspects of Inspection and planning, budgeting and management, Assessment procedure for evaluating damaged structure, causes of deterioration - Learning from failures – case studies

UNIT II DIAGNOSIS AND ASSESSMENT OF DISTRESS 9

Visual inspection – Non-destructive tests – Ultrasonic pulse velocity method – Rebound hammer technique – Pullout tests – Windsor probe test – Crack detection techniques – Case studies – single and multistorey buildings – Fibre optic method for prediction of structural weakness

UNIT III ENVIRONMENTAL PROBLEMS AND NATURAL HAZARDS 9

Effect of corrosive, chemical and marine environment – pollution and carbonation problems – durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326 - Methods of repair in concrete, steel and timber structural components

UNIT IV MODERN TECHNIQUES OF RETROFITTING 9

Structural first aid after a disaster – Guniting, jacketing – Use of chemicals in repair – Application of polymers – Ferrocement and fiber concretes as rehabilitation materials – Strengthening by pre-stressing – Case studies

UNIT V STRENGTHENING OF EXISTING STRUCTURES 9

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

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Modi, P.I., Patel, C.N, "Repair and Rehabilitation of Concrete Structures", PHI India, New Delhi 2016.
2. Santhakumar, A.R, "Training Course notes on Damage Assessment and repair in Low Cost Housing" , RHDC-NBO, Anna University, July1992
3. Peter H Emmons, "Concrete Repair and Maintenance", Galgotia Publications, 2010.
4. Robert. T Ratay, "Forensic Structural Engineering Handbook", Mc Graw Hill, 2009.
5. Dovkaminetzky, "Design and Construction Failures", Galgotia Publication, New Delhi, 2009.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Identify the modes of failure in an existing structure	Understand
CO2	Diagnose and assess the damages caused in structures	Apply
CO3	Investigate environmental problems and natural hazards	Analyze
CO4	Articulate with the recent suitable techniques for repair and retrofitting	Apply
CO5	Acquire knowledge on strengthening the existing structures	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	2	3
CO2	3	3	3	-	2	3
CO3	3	2	3	-	2	3
CO4	3	2	2	-	3	3
CO5	3	3	3	-	3	3
CO	3	3	3	-	2	3
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P21STP02	PREFABRICATED STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the design principles of prefabricated structures
- To analyse the RC prefabricated floors, stairs and roofs
- To design Industrial building and shell roofs

UNIT I DESIGN PRINCIPLES 9

General: Civil Engineering requirements – Specific requirements for planning and layout of prefabrication plant – IS Code specifications – Detailed study on IS15916-2020 – Modular co-ordination – Standardization – Disuniting of Prefabricates – Production – Transportation – Erection – Stages of loading and code provisions – Safety factors – Material properties – Deflection control – Lateral load resistance – Location and types of shear walls

UNIT II JOINTS AND CONNECTIONS IN STRUCTURAL MEMBER 9

Prefabricated structures — One way and two-way prefabricated slabs – Connections – Beam to column and column to column – Types of Joints – based on action of forces – compression joints – shear joints – tension joints – based on function – construction, contraction, and expansion. – Design of expansion joints – Dimensions and detailing – Types of sealants – Types of structural connections

UNIT III FLOORS, STAIRS AND ROOFS 9

Types of floor slabs – Hollow core slab system – Analysis – Design example of cored and panel types – Two-way systems –Staircase: slab design – Types of roof slabs and insulation requirements – Description of joints – their behaviour and reinforcement requirements – Deflection control for short term and long-term loads – Ultimate strength calculations in shear and flexure

UNIT IV WALLS 9

Types of wall panels – Long wall and cross-wall large panel buildings – Blocks and large panels – Curtain – Partition and load bearing walls – load transfer from floor to wall panels – Framed buildings with partial and curtain walls – Vertical loads – Eccentricity and stability of wall panels – Design Curves – Types of wall joints – Curve behaviour and design – Leak prevention – Joint sealants –Sandwich wall panels – Approximate design of shear walls

UNIT V INDUSTRIAL BUILDINGS AND SHELL ROOFS 9

Components of single storey – Industrial sheds with crane gantry systems – R.C. Roof Trusses – Roof Panels – Corbels and Columns – Wind bracing design – Cylindrical – Folded plate and Hyper prefabricated shells – Erection and jointing – Joint design – Hand book-based design

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Kims S. Elliot, "Precast Concrete Structures", CRC Press, Taylor & Francis, 2017.
2. Hubert Bachmann, Alfred Steinle, Precast Concrete Structures, Ernst & Sohn, Wiley Publication, 2011.
3. Ryan E. Smith, Prefab Architecture: A Guide to Modular Design and Construction, John Wiley and Sons. Inc. London, 2010.

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4. Lewitt,M. "Precast Concrete- Materials, Manufacture, Properties and Usage", Applied Science Publishers, London And New Jersey, 1982.
5. Handbook of Precast Concrete Buildings, ICI publications, 2016.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Appreciate modular construction of prefabricated and classify the components of prefabrication	Understand
CO2	Analyze the joints in structural detailing of prefabricated structures	Analyze
CO3	Design the deflection control for short term and long term loads	Apply
CO4	Refer the codal provisions for abnormal load of prefabricated structure	Understand
CO5	Identify the components of typical structures	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	-	2
CO2	2	-	2	3	-	2
CO3	2	2	2	3	2	2
CO4	2	-	2	3	2	2
CO5	2	-	2	3	-	2
CO	2	2	2	3	-	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFFESSIONAL ELECTIVES

P21STP03	OFFSHORE STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the wave theories of offshore structures
- To analyse the offshore structures by static method of analysis
- To design offshore structures as per Indian codal provisions

UNIT I WAVE THEORIES 9

Wave generation process– Small– Finite amplitude and nonlinear wave theories

UNIT II FORCES OF OFFSHORE STRUCTURES 9

Wind forces – Wave forces on small bodies and large bodies – Current forces – Morison equation

UNIT III OFFSHORE SOIL AND STRUCTURE MODELLING 9

Different types of offshore structure – Foundation modelling – Fixed jacket platform – Structural modeling

UNIT IV ANALYSIS OF OFFSHORE STRUCTURES 9

Static method of analysis – Foundation analysis and dynamics of offshore structures

UNIT V DESIGN OF OFFSHORE STRUCTURES 9

Design of platforms – Helipads – Jacket tower – Analysis and design of mooring cables – Pipelines

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Reddy.D.V and Swamidas A.S.J.,"Essential of offshore structures", CRC Press, 2014.
2. Mohamed A. El-Reedy, "Offshore Structure, Design, Construction and Maintenance", Gulf Professional Publishing, 2012.
3. Gunther Clauss, Eike Lehmann, Carsten Ostgaard, M.J. Shields, "Offshore Structures: Volume I: Conceptual Design and Hydromechanics", Springer- Verlag, 2012.
4. Turgut Sarpkaya, "Wave Forces on Offshore Structures", Cambridge University Press, 2010.
5. Eugenio Fortaleza, "Active Control of Offshore Structures", Lambert Academic Publication, 2012.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the wave generation process and wave theories	Understand
CO2	Determine the forces acting upon the offshore structures	Understand
CO3	Know the different types of offshore structures and foundation modelling	Analyze
CO4	Analysis of offshore structures by dynamic method of analysis	Analyze
CO5	Design offshore structures like platform, helipads, jackets, towers	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	1	-	2
CO2	2	3	3	1	-	2
CO3	3	2	2	2	1	2
CO4	3	3	3	3	2	1
CO5	2	3	3	3	2	2
CO	3	3	3	3	2	2
Correlation levels:	1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)		

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PROFESSIONAL ELECTIVES

P21STP04	MATRIX METHODS FOR STRUCTURAL ANALYSIS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Understand the Energy concepts in structures
- To study the transformation of information in structures
- To analyse the structures by Flexibility and stiffness method

UNIT I ENERGY CONCEPTS IN STRUCTURES 9

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

UNIT II CHARACTERISTICS OF STRUCTURES – STIFFNESS AND FLEXIBILITY 9

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

UNIT III TRANSFORMATION OF INFORMATION IN STRUTURES 9

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

UNIT IV FLEXIBILITY METHOD 9

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

UNIT V STIFFNESS METHOD 9

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

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Natarajan C and Revathi P., "Matrix Methods of Structural Analysis", PHI Learning Private Limited, New Delhi, 2014

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2. Godbole P. N., Sonparote R. S., Dhote S. U., "Matrix Methods of Structural Analysis", PHI Learning Pvt. Ltd., New Delhi, 2014
3. Bhavikatti S S., "Matrix Methods of Structural Analysis", IK Publishing, India, 2011
4. Kardestuncer.H., "Elementary matrix analysis of structures", Mc-Graw Hill, USA, 1974
5. Weaver W. and Gere J. M., "Matrix Analysis of Framed Structure", CBS Publishers, Delhi, 2013

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the structures with energy concepts	Understand
CO2	Gain knowledge on characteristics of structures by evaluation of its flexibility and stiffness	Understand
CO3	Learn the transformation of system forces to element forces and element flexibility to system flexibility	Understand
CO4	Impart knowledge about analysis of system through direct and element approach of flexibility method	Analyze
CO5	Develop stiffness matrix for structures with zero force at some coordinates	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	2
CO2	3	3	2	2	3	2
CO3	3	3	2	2	3	2
CO4	3	2	2	2	3	2
CO5	3	2	2	2	3	2
CO	3	3	2	2	3	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P21STP05	THEORY OF PLATES & SHELLS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To get introduced to various plate theories, governing equations for bending of plates and various boundary conditions
- To analyse rectangular and circular plates
- To classify and analyse the different type of shell structures

UNIT I INTRODUCTION 9

Thin and thick plates – Small and large deflections – Small deflection of thin plates – Moment curvature relations – Stress resultants – Governing differential equation in Cartesian co-ordinates – Various boundary conditions – Pure bending of plates.

UNIT II RECTANGULAR PLATES 9

Navier solution: Simply supported – Under uniform loading – Under point load – Under patch load – Levy's Method: Simply supported – Under uniform loading - Under distributed edge moments – Raleigh- Ritz approach: Introduction to shear deformation theories – Reissener – Mindlin theory – Moment curvature relationship for first order shear deformation theory.

UNIT III CIRCULAR PLATES 9

Symmetrical bending of laterally loaded circular plates – Differential equation – Uniformly loaded circular plates – Circular plate with triangular loading – Circular plate with central hole at the center – Circular plate concentrically loaded – Circular plate loaded at the centre – Circular plates with moments.

UNIT IV CLASSIFICATION AND ANALYSIS OF SHELLS 9

Classification of shells – Thin shell theory – Equations to shell surfaces – Stress resultants – Stress displacement relations – Compatibility and equilibrium equations – Shells of revolution – Membrane theory – Equilibrium equations – Strain displacement relations – Boundary conditions – Cylindrical – Conical and spherical shells.

UNIT V DESIGN OF SHELLS 9

Circular cylindrical shells – Membrane theory – Equilibrium equations – Strain displacement relations – Boundary conditions – Bending Theory – Equilibrium equation – Strain displacement relations – Governing differential equation – Solution for a simply supported cylindrical shell – Various boundary conditions – Application to pipes and pressure vessels.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Timoshenko S. and Krieger S.W. "Theory of Plates and Shells", McGraw Hill Book Company, New York, 2003
2. Szilard R., "Theory and Analysis of Plates", Prentice Hall Inc., 2004
3. Reddy J N, "Theory and Analysis of Elastic Plates and Shells", McGraw Hill Book Company, 2006
4. Billington.D.P, "Thin Shell Concrete Structures", McGraw Hill Book Co., New York, 2008
5. Ramasamy. G.S., "Design and Construction of Concrete Shells Roofs", CBS Publishers, 1986

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Familarize about various plate theories	Understand
CO2	Analyze rectangular plates using Navier's solution, Levy's solution	Analyze
CO3	Analyze circular plates for the given boundary conditions	Analyze
CO4	Analyze various shell structures	Analyze
CO5	Design various shell and spatial structures	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2	1	2
CO2	3	1	2	2	1	2
CO3	3	1	2	2	1	2
CO4	3	1	2	2	1	2
CO5	3	1	2	2	1	2
CO	3	1	2	2	1	2

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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PROFESSIONAL ELECTIVES

P19STP06	MECHANICS OF COMPOSITE MATERIALS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the behaviour of composite materials and to investigate the failure and fracture characteristics
- To analyze the stress and strain component
- To analyze the design concepts of the composite structures

UNIT I INTRODUCTION 9

Introduction to Composites – Classifying composite materials – commonly used fiber and matrix constituents – Composite Construction – Properties of Unidirectional Long Fiber Composites and Short Fiber Composites

UNIT II STRESS STRAIN RELATIONS 9

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

UNIT III ANALYSIS OF LAMINATED COMPOSITES 9

Governing equations for anisotropic and orthotropic plates. Angle – ply and cross ply laminates – Static – Dynamic and Stability analysis for Simpler cases of composite plates – Inter laminar stresses

UNIT IV FAILURE AND FRACTURE OF COMPOSITES 9

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

UNIT V APPLICATIONS AND DESIGN 9

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

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Ronald F. Gibson, "Principles of Composite Material Mechanics", CRC Press; 4 edition , 2015
2. Daniel, "Engineering Mechanics of Composite Material", OUP; 2nd edition, 2013
3. Valery V. Vasiliev, "Advanced Mechanics of Composite Materials and Structures", Elsevier; 4 edition 2018
4. Robert M. Jones, "Mechanics of Composite Materials"-International Edition, CRC Press, 2016
5. Vasiliev, V.V. "Mechanics of Composite Structures", CRC Press, 2017

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Discuss the general behaviour of steel concrete composite structure and its types	Understand
CO2	Analyse the stress and strain for the composite structure	Analyze
CO3	Explain design concepts of members	Understand
CO4	Estimate the failure mode and design the joints	Apply
CO5	Analyse the composite member and identify applications	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	3	2
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2
CO	3	3	3	3	3	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P21STP07	ANALYSIS AND DESIGN OF TALL BUILDING	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To find the behaviour of tall structures subjected to dynamic loads
- To study the behaviour of different types of tall structural systems
- To impart knowledge on analyse and design of tall structural systems

UNIT I INTRODUCTION 9

Tall building in the urban context – The tall building and its support structure – Development of high rise building structures – General planning considerations. Dead loads – Live loads – Construction loads – Snow, rain, and ice loads – Wind loads – Seismic loading – Water and earth pressure loads – Loads due to restrained volume changes of material – Impact and dynamic loads – Blast loads – Combination of loads

UNIT II BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS 9

Factors affecting growth, height and structural form – High rise behavior, Rigid frames, braced frames, In filled frames, shear walls, coupled shear walls, wall – Frames, tubular, cores, outrigger braced and hybrid mega systems

UNIT III ANALYSIS OF TALL STRUCTURES 9

Modeling for approximate analysis – Accurate analysis and reduction techniques – Analysis of buildings as total structural system considering overall integrity and major subsystem interaction – Analysis for member forces, drift and twist – Computerized three dimensional analysis – Assumptions in 3D analysis – Simplified 2D analysis

UNIT IV DESIGN OF STRUCTURAL ELEMENTS 9

Sectional shapes – Properties and resisting capacity – Design – Deflection, cracking – Prestressing – shear flow – Design for differential movement, creep and shrinkage effects – Temperature effects and fire resistance

UNIT V STABILITY OF TALL BUILDING 9

Overall buckling analysis of frames – Wall frames – Approximate methods – Second order effects of gravity of loading, P– Delta analysis – Simultaneous first-order and P-Delta analysis – Translational, Torsional instability – Out of plumb effects – Stiffness of member in stability – Effect of foundation rotation

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Michael Yit Lin Chew, "Construction Technology for Tall Building", 5th Edition, World Scientific Publishing Company, 2017.
2. B.S. Taranath, "Structural analysis and design of tall building", CRC Press, 2011.
3. Alberto Lago, "Damping Technologies for Tall Buildings: Theory, Design Guidance and Case Studies", 1st edition, Butterworth– Heinemann; 2018.
4. IS 13920 Ductile detailing of reinforced concrete structures, BIS, India.
5. IS 1893 Criteria for earthquake resistant design BIS, India.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K– Level
CO1	Familiarize with the problems associated with tall structures with respect to different loads and materials	Understand
CO2	Understand the behaviour of high rise building with various structural elements	Understand
CO3	Analyse the tall structure for gravity and lateral loads	Analyse
CO4	Design the various structural systems for high rise buildings	Apply
CO5	Carryout analysis for stability, buckling of frames and various secondary effects on tall building	Analyse

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	–	1	2
CO2	3	3	2	–	1	2
CO3	3	3	2	3	1	2
CO4	3	3	2	3	1	2
CO5	3	3	2	–	1	2
CO	3	3	2	3	1	2
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P21STP08	INDUSTRIAL STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the requirements, planning and design of Industrial structures
- To design the industrial buildings
- To analyse and design of foundation, Chimneys, Cooling towers and transmission line towers

UNIT I PLANNING AND FUNCTIONAL REQUIREMENTS 9

Classification of Industries and Industrial structures – Planning for Layout Requirements regarding Lighting – Ventilation and Fire Safety– Protection against noise and vibration – Guidelines from factories act

UNIT II INDUSTRIAL BUILDINGS 9

Roofs for industrial buildings – Roofing sheets – Purlins – Light gauge sections – Built-up sections – Roof trusses – Pre-engineered structures – Design of Corbels and Nibs – Design of gantry girders

UNIT III POWER PLANT STRUCTURES 9

Types of power plants – Nuclear containment structures – Chimney and cooling towers – Bunkers and Silos – High pressure boilers and pipe supporting structures

UNIT IV TRANSMISSION LINE STRUCTURES 9

Analysis and design of transmission line towers – Sag and tension calculations – Methods of tower testing

UNIT V MACHINE FOUNDATION 9

Design of tower foundation – Types – Design principles – Design of Turbo generator foundation

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

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

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the classification of industries	Apply
CO2	Analyse and design of corbel, nibs and staircase	Apply
CO3	Understand the types of power plants and containment structures	Understand
CO4	Analyse and design transmission tower lines and chimneys	Analyze
CO5	Analyse and design tower foundation	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	3	3
CO2	3	-	3	3	2	3
CO3	3	2	3	3	3	2
CO4	3	3	3	3	3	-
CO5	2	-	2	3	3	1
CO	3	2	3	3	3	3
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P19STP09	EXPERIMENTAL TECHNIQUES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the strain, vibration, wind flow and Non-Destructive methods
- To determine the acoustics and wind flow
- To apply non-destructive testing on structures, buildings, bridges and towers

UNIT I STRAIN MEASUREMENT 9

Methods of measurement – Errors in measurements – Calibration – Load calibration of testing machines – IS codal provisions – Measurement system– Mechanical, Optical and Acoustical extensometers – Strain measurement – Electrical resistance strain gauges – Principle, types, performance and uses – Strain rosettes – Wheatstone bridge – Photo elasticity – Principle and applications – Hydraulic jacks and pressure gauges – Electronic load cells – Proving rings

UNIT II VIBRATION MEASUREMENTS 9

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

UNIT III ACOUSTICS AND WIND FLOW MEASURES 9

Principles of Pressure and flow measurements – Pressure transducers – Sound level meter – Venturimeter – Flow meters – Wind tunnel and its use in structural analysis – Structural modelling – Direct and indirect model analysis.

UNIT IV DISTRESS MEASUREMENT AND CONTROL 9

Diagnosis of distress in structures – Crack observation and measurements – Corrosion of reinforcement in concrete – Half cell, construction and use – Damage assessment – Controlled blasting for demolition – Techniques for residual stress measurements.

UNIT V NON-DESTRUCTIVE TESTING METHODS 9

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

Contact Periods:

Lecture: 45 Periods Tutorial: – Period Practical: – Period Total: 45 Periods

TEXT BOOKS:

1. Jindal U.C., Experimental Stress Analysis, Pearson, New Delhi, 2013
2. Dalley .J.W and Riley. W. F, "Experimental Stress Analysis", McGraw Hill Book Company, NewYork, 2005.
3. Ganesan.T.P, "Model Analysis of Structures", University Press, India, 2007
4. Ravisankar.K. and Chellappan.A., "Advanced course on Non–Destructive Testing and Evaluation of Concrete Structures", SERC, Chennai, 2010.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K–Level
CO1	Show the methodology of measuring errors and strains and calibrate the machineries and equipment used in the laboratory.	Apply
CO2	Illustrate the mechanical, optical, pneumatic and electrical strain gauges for strain measurement.	Understand
CO3	Indicate the vibration measuring systems and wind flow measurements.	Understand
CO4	Gain knowledge about diagnose the distress in structures.	Understand
CO5	Demonstrate non-destructive testing methods on structures.	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	1
CO2	3	1	2	-	2	2
CO3	3	2	3	2	2	1
CO4	3	1	3	-	1	2
CO5	3	2	3	3	2	2
CO	3	2	3	3	3	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P21STP10	WIND AND CYCLONE EFFECTS ON STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the concept of wind and cyclone effects for the analysis and design of structures
- To design the special structures by using IS codal provisions
- To determine the wind and cyclone effects on low rise structures and tall buildings

UNIT I INTRODUCTION 9

Introduction – Spectral studies – Gust factor – Wind velocity – Methods of measurements – Variation of speed with height – Shape factor – Aspect ratio – Drag effects

UNIT II WIND TUNNEL STUDIES 9

Wind Tunnel Studies – Types of tunnels – Modeling requirements – Interpretation of results – Aero-elastic models

UNIT III EFFECT OF WIND ON STRUCTURES 9

Wind on structures – Rigid structures – Flexible structures – Static and Dynamic effects –Tall buildings – chimneys

UNIT IV DESIGN OF SPECIAL STRUCTURES 9

Application to design – IS 875 (Part III) code method – Chimneys – Cooling towers – Cyclone Shelters

UNIT V CYCLONE EFFECTS 9

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

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Cook.N.J., "The Designer's Guide to Wind Loading of Building Structures", Butterworths, 1989
2. Lawson T.V., "Wind Effects on Building Vol. I and II", Applied Science Publishers, London, 1980
3. Peter Sachs, "Wind Forces in Engineering", Pergamon Press, New York, 1978
4. Kolousek.V, Pirner.M, Fischer.O and Naprstek.J, "Wind Effects on Civil Engineering Structures", Elsevier Publications, 1984

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the importance of wind properties and basic parameters.	Understand
CO2	Gain knowledge about wind tunnels and modelling requirements.	Understand
CO3	Understand the static and dynamics response of tall buildings and chimneys due to wind.	Understand
CO4	Design the special structures such as chimneys, cooling towers and cyclone shelters	Apply
CO5	Gain knowledge about cyclone effects and design of claddings by using relevant codal provisions	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	2
CO2	3	3	2	2	2	2
CO3	3	3	2	2	2	2
CO4	3	3	2	2	2	2
CO5	3	3	2	2	2	2
CO	3	3	2	2	2	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P19STP11	NONLINEAR ANALYSIS OF STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To give an overview about the concept of nonlinear behavior of beams and vibrations of beams
- To know the elastic analysis of statically determinate and indeterminate flexural members
- To study the nonlinear vibration and instabilities of elastically supported beams

UNIT I INTRODUCTION TO NONLINEAR ANALYSIS 9

Types of nonlinearities – Geometric nonlinearity, material nonlinearity, nonlinear governing equation for beams: moment – Curvature nonlinearity, geometric nonlinearity due to stretching, material nonlinearity, geometrically nonlinear beam problems – Moment-curvature nonlinearity – Cantilever beam – Centrally loaded beam with two supports – Cantilever beam subjected to tip load

UNIT II INELASTIC ANALYSIS OF COLUMNS 9

Nonlinear Analysis of Columns – Post buckling of cantilever column – Large deflection of column with both ends hinged

UNIT III VIBRATION THEORY AND ANALYSIS OF FLEXURAL MEMBERS 9

Vibration theory and analysis of flexural members – Hysteretic models and analysis of uniform and variable stiffness members under cyclic loading

UNIT IV ELASTIC AND INELASTIC ANALYSIS OF PLATES 9

Nonlinear Static Analysis of Plates – Geometric and Material Nonlinearities – Governing Nonlinear equations of Plates – Stress Function Approach – Displacement Equations Approach – Nonlinear Static Analysis of Plates – Boundary Conditions and method of solution – Large Deflection of Rectangular Plates

UNIT V NONLINEAR VIBRATION AND INSTABILITY 9

Nonlinear vibration and Instabilities of elastically supported beams.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Reddy.J.N, "Non linear Finite Element Analysis", Oxford University Press, 2008
2. Iyengar N G R, "Elastic Stability of Structural elements", Macmillan India Ltd, 2007
3. Fertis, D. G.,"Nonlinear Mechanics", CRC Press, Boca Raton, Florida, 1998
4. Sathyamoorthy, M, "Nonlinear Analysis of Structures", CRC Press, Boca Raton, Florida, 1997

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the concept of geometrically nonlinear beam problems	Understand
CO2	Apply the basic ideas inelastic analysis of columns	Apply
CO3	Apply the basic ideas in vibration theory and analysis of flexural members	Apply
CO4	Perform inelastic analysis of plates.	Analyze
CO5	Perform nonlinear vibration and instability.	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	2	3	2	2
CO5	3	3	2	3	2	2
CO	3	3	2	3	2	2
Correlation levels:	1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)		

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PROFESSIONAL ELECTIVES

P21STP12	DESIGN OF SUBSTRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT I SHALLOW FOUNDATIONS 9

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

UNIT II PILE FOUNDATIONS 9

Introduction – Types of pile foundations – Load carrying capacity – Pile load test – Structural design of straight piles – Configuration of piles – Different shapes of piles cap – Structural design of pile cap

UNIT III WELL FOUNDATIONS 9

Types of well foundation – Grip length – Load carrying capacity – Construction of wells – Failures and Remedies – Design of well foundation – Lateral stability

UNIT IV MACHINE FOUNDATIONS 9

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

UNIT V SPECIAL FOUNDATIONS 9

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

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 60 Periods

REFERENCES:

1. Swamy Saran, 'Analysis and Design of substructures", Oxford and IBH Publishing Co. Pvt. Ltd., 2006
2. Bowles .J.E., "Foundation Analysis and Design", McGraw Hill Publishing Co., New York, 1997
3. Tomlinson.M.J, "Foundation Design and Construction", Longman, Sixth Edition, New Delhi, 1995
4. Varghese.P.C, "Design of Reinforced Concrete Foundations" – PHI learning private limited, New Delhi, 2009
5. W.F. Chen, Lian Duan "Bridge Engineering: Substructure Design", CRC press.2001

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Select appropriate foundation type based on available soil conditions	Understand
CO2	Determine the load carrying capacity and to design the pile foundation	Apply
CO3	Design well foundation	Apply
CO4	Understand the design of machine foundations	Understand
CO5	Design the under reamed pile foundation, concrete towers, chimneys	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	3	2
CO3	2	2	3	3	2	1
CO4	2	2	3	3	2	1
CO5	2	3	3	3	2	1
CO	2	3	3	3	2	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P21STP13	OPTIMIZATION OF STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the fundamentals of optimization concepts and their applications in the structural engineering field
- To study the linear programming methods of the optimization
- To apply various optimization techniques to solve structural engineering problems

UNIT I BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES 9

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

UNIT II LINEAR PROGRAMMING 9

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

UNIT III NON LINEAR PROGRAMMING 9

Introduction to non-linear problems – One Dimensional minimization methods: Unidimensional – Unimodal function – Exhaustive and unrestricted search – Dichotomous search – Fibonacci Method - Golden section method – Interpolation methods, Unconstrained optimization Techniques

UNIT IV GEOMETRIC PROGRAMMING AND DYNAMIC PROGRAMMING 9

Geometric Programming – Polynomial – Degree of difficulty – Reducing G.P.P. to a set of simultaneous equations – Concepts of solving problems with zero difficulty and one degree of difficulty – Dynamic Programming – Bellman's principle of optimality – Representation of a multi stage decision problem – Concept of optimization problems – Truss optimization

UNIT V STRUCTURAL APPLICATIONS 9

Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory – Minimum weight design for truss members – Fully stressed design – Optimization principles to design of R.C. structures such as multi-storey buildings, water tanks and bridges. Structural optimization for transient (dynamic) problems

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Belegundu,A.D. and Chandrapatla,T.R., "Optimisation Concepts and Applications in Engineering", Pearson Education, 2011.
2. Arora J.S., "Introduction to Optimum Design", McGraw –Hill Book Company, 2011.
3. Deb K., "Optimisation for Engineering Design", Algorithms and examples, Prentice Hall, New Delhi, 2012.

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4. Spunt, "Optimization in Structural Design", Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey 1971.
5. Rao,S.S. "Optimization theory and applications", Wiley Eastern (P) Ltd., 1984.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Apply the basic ideas in optimization to make the structures as lightly as possible	Apply
CO2	Apply the linear programming techniques in engineering optimization	Apply
CO3	Solve the unconstrained and constrained optimization problems in structural design	Understand
CO4	Understand the methods in solving the problems related to geometric programming and dynamic programming	Understand
CO5	Acquire knowledge in advanced techniques of optimization	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	1	2
CO2	3	3	3	-	1	2
CO3	3	3	3	-	1	2
CO4	3	3	3	-	1	2
CO5	3	3	3	-	1	2
CO	3	3	3	-	1	2
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)						

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PROFFESSIONAL ELECTIVES

P21STP14	DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the behaviour and design of concrete composite elementsand structures
- To know the in-depth overview for the design of various steel concrete composite structures having applications in construction
- To gain knowledge about seismic behavior of composite structures

UNIT I INTRODUCTION 9

Introduction to steel – Concrete composite construction – Theory of composite structures – Codes – Composite action – Failure Modes – Serviceability and Construction issues in design

UNIT II DESIGN OF COMPOSITE MEMBERS 9

Behaviour of composite beams – Applications of Composite beams – Design of composite beams – Design of Composite columns

UNIT III DESIGN OF CONNECTIONS 9

Shear Connectors – Types– Behaviour of shear connectors – Design of shear connectors–Degree of shear connection –Partial shear interaction

UNIT IV COMPOSITE BOX GIRDER BRIDGES 9

Introduction – Behaviour of box girder bridges – Design concepts

UNIT V CASE STUDIES AND SEISMIC BEHAVIOR 9

Case studies on steel – Concrete composite construction in buildings – Seismic behaviour of composite structures

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Johnson R.P., 'Composite Structures of steel and concrete', Blackwell Scientific Publications, UK, 2004.
2. Johnson R.P., "Composite Structures of Steel and Concrete Beams, Slabs, Columns and Frames for Buildings", Vol.I, Blackwell Scientific Publications, 2004.
3. Owens, G.W. and Knowels. P. "Steel Designers manual", Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 1992.
4. Proceedings of "Workshop on Steel Concrete Composite Structures", conducted at Anna University, 2000.
5. IS 11384 - 1985, Code of Practice for Steel concrete Composite structures.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the concept of steel-concrete composite construction	Understand
CO2	Design the composite members	Apply
CO3	Design of connections for composite members	Apply
CO4	Learn the design concepts for composite box girder bridge	Understand
CO5	Understand the seismic behaviour of composite structures	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	3	3
CO2	3	-	-	3	3	3
CO3	3	3	1	3	3	3
CO4	3	3	2	2	3	3
CO5	3	-	1	1	3	3
CO	3	3	1	2	3	3

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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PROFFESSIONAL ELECTIVES

P19STP15	DESIGN OF BRIDGES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the loads, forces on bridges and design of several types of bridges
- To learn and understand the design of various elements of the bridge structure
- To gain knowledge about analyze and design of substructure

UNIT I INTRODUCTION AND SHORT SPAN RC BRIDGES 9

Types of bridges and loading standards – Choice of type – IRC Specifications for road bridges – Design of RCC solid slab bridges – Analysis and design of box culverts – Tee beam and slab bridges.

UNIT II LONG SPAN RC BRIDGES 9

Design principles of continuous girder bridges box girder bridges and balanced cantilever bridges – Segmental construction and launching of girders.

UNIT III PLATE GIRDER BRIDGES 9

Elements of plate girder – Design of plate girder – Intermediate Structure – Design Problem.

UNIT IV PRESTRESSED CONCRETE BRIDGES 9

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

UNIT V BEARINGS AND SUBSTRUCTURES 9

Different types of bearings – Design of bearings – Design of piers and abutments of different types – Design of Earth retaining structures – Types of bridge foundations – Design of foundations.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Jagadeesh.T.R. and Jayaram.M.A., "Design of Bridge Structures", Prentice Hall of India Pvt. Ltd, 2019
2. Ponnuswamy S., "Bridge Engineering", Tata McGraw Hill, 2008
3. Krishnaraju N, "Design of Bridges" Oxford & IBH publishing Co. Pvt Ltd, 4th Edition, 2008
4. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. New Delhi, 6th Edition, 2008
5. Raina. V.K. "Concrete Bridge Practice" Shroff Pub & Dist. Pvt. Ltd 2007

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the fundamentals and codes of practice of bridge design	Understand
CO2	Learn about the design principles of bridges and culverts	Understand
CO3	Analyze and design of plate girders	Analyze
CO4	Analyze and design of prestressed concrete bridges	Analyze
CO5	Design of component of bridges and foundations.	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	3
CO2	3	2	3	3	3	2
CO3	3	2	2	3	2	2
CO4	3	2	2	3	3	3
CO5	3	3	2	2	3	3
CO	3	2	2	3	3	3
Correlation levels :	1 :Slight (Low)		2: Moderate {Medium)		3: Substantial (High)	

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PROFFESSIONAL ELECTIVES

P21STP16	SMART MATERIALS AND STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concepts of smart systems for advanced construction in future
- To impart knowledge on both conventional and advanced applications of smart materials with case studies
- To acquire knowledge on advanced smart materials and structures

UNIT I INTRODUCTION 9

Introduction to passive and active systems – Need for active systems – Smart systems – Definitions and implications - Active control and adaptive control systems – Examples.

UNIT II FIBRE OPTICS 9

Introduction – Physical Phenomenon and Characteristics – Fibre optic strain sensors – Twisted and Braided Fibre Optic sensors – Optical fibres as load bearing elements – Crack detection applications – Integration of Fibre optic sensors and Shape memory elements.

UNIT III SMART MATERIALS AND SYSTEMS 9

Smart Materials – Types and its application – Materials used in smart systems – Characteristics and behaviour of smart materials – Modelling smart materials – Components of smart systems – System features and interpretation of sensor data – Proactive and reactive systems.

UNIT IV SMART ACTUATORS 9

Smart materials and their application for sensing and actuation – Piezoelectric actuator – Linear actuators – Hybrid actuators – Applications – Shape memory alloys actuator – Magneto-strictive actuators and Electro-strictive actuators – Electro and magnetorheological fluid actuators – Case study.

UNIT V ADVANCES IN SMART STRUCTURES & MATERIALS 9

Self-Sensing Piezoelectric Transducers – Energy Harvesting Materials – Autophagous Materials – Self-Healing Polymers – Intelligent System Design – Emergent System Design

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. M.V.Gandhi and B.S.Thompson, "Smart Materials and Structures", Chapmen & Hall, London, 1992.
2. Srinivasan A.V. and Michael McFarland D, "Smart Structures: Analysis and Design", Cambridge University Press, 2009.
3. Brian Culshaw, "Smart Structures and Materials", Artech House, 2000.
4. Yoseph Bar Cohen, "Smart Structures and Materials 2003", The International Society for Optical Engineering, Spie, 2003.
5. Michelle Addington and Daniel L. Schodek, "Smart Materials and Technologies: For the Architecture and Design Professions", Routledge 2004.
6. Antonella D'Alessandro, Annibale Luigi Materazzi, Filippo Ubertini, "Nanotechnology in Cement Based Construction", Jenny Stanford Publishers, 2020.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Illustrate the smart systems and its applications.	Understand
CO2	Analyze the concept of fibre optics in crack detections.	Analyze
CO3	Identify different smart materials and its components.	Understand
CO4	Apply the concept of actuators and its applications.	Apply
CO5	Outline the Advances In Smart Structures & Materials.	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	-	2	1
CO2	3	3	2	1	3	2
CO3	3	2	2	1	-	2
CO4	3	1	2	-	1	-
CO5	3	3	2	-	2	2
CO	3	3	2	1	2	2
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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PROFFESSIONAL ELECTIVES

P21STP17	COMPUTER AIDED ANALYSIS AND DESIGN	Category: PEC			
		L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To learn the principles of computer graphics, structural analysis, structural design, Finite Element Analysis
- To impart the parametric fundamentals to create and stimulate analysis of steel sections using suitable software
- To understand basic principles of optimization and Artificial Intelligence supported by software tools

UNIT I COMPUTER GRAPHICS 6

Graphic primitives – Transformations – Basics of 2D drafting – Modelling of curves and surfaces – Wire frame modelling – Solid Modelling – Graphic standards – Drafting Software packages

UNIT II STRUCTURAL ANALYSIS I 6

Computer method of structural analysis – Simulation and Analysis of steel sections I, channel and Angle

UNIT III STRUCTURAL ANALYSIS II 6

PEB Elements – RCC and Composite members – Nonlinear Analysis through software packages

UNIT IV STRUCTURAL DESIGN 6

Computer Aided Design of Steel and RC structural elements – Detailing of reinforcement – Detailed Drawing

UNIT V OPTIMIZATION 6

Introduction to Optimization – Applications of Linear programming – Simplex Algorithm – Post Optimality Analysis

LIST OF EXPERIMENTS

1. 2D Frame Modelling and Analysis.
2. 3D Frame Modelling and Analysis.
3. Non Linear Analysis using Design software.
4. Design and Detailing of Structural Elements.
5. Simulation and Analysis of steel beam using FEA software.
6. Simulation and Analysis of RC Beam using FEA software.
7. Simulation and Analysis of Composite elements using FEA software.
8. Eigen Value Buckling analysis using FEA software.

Contact Periods:

Lecture: 30 Periods Tutorial: - Periods Practical: 30 Periods Total: 60 Periods

REFERENCES:

1. Krishnamoorthy C.S and Rajeev S., "Computer Aided Design", Narosa Publishing House, New Delhi.

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2. Groover M.P. and Zimmers E.W. Jr.," CAD/CAM, Computer Aided Design and Manufacturing", Prentice Hall of India Ltd, New Delhi, 1993.
3. Shah V.L. "Computer Aided Design in Reinforced Concrete" Structural Publishers, 2014
4. Rao. S.S., "Optimisation Theory and Applications ", Wiley Eastern Limited, New Delhi, 2009.
5. W Harrison H.B., "Structural Analysis and Design Vol.I and II", Pergamon Press, 1991

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Know basics of 2D drafting and drafting software packages	Understand
CO2	Carryout computer method of structural analysis	Apply
CO3	Illustrate Simulation and Analysis of steel sections I, channel and Angle	Understand
CO4	Perform computer aided design of steel and RC structural elements	Apply
CO5	Know optimization techniques and to be familiar with Post Optimality Analysis and knowledge based expert systems	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	3
CO2	3	3	2	3	2	3
CO3	3	3	2	3	2	3
CO4	3	3	2	3	2	3
CO5	3	3	2	3	2	3
CO	3	3	2	3	2	3

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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PROFESSIONAL ELECTIVES

P21STP18	ENERGY EFFICIENT BUILDINGS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the green buildings concepts applicable to alternate design and to incorporate renewable energy systems in buildings
- To acquire knowledge on landscape and Heating, Ventilation and Airconditioning in Buildings
- To impart knowledge on Eco friendly building concepts

UNIT I INTRODUCTION 9

Conventional versus Energy Efficient buildings – Historical perspective – Water Energy – IAQ requirement analysis – Future building design aspects – Guidelines for LEED certifications – Criticality of resources and needs of modern living – Codal Provisions.

UNIT II LANDSCAPE AND BUILDING ENVELOPES 9

Energy efficient Landscape design – Micro climates – various methods – Shading – Water bodies – Building envelope – Building materials, Envelope heat loss and het gain its evaluation – Paints, Insulation – Design methods and tools

UNIT III HEATING, VENTILATION AND AIRCONDITIONING IN BUILDINGS 9

Natural Ventilation, Passive cooling and heating – Application of wind, water and earth for cooling, evaporative cooling, radiant cooling – Hybrid methods – Energy Conservation measures, Thermal Storage integration in buildings

UNIT IV LIGHTING AND ILLUMINATION IN BUILDINGS 9

Surface co-efficient: air Scavity, internal and external surfaces – Overall thermal transmittance – Wall and windows – Heat transfer due to ventilation/infiltration – Internal heat transfer – Solar temperature – Decrement factor – Phase lag – Design of day lighting– Computer packages for carrying out thermal design of buildings and predicting performance

UNIT V PASSIVE COOLING & RENEWABLE ENERGY IN BUILDINGS 9

Passive cooling concepts – Evaporative cooling – Radioactive cooling – Application of wind – Water and earth for cooling – Shading, paints and cavity walls for cooling – Roof radiation traps – Earth air-tunnel – Introduction of renewable sources in buildings – Solar water heating – Small wind turbines – Stand-alone PV systems – Hybrid system – Economics

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Clarke, Joseph. "Energy simulation in building" 2nd Edition, Routledge,2007.
2. Krishan, Arvind, "Climate responsive architecture: a design handbook for energy efficient buildings", Tata McGraw-Hill Education, 2001.
3. Krieder, J and Rabi A, "Heating and Cooling of buildings: Design for Efficiency", McGraw Hill, 1994.
4. Paul tymkow, Savvas tassov, Maria kolokotrani and Hussam jouhara, "Building Services and Design for Energy efficient building" 2nd Edition, Taylor and Francis, Routledge.
5. Yap Eh "Energy Efficient Buildings", Intech publications, 2018.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Illustrate the design aspects of energy efficient buildings	Understand
CO2	Gain knowledge on the role and importance of landscape	Understand
CO3	Design HVAC components in buildings	Apply
CO4	Acquire knowledge on the process of heat transmission in buildings	Understand
CO5	Outline the renewable energy systems in buildings	Understand

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	2	-	1
CO2	3	-	3	-	3	1
CO3	3	-	3	3	-	1
CO4	3	-	3	-	3	1
CO5	3	-	3	-	-	1
CO	3	-	3	-	-	1
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P21STP19	STRUCTURAL HEALTH MONITORING	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concepts involved in the assessment, evaluation and technical diagnosis of different structural systems of strategic importance
- To impart knowledge on both elementary and advanced applications of SHM with case studies
- To impart knowledge on sensor techniques to monitor the health of structure without damaging the structure

UNIT I INTRODUCTION 9

Introduction to Structural Health Monitoring – Necessity –Challenges – Advantages – Components of SHM process – SHM issues applied to concrete structures – Level of uncertainties in SHM process - SHM Design.

UNIT II STRUCTURAL HEALTH MONITORING METHODS 9

Short term and Long term Monitoring – Local and Global Monitoring – Static and Vibration based SHM – SHM planning and Management – SHM Methods

UNIT III DAMAGE IDENTIFICATION METHODS 9

Damage Identification – Visual Inspection – Comparison of damage identification methods – Non-Destructive testing and Evaluation – Vibration based damage detection

UNIT IV SENSOR NETWORKING 9

Sensor Technologies – Fibre optic sensors – Smart Sensing for SHM – Sensing requirements in special structures – Sensor requirements and Data Acquisition – Acquisition system and Networking for SHM – Wireless Sensor Networking – MEMS – Artificial Intelligence in SHM

UNIT V APPLICATIONS OF SHM 9

Application of SHM in bridges, buildings and offshore structures – Application in structural control strategies

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

REFERENCES:

1. Daniel Balageas, Claus-Peter Fritzen and Alfredo Güemes, "Structural Health Monitoring" Wiley ISTE, 2010.
2. Douglas E Adams, "Health Monitoring of Structural Materials and Components-Methods with Applications", John Wiley and Sons, 2007.
3. Glisic B and Inaudi D, "Fibre optic methods for structural health monitoring", John Wiley and Sons, 2008.
4. Nagayama T and Spencer Jr B.F, "Structural health monitoring using smart sensors", Newmark Structural Engineering Laboratory, University of Illinois at Urbana-Champaign, 2007.
5. Gopalakrishnan Srinivasan, Ruzzene Massimo, Hanagud Sathyanaraya, "Computational Techniques for Structural Health Monitoring", Springer Publication, 2007.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Illustrate the structural health monitoring process and its necessity.	Understand
CO2	Identify suitable structural health monitoring methods.	Understand
CO3	Analyze the various damage identification methods.	Analyze
CO4	Assess the sensor networking in structures based on damage level.	Apply
CO5	Apply the structural health monitoring strategy to various structures.	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	-	-	3
CO2	3	3	3	-	-	3
CO3	3	2	2	-	2	1
CO4	3	3	3	-	2	2
CO5	3	3	3	-	1	3
CO	3	3	3	-	2	3
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P21STP20	ADVANCED CONCRETE TECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge about applications of special concretes
- To impart the quality assurance and maintenance of concrete
- To understand microstructure of concrete

UNIT I CHARACTERISTICS OF CONCRETE INGREDIENTS 9

Importance of Bogue's compounds – Structure of a Hydrated Cement Paste – Volume of hydrated product – Porosity of paste and concrete – Transition Zone – Elastic Modulus – Factors affecting strength and elasticity of concrete – Rheology of concrete in terms of Bingham's parameter

UNIT II DEVELOPMENTS IN CONCRETE 9

Bacterial Concrete – Born Again Concrete (Recycled Aggregate Concrete) – Electric Concrete (Smart Concrete) Description and Applications – Roller Compacting Concrete – Reactive Powder Concrete – Translucent concrete – Graphic Concrete –Description, Properties and Applications

UNIT III ADVANCED CEMENTITIOUS COMPOSITES 9

Fiber-Reinforced Cementitious Composites – High-Strength Cementitious Composites – Polymers in Concrete – Shrinkage-Compensating Concrete – Self-Compacting Concrete –Engineered Cementitious Composite – Tube-Reinforced Concrete – High-Volume Fly Ash Concrete – Structural Lightweight Concrete – Heavyweight Concrete

UNIT IV CONCRETE FRACTURE MECHANICS

Introduction – Linear Elastic Fracture Mechanics – Crack Tip Plastic Zone – Crack Tip Opening Displacement – Fracture Process in Concrete – Nonlinear Fracture Mechanics for Concrete – Two-Parameter Fracture Model – Size Effect Model – Fictitious Model by Hillerborg– R-Curve Method for Quasi-Brittle Materials

UNIT V MICROSTRUCTURE OF CONCRETE 9

Microstructure of Concrete – Significance – Complexities – Description of Different Types of Microstructure Tests – Microstructure Property Relationship between aggregate phase and Hydrated Cement Paste – Interfacial Transition Zones – Influence of Interfacial Transition Zone – Concrete Fracture Mechanics

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

EFERENCES:

1. Zongjin Li., "Advanced Concrete Technology",Wiley Publications, 2011.
2. Neville A.M.,"Properties of Concrete", Trans-Atlantic Publications, Inc., 2012.
3. Job Thomas., "Concrete Technology", Cenage learning, 2015.
4. R. Santhakumar, "Concrete Technology", Oxford Universities Press, 2006.
5. Shetty M. S., "Concrete Technology", S. Chand & Co., 2008.

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Learn Beyond

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Outline the characteristics of concrete ingredients	Understand
CO2	Acquire knowledge on recent advancements in concrete with its applications	Understand
CO3	Identify the various advanced cementitious composites and its uses	Apply
CO4	Investigate on Concrete Fracture Mechanics	Apply
CO5	Gain knowledge on microstructure studies in concrete and its ingredients	Understand

COURSE ARTICULATION MATRIX:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	-	2	2
CO2	3	3	2	-	2	2
CO3	3	3	2	-	2	2
CO4	3	3	2	-	2	2
CO5	3	3	2	-	2	2
CO	3	3	2	-	2	2
Correlation	1. Slight (Low)		2. Moderate (Medium)		3. Substantial (High)	

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