KPR Institute of Engineering and Technology

Learn Beyond (Autonomous, NAAC "A")

Avinashi Road, Arasur, Coimbatore.

Great Place To Work. Certified MAR 2023-MAR 2024 INDIA

M.E. – Structural Engineering

Curriculum and Syllabi

(Regulations – 2023)

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	✓	-	-	-	-	-
		Seismic Resistant Design of Structures	✓	✓	✓	✓	✓	✓
		Theory of Elasticity and Plasticity	✓	✓	✓	✓	✓	✓
		Research Methodology & IPR	✓	✓	-	-	-	-
	SEM II	Finite Element Analysis	✓	✓	✓	✓	✓	✓
		Advanced Reinforced concrete design	✓	✓	✓	✓	✓	✓
		Advanced Steel Structures	✓	✓	✓	✓	✓	✓
		Advanced Structural Engineering Laboratory	✓	✓	✓	✓	✓	✓
		Technical Seminar	✓	✓	✓	-	✓	✓
II Year	SEM III	Advanced Prestressed Concrete	✓	✓	✓	✓	✓	✓
		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	✓	✓	✓	✓	✓	✓
		Industrial Structures	✓	✓	✓	✓	✓	✓

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		Experimental Techniques	✓	✓	✓	✓	✓	✓
		Wind and Cyclone Effects on Structures	✓	✓	✓	-	-	-
		Design of Sub Structures	✓	✓	✓	✓	✓	✓
		Optimization of Structures	✓	✓	✓	-	✓	✓
		Design of Steel Concrete Composite Structures	✓	✓	✓	-	-	✓
		Design of Bridges	✓	✓	✓	✓	✓	✓
		Smart Materials and Systems	✓	✓	✓	✓	✓	✓
		Energy Efficient Building	✓	-	✓	✓	✓	✓
		Structural Health Monitoring	✓	✓	✓	-	✓	✓
		Stability of Structures	✓	✓	✓	✓	✓	✓
		Advanced Concrete Technology	✓	✓	✓	✓	✓	✓
		Design of Formwork	✓	✓	✓	✓	✓	✓
		Building Information Modelling in Architecture, Engineering and Construction	✓	✓	✓	✓	✓	✓

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M.E. STRUCTURAL ENGINEERING

REGULATIONS – 2023

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	P23MA102	Advanced Mathematical Methods	FC	3	0	0	3
2	P23ST101	Seismic Resistant Design of Structures	PCC	3	0	2	4
3	P23ST102	Theory of Elasticity and Plasticity	PCC	3	0	0	3
4	P23RMC01	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	0	2	19

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P23ST201	Finite Element Analysis	PCC	3	0	2	4
2	P23ST202	Advanced Reinforced concrete design	PCC	3	0	0	3
3	P23ST203	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	P23ST204	Advanced Structural Engineering Laboratory	PCC	0	0	4	2
7	P23ST205	Technical Seminar	EEC	0	0	4	2
			TOTAL	15	0	10	20

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SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P23ST301	Advanced Prestressed Concrete	PCC	3	0	0	3
2	-	Professional Elective V	PEC	3	0	0	3
3	-	Professional Elective VI	PEC	3	0	0	3
PRACTICALS							
4	P23ST302	Project Work (Phase-I)	EEC	0	0	12	6
			TOTAL	**9**	**0**	**12**	**15**

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P23ST401	Project Work (Phase-II)	EEC	0	0	24	12
2	P23STI01	Industrial Training / Internship (4 weeks)	EEC	0	0	0	2
			TOTAL	**0**	**0**	**24**	**14**

TOTAL CREDITS: 68

LIST OF COURSES BASED ON ITS CATEGORY

FOUNDATION COURSES (FC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P23MA102	Advanced Mathematical Methods	FC	3	0	0	3

PROFESSIONAL CORE COURSES (PCC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P23ST101	Seismic Resistant Design of Structures	PCC	3	0	2	4
2	P23ST102	Theory of Elasticity and Plasticity	PCC	3	0	0	3

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3	P23ST201	Finite Element Analysis	PCC	3	0	2	4
4	P23ST202	Advanced Reinforced concrete design	PCC	3	0	0	3
5	P23ST203	Advanced Steel Structures	PCC	3	0	0	3
6	P23ST204	Advanced Structural Engineering Laboratory	PCC	0	0	4	2
7	P23ST301	Advanced Prestressed Concrete	PCC	3	0	0	3

PROFESSIONAL ELECTIVES COURSES (PEC)

S.NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	P23STP01	Maintenance and Rehabilitation of Structures	3	0	0	3
2	P23STP02	Prefabricated Structures	3	0	0	3
3	P23STP03	Offshore Structures	3	0	0	3
4	P23STP04	Matrix Methods for Structural Analysis	3	0	0	3
5	P23STP05	Theory of Plates and shells	3	0	0	3
6	P23STP06	Mechanics of Composite Materials	3	0	0	3
7	P23STP07	Analysis and Design of Tall Building	3	0	0	3
8	P23STP08	Industrial Structures	3	0	0	3
9	P23STP09	Experimental Techniques	3	0	0	3
10	P23STP10	Wind and Cyclone Effects on Structures	3	0	0	3
11	P23STP11	Design of Sub Structures	3	0	0	3
12	P23STP12	Optimization of Structures	3	0	0	3
13	P23STP13	Design of Steel Concrete Composite Structures	3	0	0	3
14	P23STP14	Design of Bridges	3	0	0	3
15	P23STP15	Smart Materials and Systems	3	0	0	3
16	P23STP16	Energy Efficient Building	3	0	0	3
17	P23STP17	Structural Health Monitoring	3	0	0	3
18	P23STP18	Stability of Structures	3	0	0	3
19	P23STP19	Advanced Concrete Technology	3	0	0	3
20	P23STP20	Design of Formwork	3	0	0	3
21	P23STP21	Building Information Modelling in Architecture, Engineering and Construction	3	0	0	3

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RESEARCH METHODOLOGY & IPR COURSES (RMC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P23RMC01	Research Methodology & IPR	RMC	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P23ST205	Technical Seminar	EEC	0	0	4	2
2	P23ST302	Project Work (Phase-I)	EEC	0	0	12	6
3	P23ST401	Project Work (Phase-II)	EEC	0	0	24	12
4	P23STI01	Industrial Training / Internship (4 weeks)	EEC	0	0	0	2

VIII. Scheme of Credit distribution – Summary

S.No	Stream	Credits/Semester				Credits	%	Suggested by AICTE
		I	II	III	IV			
1.	Foundation Courses (FC)	3	-	-	-	3	4.41	-
2.	Professional Core Courses (PCC)	7	12	3	-	22	32.40	-
3.	Professional Elective Courses (PEC)	6	6	6	-	18	26.47	-
4.	Research Methodology & IPR Courses (RMC)	3	-	-	-	3	4.41	-
5.	Employability Enhancement Courses (EEC)	-	2	6	14	22	32.40	-
Total		**19**	**20**	**15**	**14**	**68**	**100**	-

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SEMESTER I

P23MA102	ADVANCED MATHEMATICAL METHODS	Category: FC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To encourage students to solve partial differential equations using Laplace and Fourier transforms
- To enable students to use calculus of variations to find the extreme values of functions in engineering discipline
- To enable the students to understand the tensor algebra and its applications in engineering

UNIT I LAPLACE TRANSFORM FOR PDE 9

Laplace transform - Definitions – Properties – Transform 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 FOR PDE 9

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

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

UNIT IV CONFORMAL MAPPING AND APPLICATIONS 9

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

UNIT V TENSOR ANALYSIS 9

Summation convention – Contravariant and covariant vectors – Contraction of tensors – Inner product – Quotient law – Metric tensor – Christoffel symbols – Covariant differentiation – Gradient - Divergence and curl

Contact Periods:

Lecture: 45 Periods Tutorial: Periods Practical: – Periods Project: – Periods

Total 45 Periods

REFERENCES:

1. Sankara Rao, K., "Introduction to Partial Differential Equations", 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
2. Spiegel, M.R., "Theory and Problems of Complex Variables and its Applications", Schaum's Outline Series, McGraw Hill Book Co., 1981.

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COURSE OUTCOMES:

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

COs	Statements	K-Level
CO1	Apply Laplace transforms to solve the initial value, initial–boundary value and boundary value problems in Partial Differential Equations	Apply
CO2	Apply Fourier transforms to solve the initial value, initial–boundary value and boundary value problems in Partial Differential Equations	Apply
CO3	Maximizing and minimizing the functions that occur in various branches of Engineering Disciplines	Apply
CO4	Construct conformal mappings between various domains and use conformal mapping in studying problems in engineering	Apply
CO5	Competently use tensor analysis as a tool in the field of applied sciences and related	Understand

COURSE ARTICULATION MATRIX:

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

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SEMESTER I

P23ST101	SEISMIC RESISTANT DESIGN OF STRUCTURES	Category: PCC			
		L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To study the response of structures subjected to dynamic loads
- To design the structures subjected to seismic forces
- To design the concepts of seismic analysis and application using software

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 – Single and multiple degree freedom systems

UNIT II EARTHQUAKE RESPONSE 9

Earthquake Response to Elastic and Inelastic Buildings – Response Spectrum Theory – Design spectrum – Design principles, Capacity based design, Strong column – Weak beam concept, Ductility – Definition, Types, Importance and Requirements

UNIT III CODAL SPECIFICATIONS AND SEISMIC ANALYSIS 9

Code Provisions of Design of Buildings as per IS1893 and IS4326 – Behaviour and Design of Masonry Structures as per IS 13827 and IS13828. Methods of Seismic Analysis: Equivalent static analysis – Response Spectrum method – Time history method – Pushover Analysis

UNIT IV DUCTILE DESIGN AND DETAILING 9

Code Provisions of Ductile Detailing of Structures as per IS13920 – Design of RC beams, columns, Beam column joints and shear walls

UNIT V SPECIAL TOPICS 9

Modern Concepts – Base Isolation, Passive Control and Active Control Systems – Seismic retrofitting strategies for RC and masonry buildings, soil Liquefaction

LIST OF EXPERIMENTS

1. Seismic load calculation by static analysis method using Excel spreadsheets
2. Seismic load calculation by dynamic analysis method using Excel spreadsheets
3. Analysis and design of multistory building for seismic force using software
4. Design & ductile detailing of beams
5. Design & ductile detailing of column
6. Design & ductile detailing of shear wall

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: 30 Periods Total: 75 Periods

REFERENCES:

1. Chopra A.K., "Dynamics of Structures", 5th edition, N J Pearson Education Inc., 2017.
2. Duggal S.K., "Earthquake Resistant Design of Structures", 2nd edition, Prentice Hall of India, New Delhi, 2013.
3. Brebbia C. A., "Earthquake Resistant Engineering Structures VIII", WIT Press, 2015.
4. Paulay.T and Priestley M.J.N., "Seismic Design of Reinforced Concrete and Masonry Buildings", 1st edition, John Wiley and Sons, 2013.
5. Mukhopadhyay, M., "Structural Dynamics", 1st edition, Ane Books, India, 2006.

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COURSE OUTCOMES:

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

COs	Statements	K-Level
CO1	Acquire knowledge on behavior of structures subjected to earthquake	Understand
CO2	Calculate the effect of earthquake forces and response of the structure	Apply
CO3	Understand and interprets the suitable application of codal provisions	Understand
CO4	Design and detailing of RCC framed and Shear wall Structures	Apply
CO5	Understand retro-fitting of existing damaged buildings and vibration control measures	Understand

COURSE ARTICULATION MATRIX:

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

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

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SEMESTER I

P23ST102	THEORY OF ELASTICITY AND PLASTICITY	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand elastic properties, stress and strain relations in Cartesian coordinate systems
- To study 2D stress strain relationship, energy theorem and energy methods
- 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", 4th Edition, Prentice, 2013.
2. Sadhu Singh, "Theory of Elasticity", 4th Edition, Dhanpat Rai sons Private Limited, New Delhi, Edition, 2013.
3. Chakrabarty.J, "Theory of Plasticity", 3rd Edition, Elsevier Butterworth Heinmann – UK, 2007.
4. Timoshenko S. and GoodierJ.N. "Theory of Elasticity", 3rd Edition McGraw Hill Book Co., New York, 2017.
5. Sadd, M. H. "Elasticity theory", 3rd Edition, 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	Apply stress-strain relations for linearly elastic solids and torsion on non- circular section	Apply
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	-	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER I

P23RMC01	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 etc.,

Contact Periods:

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

REFERENCES:

1. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for 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	Analyze
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	-	-	-	-
CO2	3	3	-	-	-	-
CO3	3	3	-	-	-	-
CO4	3	3	-	-	-	-
CO5	3	3	-	-	-	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P23ST201	FINITE ELEMENT ANALYSIS	Category: PCC			
		L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To study the basics of the finite element techniques
- 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

Historical background – Mathematical modelling of field problems in Engineering – Governing equations – Discrete and Continuous models – Boundary, Initial and Eigen value problems – Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method

UNIT II ONE - DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization types – Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors – Assembly of Matrices – Solution of problems from solid mechanics and heat transfer – Longitudinal vibration frequencies and mode shapes – Fourth order beam equation – Transverse deflections and Natural frequencies of beams

UNIT III TWO-DIMENSIONAL VARIABLE PROBLEMS 9

Second order 2D equations involving scalar variable functions – Variational formulation – Finite element formation – Triangular elements – Shape functions and element matrices and vectors – Application to field problems – Thermal problems – Higher order elements – Plane stress, Plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations

UNIT IV ISOPARAMTETRIC FORMULATION 9

Natural co-ordinate systems – Isoparametric elements – Shape functions for ISO parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matric solution techniques – Solutions techniques to dynamic problems

UNIT V ANALYSIS OF BEAM AND RIGID FRAMES 9

Introduction – Beam analysis using two noded elements – Analysis of rigid plane frame using 2 noded beam elements – A three dimensional rigid frame element – Timoshenko beam element

LIST OF EXPERIMENTS

1. Analysis of RCC Beam using FEM software.
2. Analysis of RCC Plane Frame using FEM software
3. Analysis of RCC Space Frame using FEM software
4. Analysis of Pre- stressed concrete elements using FEM software
5. Analysis of Retaining wall using FEM software

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: 30 Periods Total: 75 Periods

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REFERENCES:

1. Bhavikatti.S.S, "Finite Element Analysis", New Age International Publishers, 2nd edition, 2015
2. Chandrupatla, R.T. and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 4th edition, 2015
3. Rao.S.S, "Finite Element Method in Engineering", Butterworth – Heinmann, UK, 2nd edition, 2019
4. Logan D. L., A First Course in the Finite Element Method, Thomson Learning, 1st edition, 2012.
5. David Hutton,"Fundamentals of Finite Element Analysis", Tata McGraw Hill Publishing Company Limited, New Delhi, 2nd edition, 2017.
6. https://archive.nptel.ac.in/courses/112/104/112104193/

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 one dimensional element.	Apply
CO3	Apply finite element method for Plane stress and plane strain problems in 2D.	Apply
CO4	Analyze Isoparametric elements and formulation of element equations.	Analyze
CO5	Understand the applications of finite element method for rigid frames and beams.	Understand

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	3	-	2	3	3	1

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

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SEMESTER II

P23ST202	ADVANCED REINFORCED CONCRETE DESIGN	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To design special RC elements like 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

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

UNIT IV INELASTIC BEHAVIOUR OF CONCRETE BEAMS AND COLUMNS 9

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

UNIT V DESIGN OF SPECIAL STRUCTURES 9

Introduction – Design of bunker – Design of Silos – Design of RC walls

Contact Periods:

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

REFERENCES:

1. Gambhir.M.L., "Design of Reinforced Concrete Structures", 4th edition, Prentice Hall of India, New Delhi, 2013.
2. Varghese. P.C., "Advanced Reinforced Concrete Design", 3rd edition, PHI Learning Pvt. Ltd., New Delhi, 2011.
3. Subramanian. N., "Design of Reinforced Concrete Structures", Oxford University Press, New Delhi, 3rd edition, 2015.
4. Sinha.N.C. and Roy S.K., "Fundamentals of Reinforced Concrete", S.Chand and Company Limited, New Delhi, 2nd edition, 2003.
5. Unnikrishna Pillai and Menon., "Reinforced concrete Design', Tata McGraw Hill Publishers Co. Ltd., New Delhi, 3rd edition, 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	Analyze inelastic behavior 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	3	3	3	3	3
CO3	3	2	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	2	3	3	3	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P23ST203	ADVANCED STEEL STRUCTURES	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the behavior of members and connections
- To analyze and design the Industrial buildings of roofs and chimneys
- To study the design of light gauge and 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	Apply
CO3	Understand the design concept of crane foundations, monorail, gantry girders	Analyze
CO4	Analyze and design steel industrial appurtenances	Apply
CO5	Design of industrial roof systems	Analyze

COURSE ARTICULATION MATRIX:

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

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SEMESTER II

P23ST204	ADVANCED STRUCTURAL ENGINEERING LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To understand the various parameters of the concrete mix design
- To test hardened properties of concrete
- Perform NDT on concrete

LIST OF EXPERIMENTS

1. Concrete mix design for M30, M60 grade.
    a) Indian Standard Method
    b) ACI Method
2. Flow characteristics of self-compacting concrete
3. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behavior.
4. Testing of simply supported steel beam for strength and deflection behavior.
5. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading
6. Dynamic Response of cantilever steel beam.
    a) To determine the damping coefficients from free vibrations
    b) To evaluate the mode shapes
7. Static cyclic testing of single bay two storied steel frames and evaluate
    a) Drift of the frame.
    b) Stiffness of the frame.
    c) Energy dissipation capacity of the frame
8. Non-Destructive Test on concrete
    a) Rebound hammer
    b) Ultrasonic Pulse Velocity Tester

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project – Periods

Total 60 Periods

REFERENCES:

1. Neville A.M, "Properties of Concrete", Pearson Education Ltd., England, 5th edition, 2011.
2. Santhakumar A.R., "Concrete Technology", Oxford University Press, New Delhi, 2021.
3. Krishnaraju, N, "Design of concrete mixes", Sehgal Educational Consultants & Publishers Pvt.Ltd., Faridabad, 5th edition, 2018.
4. IS: 10262-2009, Concrete Mix Proportioning, Guideline, BIS, New Delhi.

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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.	Understand
CO2	Design and develop the self-compacting concrete and its fresh properties	Apply
CO3	Apply engineering principles to understand behavior of structural/ elements	Apply
CO4	Understand the dynamic testing on steel beams and to know about the method of static cyclic testing of single bay two storied steel frames (Understand)	Understand
CO5	Conduct Non-Destructive Tests on existing concrete structures	Apply

COURSE ARTICULATION MATRIX:

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

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SEMESTER II

P23ST205	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
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER III

P23ST301	ADVANCED PRESTRESSED CONCRETE	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop an understanding of the philosophy of design of prestressed concrete
- To be able to design indeterminate prestressed concrete structure
- To design the various prestressed concrete structures

UNIT I INTRODUCTION 9

Concepts of Prestressing – Materials and methods of prestressing – Design philosophy – Analysis methods, Time-dependent deformation of concrete and losses of prestress.

UNIT II DESIGN FOR FLEXURE, SHEAR AND TORSION 9

Behaviour of flexural members, Determination of ultimate flexural strength using various Codal provisions – Design for Flexure, Shear, torsion and bond of pre-stressed concrete elements – Transfer of prestress – Deflection and crack control.

UNIT III DESIGN OF CONTINUOUS AND COMPOSITE BEAMS 9

Statically indeterminate structures – Analysis and design of continuous beams and frames – Choice of cable profile – Methods of achieving continuity – Concept of linear transformations, concordant cable profile and gap cables – Composite sections of prestressed concrete beam and cast in situ RC slab – Design of composite sections – Partial prestressing – Limit State design of partially prestressed concrete beams

UNIT IV DESIGN OF TENSION AND COMPRESSION MEMBERS 9

Pre-stressed concrete compression and tension members – Application in the design of prestressed pipes and prestressed concrete cylindrical water tanks – Design of compression members with and without flexure – Design of Piles and flagmasts – Two way pre-stressed concrete floor systems – Connections for pre-stressed concrete elements

UNIT V DESIGN OF PRESTRESSED CONCRETE BRIDGES 9

Review of IRC and IRS loadings – Effect of concentrated loads on deck slabs, load distribution methods for concrete bridges – Analysis and Design of superstructures – Design of pre-stressed concrete bridges incorporating long-term effects like creep, shrinkage, relaxation, and temperature effects – Dynamic response of bridge decks.

Contact Periods:

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

REFERENCES:

1. Johnson Victor, D., "Essentials of Bridge Engineering", Oxford and IBH Publishing Co., New Delhi 6th Edition, 2019
2. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill Publishing Co., New Delhi, 6th Edition, 2018.
3. Rajagopalan.N, "Prestressed Concrete", Narosa Publications, New Delhi, 2nd Edition, 2014.
4. Lin.T.Y.andBurns.H "Design of Prestressed Concrete Structures", John Wiley and Sons Inc, 3rd Edition, 2010.
5. Arthur H. Nilson, "Design of Prestressed Concrete", John Wiley and Sons Inc, New York, 2nd Edition, 2004.

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COURSE OUTCOMES:

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

Cos	Statements	K-Level
CO1	Identify the various methods of prestressing and estimate the loss	Understand
CO2	Design the beams for flexure, shear, bond and torsion	Apply
CO3	Design the continuous beams and composite beams	Analyze
CO4	Design the water tank, piles and masts	Apply
CO5	Analyze and design the prestressed concrete bridge	Analyze

COURSE ARTICULATION MATRIX:

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

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SEMESTER III

		Category: EEC			
P23ST302	PROJECT WORK (PHASE - I)	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	1	3	3
CO2	3	3	3	1	3	3
CO3	3	3	3	1	3	3
CO4	3	3	3	1	3	3
CO5	3	3	3	1	3	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER IV

P23ST401	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	1	3	3
CO2	3	3	3	1	3	3
CO3	3	3	3	1	3	3
CO4	3	3	3	1	3	3
CO5	3	3	3	1	3	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVE

		Category: PEC			
P23STP01	MAINTENANCE AND REHABILITATION OF STRUCTURES	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 – pull out tests – Windsor probe test – Thermogram – Crack detection techniques – Case studies – Single and multi-storey buildings

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 – Ferro cement 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: 45Periods Tutorial: – Periods Practical – Periods Total 45 Periods

REFERENCES:

1. Modi, P.I., Patel, C.N, "Repair and Rehabilitation of Concrete Structures", 1st Edition, PHI India, New Delhi 2016.
2. Peter H Emmons, "Concrete Repair and Maintenance", 3rd Edition Galgotia Publications, 2019.
3. Robert. T Ratay, "Forensic Structural Engineering Handbook", 2nd Edition Mc Graw Hill, 2009.
4. Bhattacharjee. J, "Concrete Structures Repair Rehabilitation And Retrofitting", 2nd Edition CBS Publishers & Distributors, New Delhi, 2019.
5. Dodge Woodson R., "Concrete Structures – protection, repair and rehabilitation", 1st Edition, Elsevier Butterworth – Heinmann, UK, 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	Understand
CO3	Outline environmental problems and natural hazards	Understand
CO4	Adopt 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
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

		Category: PEC			
P23STP02	PREFABRICATED STRUCTURES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the design principles of prefabricated structures
- To analyze 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 – 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", 3rd edition, CRC Press, Taylor & Francis, 2017.
2. Hubert Bachmann, Alfred Steinle, "Precast Concrete Structures", 2nd edition, Ernst & Sohn, Wiley Publication, 2015.
3. Ryan E. Smith, "Prefab Architecture: A Guide to Modular Design and Construction", 2nd edition, John Wiley and Sons. Inc. London, 2010.
4. Handbook of Precast Concrete Buildings, ICI publications, 2016.
5. Laszlo Mokk, "Prefabricated Concrete for Industrial and Public Structures", 3rd edition, Academia Kiado, Budapest, 2007.

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KPRIET
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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	3	2	2	3	-	2
CO2	3	-	2	3	-	2
CO3	2	2	2	3	2	2
CO4	2	-	2	3	2	2
CO5	2	-	2	3	2	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P23STP03	OFFSHORE STRUCTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the types and functions of offshore structure
- To analyze and design the offshore structures
- To design offshore structures as per Indian codal provisions

UNIT I INTRODUCTION 9

Types of Offshore Structures – Types of Offshore Platforms – Functions of Offshore Structures – Components of a Typical Offshore Structure

UNIT II LOADS ON OFFSHORE STRUCTURES 9

Wave forces on Structures – Environmental Loadings – Use of Morrison Equipment

UNIT III WAVE THEORIES 9

Wave Generation and Propagation – Small and Finite amplitude wave theories – Wave Energy and Pressure distribution

UNIT IV ANALYSIS OF OFFSHORE STRUCTURES 9

Foundation Modelling – Static method of analysis – Dynamics of Offshore structures

UNIT V DESIGN OF OFFSHORE STRUCTURES 9

Design of Platforms – Derricks – Helipads – Design Principles and examples of Jacket tower – 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", 1st Edition, CRC Press, 2013.
2. Mohamed A. El-Reedy, "Offshore Structure, Design, Construction and Maintenance", 1st Edition, Gulf Professional Publishing, 2012.
3. Gunther Clauss, Eike Lehmann, Carsten Ostgaard, M.J. Shields, "Offshore Structures: Volume I: Conceptual Design and Hydromechanics", 2nd Edition, Springer- Verlag, 2012.
4. Turgut Sarpkaya, "Wave Forces on Offshore Structures", 1st Edition, Cambridge University Press, 2010.
5. Eugenio Fortaleza, "Active Control of Offshore Structures", 1st Edition, 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	Identify the types and functions of offshore structures	Understand
CO2	Understand the loads experienced by offshore structures	Understand
CO3	Understand the wave offshore structures	Understand
CO4	Analyze the offshore structures subjected to static and dynamic loads	Analyze
CO5	Design Offshore structures like Platform, Helipads, Jackets and 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
Correlation levels:	1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)		

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PROFESSIONAL ELECTIVES

P23STP04	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 analyze 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 from 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", 1st Edition, PHI Learning Private Limited, New Delhi, 2014
2. Godbole P. N., Sonparote R. S., Dhote S. U., "Matrix Methods of Structural Analysis", 1st Edition, PHI Learning Pvt. Ltd., New Delhi, 2014
3. Bhavikatti S S., "Matrix Methods of Structural Analysis", 1st Edition, IK Publishing, India, 2011
4. Kardestuncer.H., "Elementary matrix analysis of structures", 1st Edition, Mc-Graw Hill, USA, 1974
5. Weaver W. and Gere J. M., "Matrix Analysis of Framed Structure", 1st Edition , CBS Publishers, Delhi, 2013

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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	Analyze
CO3	Learn the transformation of system forces to element forces and element flexibility to system flexibility	Analyze
CO4	Impart knowledge about analysis of system through direct and element approach of flexibility method	Analyze
CO5	Analyse stiffness matrix for structures with zero force at some coordinates	Analyze

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

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PROFESSIONAL ELECTIVES

P23STP05	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 analyze 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	Familiarize 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	-	-	-
CO2	3	1	2	2	-	1
CO3	3	2	2	2	2	2
CO4	3	2	3	2	2	3
CO5	3	1	3	3	2	2
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVE

		Category: PEC			
P23STP06	MECHANICS OF COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the behaviour of composite materials and to investigate the 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, 4th 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; 4th edition 2018.
4. Robert M. Jones, "Mechanics of Composite Materials"-International Edition, CRC Press, 2nd edition, 2016.
5. Vasiliev, V.V. "Mechanics of Composite Structures", CRC Press, 2nd edition, 2017.
6. https://nptel.ac.in/courses/112104168

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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 characteristics of composite structure and its types	Understand
CO2	Estimate the stress and strain behavior of composite structures	Analyze
CO3	Analyse the various laminated composites members	Analyze
CO4	Identify the failure mode and Fracture mechanics	Apply
CO5	Design the composite joints and review the applications	Analyze

COURSE ARTICULATION MATRIX:

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

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PROFESSIONAL ELECTIVE

P23STP07	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 analyze 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. Taranath B.S., "Structural Analysis and Design of Tall Buildings", McGraw Hill, 2nd edition, 2012.
2. Beedle.L.S., "Advances in Tall Buildings", CBS Publishers and Distributors, Delhi, 2nd edition, 1986.
3. B Michael Yit Lin Chew, "Construction Technology for Tall Building", 5th Edition, World Scientific Publishing Company, 2017.
4. IS 13920, Ductile detailing of reinforced concrete structures, BIS, India.
5. IS 1893, Criteria for earthquake resistant design BIS, India.
6. IS 16700, Criteria for Structural Safety of Tall Concrete Buildings, BIS, India.

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COURSE OUTCOMES:

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

COs	Statements	K– Level
CO1	Identify 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	Analyze
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	Analyze

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

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PROFESSIONAL ELECTIVE

P23STP08	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 TOWER FOUNDATION USING MACHINES 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", 2nd Edition, Tata McGraw Hill, 2010.
2. Jurgen Axel Adam, KatharriaHausmann, Frank Juttner, Klauss Daniel, "Industrial Buildings: A Design Manual", 2nd Edition, Birkhauser Publishers, 2018.
3. Manohar S.N, "Tall Chimneys - Design and Construction", 2nd Edition, Tata McGraw Hill, 2010.
4. Srinivasulu P and Vaidyanathan.C, "Handbook of Machine Foundations", 2nd Edition Tata McGraw Hill, 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 classification of industries	Apply
CO2	Analyze and design of corbel, nibs and staircase	Apply
CO3	Understand the types of power plants and containment structures	Understand
CO4	Analyze and design transmission tower lines and chimneys	Analyze
CO5	Analyze 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
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P23STP09	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

REFERENCES:

1. Jindal U.C., Experimental Stress Analysis, Pearson, New Delhi, 1st Edition 2013
2. Dalley .J.W and Riley. W. F, "Experimental Stress Analysis", McGraw Hill Book Company, NewYork, 3rd Edition, 2005.
3. Ganesan.T.P, "Model Analysis of Structures", University Press, India, 2007
4. Dr.Sadhu Singh "Experimental Stress Analysis" Khanna Publishers; Standard Edition, 2009.

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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	Indicate the vibration measuring systems and wind flow measurements.	Understand
CO3	Identify acoustics and wind flow measures	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
Correlation levels:	1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)		

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PROFESSIONAL ELECTIVE

P23STP10	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
- To determine the wind and cyclone effects

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. Lawson T.V., "Wind Effects on Building Vol. I and II", Applied Science Publishers, London, 1980.
2. Peter Sachs, "Wind Forces in Engineering", Pergamon Press, New York, 1978.
3. Cook.N.J., "The Designer's Guide to Wind Loading of Building Structures", Butterworths, 1989

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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	Classify the static and dynamics response of tall buildings and chimneys due to wind.	Understand
CO3	Identify the code provisions for the design of special structures for wind loading.	Understand
CO4	Understand the cyclone effect on low rise, sloped roof and tall building structures.	Understand
CO5	Interpret the design, analytical procedure and modeling of claddings	Understand

COURSE ARTICULATION MATRIX:

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

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PROFESSIONAL ELECTIVES

P23STP11	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: 45 Periods

REFERENCES:

1. Swamy Saran, "Analysis and Design of substructures", Oxford and IBH Publishing Co. Pvt. Ltd., 2nd Edition, 2015
2. Bowles .J.E., "Foundation Analysis and Design", McGraw Hill Publishing Co., New York, 5th Edition, 2001
3. Tomlinson.M.J, "Foundation Design and Construction", Longman, 6th Edition, New Delhi, 2003
4. .Varghese.P.C, "Design of Reinforced Concrete Foundations" – PHI learning private limited, New Delhi, 1st Edition, 2009
5. W.F. Chen, Lian Duan "Bridge Engineering: Substructure Design", CRC press, 1st Edition, 2007

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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 based on available soil conditions	Understand
CO2	Determine the load carrying capacity and 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
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVE

		Category: PEC			
P23STP12	OPTIMIZATION OF STRUCTURES	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 – Multi variable 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", 2nd edition, Pearson Education, 2017.
2. Arora J.S., "Introduction to Optimum Design", 3rd edition, McGraw –Hill Book Company, 2019.
3. Deb K., "Optimisation for Engineering Design", 1st edition , Algorithms and examples, Prentice Hall, New Delhi, 2014.
4. Spunt, "Optimization in Structural Design", 1st edition, Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey, 1971.

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5. Rao,S.S. "Optimization theory and applications", 4th edition, Wiley Eastern (P) Ltd., 2009.

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

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PROFFESSIONAL ELECTIVE

		Category: PEC			
P23STP13	DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the behaviour and design of concrete composite elements and 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 Beams, Slabs, Columns and Frames for Buildings", Vol.I, Blackwell Scientific Publications, 8th edition, 2018.
2. Owens, G.W. and Knowels, P, "Steel Designers manual", 5th edition, Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 2018.
3. Proceedings of "Workshop on Steel Concrete Composite Structures", conducted at Anna University, 2016.
4. IS 11384 – 2022, Code of Practice for steel concrete Composite structures.
5. https://www. youtube.com/playlist? list=PLDYKd0KLmzo5e4g4-DGIGGYQugyWBeYMn.

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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
CO2	3	-	2	-	-	-
CO3	3	3	-	-	-	-
CO4	3	3	-	-	-	2
CO5	3	-	-	-	-	2
Correlation levels:	1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)		

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PROFESSIONAL ELECTIVE

P23STP14	DESIGN OF BRIDGES	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To design different types of bridges considering the loads, forces acting on bridges.
- To acquire knowledge on design of various elements in a bridge structure.
- To understand the concept of bearings and foundation design in a bridge structure.

UNIT I SHORT SPAN RC BRIDGES 9

Classification of bridges and loading standards – Choice of type – IRC Specification for road bridges – Design of RCC solid slab bridges – Analysis and design of slab 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 – Arch bridges – Box culverts

UNIT III PRESTRESSED CONCRETE BRIDGES 9

Design of prestressed concrete bridges – Preliminary dimensions – Design of girder section – Maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable zone in girder – Short term and long-term deflections

UNIT IV STEEL BRIDGES 9

Introduction – Elements of plate girder – Design of plate girder for high speed trains as per IRS – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners

UNIT V BEARINGS AND SUBSTRUCTURE IN BRIDGES 9

Different types of bearings – Design of bearings – Design of piers and abutments of different types – Types of bridge foundations – Design of foundations in bridges

Contact Periods:

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

REFERENCES:

1. Krishnaraju N, "Design of Bridges", Oxford & IBH Publishing Co. Pvt Ltd, 5th Edition, 2019.
2. Jagadeesh.T.R. and Jayaram.M.A., "Design of Bridge Structures", Prentice Hall of India Pvt. Ltd, 2nd Edition,2019.
3. Krishnaraju N, "Prestressed Concrete Bridges" CBS Publishers and Distributors Pvt Ltd, 2nd Edition, 2022.
4. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. New Delhi, 6th Edition, 2019.
5. Raina V K, "Field Manual for Highway and Bridge Engineers", Shroff Publishers, 2nd Edition, 2017.
6. https://archive.nptel.ac.in/courses/105/105/105105216/
7. Ponnusamy S, "Bridge Engineering", McGraw Hill Education, 3rd Edition, 2017.
8. IRC: 112, 2011, Code of Practice for Concrete Road Bridges.
9. IRC: 6 and 21 2000,Code of Practice for Concrete Road Bridges.

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COURSE OUTCOMES:

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

COs	Statements	K-Level
CO1	Analyze the fundamentals concepts and codes of practice of short span RC bridge design.	Analyze
CO2	Examine the design principles of bridges and culverts	Analyze
CO3	Analyze and design of prestressed concrete bridges.	Analyze
CO4	Analyze and design the members of steel bridges.	Analyze
CO5	Design the bearings and foundations in bridges	Analyze

COURSE ARTICULATION MATRIX:

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

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

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PROFESSIONAL ELECTIVE

P23STP15	SMART MATERIALS AND SYSTEMS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concepts of smart materials and systems for advanced construction in future
- To compare both conventional and advanced smart materials with case studies and its applications
- 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 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 – System features and interpretation of sensor data – Proactive and reactive systems

UNIT III 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 IV SMART ACTUATORS 9

Piezoelectric actuator – Linear actuators – Hybrid actuators – Applications – Shape memory alloys actuator – Magneto-strictive actuators and Electro-strictive actuators – Electro and magnetorheological fluid actuators – Case studies

UNIT V ADVANCES IN SMART MATERIALS 9

Nano materials – Construction beyond Brick and Mortar – Various Nano materials and its application in buildings – Nano Coatings – Nanotechnology in Concrete, Steel and Wood – Application, Advantages and Drawbacks.

Contact Periods:

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

REFERENCES:

1. Haim Abramovich, "Intelligent materials and structures", De Gruyter Publishers, 2nd Edition, 2021.
2. Antonella D'Alessandro, Annibale Luigi Materazzi, Filippo Ubertini, "Nanotechnology in Cement Based Construction", Jenny Stanford Publishers, 3rd Edition, 2020.
3. Srinivasan A.V. and Michael McFarland D, "Smart Structures: Analysis and Design", Cambridge University Press, 3rd Edition, 2009.
4. Vijay K Varadan, Vinoy K J and Gopalakrishnan S, "Smart Material Systems and MEMS: Design and Development Methodologies", Wiley Publication, 1st Edition, 2006.
5. Michelle Addington and Daniel L. Schodek, "Smart Materials and Technologies: For the Architecture and Design Professions", Routledge, 5th Edition, 2004.
6. Brain Culshaw, "Smart Structures and Materials", Artech House, 2nd Edition, 2000.
7. https://nptel.ac.in/courses/112104173
8. https://iopscience.iop.org/article/10.1088/0964-1726/5/2/008/meta

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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	Identify different smart materials and its system features for interpretation of sensor data	Apply
CO3	Make use of optical fibre as smart material in crack detection applications	Apply
CO4	Summarize the usage of different types of actuators in buildings	Understand
CO5	Outline the application of nano materials in construction industry	Understand

COURSE ARTICULATION MATRIX:

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

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

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PROFESSIONAL ELECTIVE

		Category: PEC			
		L	T	P	C
P23STP16	ENERGY EFFICIENT BUILDINGS	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 Air conditioning 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" 3rd Edition, Routledge, 2019.
2. Krishan, Arvind, "Climate responsive architecture: a design handbook for energy efficient buildings", 2nd Edition, Tata McGraw-Hill Education, 2014.
3. Krieder, J and Rabi A, "Heating and Cooling of buildings: Design for Efficiency", 2nd Edition, McGraw Hill, 2002.
4. Paul tymkow, Savvas tassov, Maria kolokotrani and Hussam jouhara, "Building Services and Design for Energy efficient building" 3rd Edition, Taylor and Francis, Routledge, 2020.
5. Yap Eh "Energy Efficient Buildings", 1st Edition, 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
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P23STP17	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– SHM issues applied to concrete structures – Level of uncertainties in SHM process.

UNIT II STRUCTURAL HEALTH MONITORING METHODS 9

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

UNIT III DAMAGE IDENTIFICATION METHODS 9

Damage Identification – Visual Inspection – Comparison of damage identification methods – Ultrasonic testing – Magnetic particle testing – Eddy current testing – Radiography – Thermography – Acoustic emission testing and valuation – Vibration based damage detection

UNIT IV SENSOR NETWORKING 9

Sensor Technologies – Smart Sensing for SHM – 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" 2nd Edition Wiley ISTE, 2011.
2. Douglas E Adams, "Health Monitoring of Structural Materials and Components-Methods with Applications", 1st John Wiley and Sons, 2010.
3. Glisic B and Inaudi D, "Fibre optic methods for structural health monitoring", 2nd Edition John Wiley and Sons, 2014.
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, 2015.

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

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PROFESSIONAL ELECTIVE

P23STP18	STABILITY OF STRUCTURES	Category: PEC			
		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 of stability 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", 1st edition, Prentice Hall, 2011.
2. Ashwini Kumar, "Stability Theory of Structures", 1st edition, Allied publishers Ltd., New Delhi, 2003.
3. Gambhir, "Stability Analysis and Design of Structures", 1st edition, Springer, New York, 2019.
4. Timoshenko.S.P, and Gere.J.M, "Theory of Elastic Stability", 2nd edition, McGraw Hill Book Company, 2009.
5. Manikaselvam V K, "Elements of Matrix and Stability Analysis of Structures" 8th edition, 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 beam	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
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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PROFESSIONAL ELECTIVES

P23STP19	ADVANCED CONCRETE TECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge about concrete properties
- To interpret types of special concrete and their properties
- To identify micro structural analysis techniques

UNIT I CONCRETE PROPERTIES 9

Concrete properties – setting and hardening – transition zone in concrete – Elastic behavior in concrete – creep, shrinkage and thermal properties of concrete. Strength – porosity relationship-Permeability of concrete – pore structure and water transport process

UNIT II MIX DESIGN 9

Principles of concrete mix design, Methods of concrete mix design, IS Method and ACI Method – Mix design for special concretes – Self Compacting Concrete – High strength concrete.

UNIT III CONCRETING METHODS 9

Process of manufacturing of concrete, methods of transportation, placing and curing, cracking, plastic shrinkage, Extreme weather concreting, Special concreting methods. Vacuum dewatering – Underwater Concrete

UNIT IV SPECIAL CONCRETE 9

Light weight concrete, High volume Fly ash concrete, Fiber reinforced concrete, Sulphur impregnated concrete, Polymer Concrete – High performance concrete. High performance fiber reinforced concrete, Self-Compacting Concrete, Geo Polymer Concrete, Waste material-based concrete – Ready mixed concrete.

UNIT V MICROSTRUCTURAL ANALYSIS 9

Scanning Electron Microscope - X- Ray Diffraction – Energy Dispersive X-Ray Analysis – Thermo gravimetry Analysis – Electron Microscopy - Micro hardness

Contact Periods:

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

REFERENCES:

1. Shetty M. S., Jain A.K "Concrete Technology", , S. Chand & Co., 8th Edition,2021
2. Neville A.M.,"Properties of Concrete", Trans-Atlantic Publications, Inc., 5th Edition, 2012.
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COURSE OUTCOMES:

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

COs	Statements	K-Level
CO1	Asses concrete properties and its characteristics	Understand
CO2	Perform mix design for concrete by various methods	Apply
CO3	Identify special concreting methods and its process of manufacturing	Apply
CO4	Summarize types of special concrete and their properties	Apply
CO5	Gain knowledge on micro structure analysis in concrete	Understand

COURSE ARTICULATION MATRIX:

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

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PROFESSIONAL ELECTIVE

P23STP20	DESIGN OF FORMWORK	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the basic concepts and types of formwork, parameters to be considered for the selection of right formwork, design principles deployed, different systems and materials adopted in construction.
- To identify the formwork selection criteria, applications across structures and scaffolding systems.
- To understand the special formwork for tunneling, high rise constructions and bridges.

UNIT I INTRODUCTION AND TYPES OF FORMWORK 9

General Objectives – Classification – Benefits – Areas of competitiveness – Selection of Formwork, Selection of Materials – Accessories and Consumables – Application of Tools – Formwork for Foundation – Wall, Columns, Slab and Beam – Conventional Drawings – Vertical Application of Conventional Foundation Formwork – Formwork System – Components, Assembly, De-shuttering, Flex System, Heavy Duty Tower System – Safety of Work – Formwork for Stairs – Load Bearing Tower.

UNIT II FORMWORK PLANNING AND DESIGN 9

Formwork Planning and Monitoring – Configuration, Scope, Strategy & Costing of Formwork – Productivity – Design Loads, Pressures on Concrete – Design Methods & Assumptions – Vertical & Horizontal Applications – Concepts, Slab Design, wall formwork, Checks – Formwork Drawing Concept and Preparation Guidelines – General Layout and Detailed Drawings – BOQ Calculation and Checklist.

UNIT III FORMWORK ERECTION AND QUANTITY 9

Formwork Assembly for Wall & Column Panels, Stop end & Box outs – Equipment and Layout – Formwork Erection and Safety – Inspection and Corrections – Plant and Machinery – Codal and Contractual Requirements – Schedule of formwork – Mobilization distribution – BOQ – Quantity Calculation – Cost optimization – BIM for planning operations.

UNIT IV BASICS OF SCAFFOLDING AND MODULAR FORMWORK 9

Modular scaffold Installation sequence – Tie and material specification – Ladder safety, Loadin Classification, application – Components of LTMS – Access scaffold Do's and Don'ts – Innovatio and Global practices – Modular Formwork – Advantages and Limitations – Vertical and Horizonta Application – Shuttering & De-shuttering – Application – Aluminum formwork – Drawings Components – Activities.

UNIT V SPECIAL FORMWORK AND APPLICATION 9

Tunnel formwork – 3D design Details – High rise construction – Various climbing system – Table lifting system – Bridge construction systems – Project Application

Contact Periods:

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

REFERENCES:

1. Janardan Jha., and Sinha S.K., "Modern Practices in Formwork for Civil Engineering Construction Works", 1st edition, Laxmi Publications, 2017.
2. Kumar. Neeraj Jha , "Formwork for Concrete Structures",1st edition, McGraw Hill Education, 2017.
3. Arora S.P. and Bindra S.P., "Formwork and False work for heavy Construction", fib Federation international du beton, 2009
4. Awad S.Hanna, "Concrete Formwork Systems", 1th edition CRC Press, 2019.

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5. Geoffrey Lee, Peter McAdam, "Formwork", 1st edition, A Practical CRC Press, 1997

COURSE OUTCOMES:

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

COs	Statements	K-Level
CO1	Explain the role of engineer in formwork and objectives of formwork	Understand
CO2	Design formwork systems based on industry requirements	Apply
CO3	Analyse the formwork erection and quantity calculation	Apply
CO4	Know the modular formwork	Understand
CO5	Examine the application of formwork for RCC structures	Apply

COURSE ARTICULATION MATRIX:

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

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

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PROFESSIONAL ELECTIVE

P23STP21	BUILDING INFORMATION MODELLING IN ARCHITECTURE, ENGINEERING AND CONSTRUCTION	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop the model based on real world construction projects.
- To balance the technical requirements in implementing BIM methodology.
- To design and work with building components of Civil, Architecture and MEP.

UNIT I INTRODUCTION TO BIM 9

Building Information Modelling – Introduction & Process – Evolution of BIM – BIM Model of various buildings like Commercial & Residential, WTP, Transportation, Airports – Isometric View – Introduction – Examples and Problems – 3D Modelling

UNIT II DESIGN AUTHORING AND VISUALIZATION 9

Design Authoring – Workflow, Discipline Based Modeling, Architectural, Engineering Analysis, Structural Analysis, HVAC, Electrical, Plumbing, Energy Analysis, Lighting Analysis, Design Review – Views in Model, Visualization Modes, Walkthrough & Fly through the Model, Layers & Properties, AR, VR & MR.

UNIT III INTERFERENCE / CLASH CHECK 9

Clash Check, Types of Clashes, Federated Model – Clash avoidance process, Clash Detection Process – Introduction, Clash Detection – Priority Matrix, Clash Detection – Rules, Clash Detection – Report, Clash Detection – Grouping, Clash Detection – Roles & Responsibilities, Clash Detection Process – Demo.

UNIT IV DOCUMENTATION, COMMON DATA ENVIRONMENT AND LEVEL OF DEVELOPMENT 9

2D drawings generation, Cloud Computing, CDE – Level of Detail & Level of Information, LOD for a elements – Chart & Matrix.

UNIT V 4D , 5D AND EMERGING TRENDS IN BIM 9

Project Schedule, 4D BIM Modelling, Construction Analysis, 3D Control & Planning, BIM for Safety, Disaster & Risk Analysis, Digital Fabrication, Phase Planning, As-built/Record Models, 5D in BIM – 5D BIM and Quantity Take off with UOM, Exercise & Demo, Quantity Take Off, 5D – Estimation and Analysis, Cost Control, Asset Information Model, COBie and Deliverables, Space Attributes, Asset Attributes and Asset requirement, Infrastructure System, Information Exchange with Facility Management – Industrialization of construction through BIM – IoT in BIM – Data analytics using AI & ML – Smart Infrastructure – Digital twin – Connected Infrastructure.

Contact Periods:

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

REFERENCES:

1. Eastman, C., Teicholz, P., Sacks, R., & Liston, C. BIM handbook: "A guide to building information modeling for owners, managers, designers, engineers and contractors", 2nd edition, John Wiley & Sons, 2011.
2. Hardin, B., & McCool, D., "BIM and construction management: proven tools, methods, and workflows", 2nd edition, John Wiley & Sons, 2015.
3. Issa, R. R., & Olbina, S., "Building Information Modeling Applications and Practices", 1st edition, American Society of Civil Engineers, 2015.
4. Pittard, S., & Sell, P. "BIM and Quantity Surveying" ,1st edition ,Routledge, 2016
5. Karen Kensek, "Building Information Modeling: BIM in Current and Future Practice", 1st edition, Douglas Noble, 2014.

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COURSE OUTCOMES:

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

COs	Statements	K-Level
CO1	Know the process and BIM Model for various buildings	Understand
CO2	Create a workflow for a building with all required deliverables to be covered in the project output	Apply
CO3	Create the clash detection matrix for the federated structural, architectural and MEP model	Apply
CO4	Arrive the final design solution, inclusive of the deliverables from the model at each stage	Understand
CO5	Understand the concept of 4D, 5D and how BIM works in coordination with other disciplines	Understand

COURSE ARTICULATION MATRIX:

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

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

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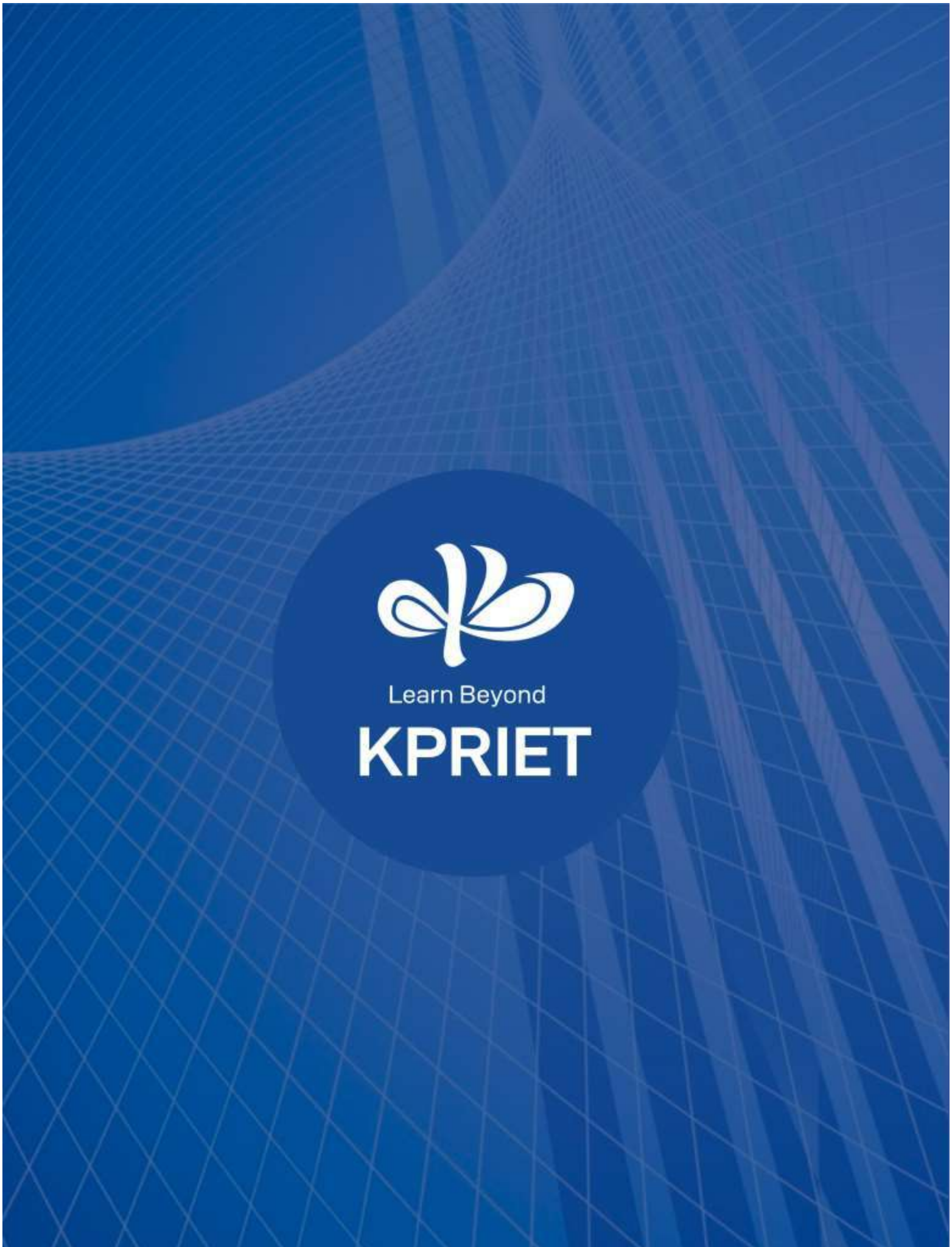
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