SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur-603203.

(Approved by AICTE, Affiliated to Anna University, 'A' Grade Accredited by NAAC, NBA Accredited, ISO 9001: 2015 Certified)

Post Graduate

CURRICULA AND SYLLABI

M.E Structural Engineering

(Regulations 2023)

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University, Chennai,
'A' grade accredited by NAAC, NBA accredited ISO 9001: 2015 certificated)

M. E. STRUCTURAL ENGINEERING
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
CURRICULA& SYLLABI (I – IV SEMESTERS)

SEMESTER I

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA3129	Advanced Mathematics for Structural Engineering	BSC	4	4	0	0	4
2.	ST3161	Theory of Elasticity and Plasticity	PCC	3	3	0	0	3
3.	ST3162	Structural Dynamics and Earthquake Engineering	PCC	3	3	0	0	3
4.	ST3163	Advanced Concrete Structures	PCC	3	3	0	0	3
5.	PST1XX	Professional Elective I	PEC	3	3	0	0	3
6.	PST2XX	Professional Elective II	PEC	3	3	0	0	3
PRACTICALS								
7.	ST3164	Structural Engineering Laboratory	PCC	4	0	0	4	2
8.	ST3165	Structural Design and Drawing Laboratory	PCC	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**08**	**23**

SEMESTER II

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	ST3261	Advanced Steel Structures	PCC	3	3	0	0	3
2.	ST3262	Industrial Structures	PCC	3	3	0	0	3
3.	ST3263	Experimental Techniques and Instrumentation	PCC	3	3	0	0	3
4.	ST3264	Finite Element Analysis in Structural Engineering	PCC	3	3	0	0	3
5.	PST3XX	Professional Elective III	PEC	3	3	0	0	3
6.	PST4XX	Professional Elective IV	PEC	3	3	0	0	3
PRACTICALS								
7.	ST3265	Structural Design Studio	PCC	4	0	0	4	2
			TOTAL	**22**	**18**	**0**	**4**	**20**

SEMESTER III

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PST5XX	Professional Elective V	PEC	3	3	0	0	3
2.	PST6XX	Professional Elective VI	PEC	3	3	0	0	3
3.	BA3371	Research Methodology and IPR	RMC	3	3	0	0	3
PRACTICALS								
4.	ST3341	Technical Seminar	EEC	2	0	0	2	1
5.	ST3342	Internship (4 Weeks)	EEC	0	0	0	0	3
6.	ST3343	Project Work Phase - I	EEC	12	0	0	12	6
			TOTAL	**23**	**9**	**0**	**14**	**19**

SEMESTER IV

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	ST3441	Project Work Phase - II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL NO. OF CREDITS: 74

SUMMARY

Sl. No.	Name of the Programme: M.E STRUCTURAL ENGINEERING					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	BSC	04	00	00	00	04
2.	PCC	13	14	00	00	27
3.	PEC	06	06	06	00	18
4.	RMC	00	00	03	00	03
5.	EEC	00	01	09	12	22
	TOTAL CREDIT	**23**	**21**	**18**	**12**	**74**

PROFESSIONAL COURSES (PCC)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	ST3161	Theory of Elasticity and Plasticity	PCC	3	3	0	0	3
2.	ST3162	Structural Dynamics and Earthquake Engineering	PCC	3	3	0	0	3
3.	ST3163	Advanced Concrete Structures	PCC	3	3	0	0	3
4.	ST3164	Structural Engineering Laboratory	PCC	4	0	0	4	2
5.	ST3165	Structural Design and Drawing Laboratory	PCC	4	0	0	4	2
6.	ST3261	Advanced Steel Structures	PCC	3	3	0	0	3
7.	ST3262	Industrial Structures	PCC	3	3	0	0	3
8.	ST3263	Experimental Techniques and Instrumentation	PCC	3	3	0	0	3
9.	ST3264	Finite Element Analysis in Structural Engineering	PCC	3	3	0	0	3
10.	ST3265	Structural Design Studio	PCC	4	0	0	4	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1.	ST3341	Technical Seminar	EEC	2	0	0	2	1
2.	ST3342	Internship (4 Weeks)	EEC	0	0	0	0	3
3.	ST3343	Project Work Phase - I	EEC	12	0	0	12	6
4.	ST3441	Project Work Phase - II	EEC	24	0	0	24	12

BASIC SCIENCES COURSES (BSC)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA3129	Advanced Mathematics for Structural Engineering	BSC	4	4	0	0	4

RESEARCH METHODOLOGY COURSES (RMC)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	BA3371	Research Methodology and IPR	RMC	3	3	0	0	3

LIST OF PROFESSIONAL ELECTIVE COURSES [PEC]

SEMESTER I, ELECTIVE I

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PST101	Non-linear Analysis of Structures	PEC	3	3	0	0	3
2.	PST102	Maintenance, Repair and Rehabilitation of Structures	PEC	3	3	0	0	3
3.	PST103	Wind and Cyclone Effects on Structures	PEC	3	3	0	0	3
4.	PST104	Reliability Analysis of Structures	PEC	3	3	0	0	3

SEMESTER I, ELECTIVE II

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PST201	Prefabricated Structures	PEC	3	3	0	0	3
2.	PST202	Mechanics of Fiber Reinforced Polymer Composite Materials	PEC	3	3	0	0	3
3.	PST203	Matrix Methods for Structural Analysis	PEC	3	3	0	0	3
4.	PST204	Design of Masonry Structures	PEC	3	3	0	0	3

SEMESTER II, ELECTIVE III

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PST301	Design of Steel-Concrete Composite Structures	PEC	3	3	0	0	3
2.	PST302	Computer Aided Analysis and Design	PEC	3	3	0	0	3
3.	PST303	Advanced Concrete Technology	PEC	3	3	0	0	3
4.	PST304	Design of Formwork	PEC	3	3	0	0	3

SEMESTER II, ELECTIVE IV

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PST401	Analysis and Design of Tall Buildings	PEC	3	3	0	0	3
2.	PST402	Energy Efficient Buildings	PEC	3	3	0	0	3
3.	PST403	Advanced Prestressed Concrete	PEC	3	3	0	0	3
4.	PST404	Design of Offshore Structures	PEC	3	3	0	0	3

SEMESTER III, ELECTIVE V

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PST501	Structural Health Monitoring	PEC	3	3	0	0	3
2.	PST502	Performance of Structures with Soil-Structure Interaction	PEC	3	3	0	0	3
3.	PST503	Design of Bridges	PEC	3	3	0	0	3
4.	PST504	Design of Shell and Spatial Structures	PEC	3	3	0	0	3

SEMESTER III, ELECTIVE VI

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PST601	Stability of structures	PEC	3	3	0	0	3
2.	PST602	Theory of Plates	PEC	3	3	0	0	3
3.	PST603	Design of Sub Structures	PEC	3	3	0	0	3
4.	PST604	Optimization of Structures	PEC	3	3	0	0	3

SRM VALLIAMMAI ENGINEERING COLLEGE

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M. E. STRUCTURAL ENGINEERING

REGULATIONS – 2023

CURRICULA & SYLLABI (I –IV SEMESTERS)

1.PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the Programme M E Structural Engineering will

PEO1 Gain knowledge and skills in structural engineering which will enable them to have a career and professional accomplishment in the public or private sector organizations

PEO2 Become consultants in Structural Engineering and solve complex real-life issues related tothe analysis, design and maintenance of structures under various environmental conditions.

PEO3 Contribute to the enhancement of knowledge in Structural Engineering by performing quality research in institutions of international repute or Research organizations or Academia.

PEO4 Practice their profession with good communication, leadership, ethics and social responsibility and formulate solutions that are technically sound, economically feasible, and socially acceptable.

PEO5 Graduates will function in multi-disciplinary teams and adapt to evolving technologies through life-long learning and innovation

2.PROGRAMME OUTCOMES (POs):

Graduates of the programme M.E. Structural Engineering will acquire the following:

PO#	Graduate Attribute	Programme Outcome
PO1	Research Aptitude	An ability to carry out the research, investigation, and development to address practical challenges.
PO2	Technical Documentations	To produce and deliver a substantial technical report or document effectively.
PO3	Technical Competence	Students should be able to demonstrate a level of expertise in the area of speciality for the programme. The mastery should be at a higher level than the standards of the relevant bachelor degree.
PO4	Critical Analysis of Structural Engineering Problems	Analyse complicated structural engineering problems critically and apply independent judgement for synthesizing information.
PO5	Conceptualization and Evaluation of Innovative Engineering Solutions to Structural Design Issues	Conceptualize and solve structural engineering issues, assess prospective solutions, and reach technically feasible, economically viable, and ecologically sound solutions while taking into account health, safety, and socio-cultural considerations.
PO6	Life-long Learning	An ability to identify the need for independent, life-long learning and adapt to emerging technologies in Structural Engineering and solutions to novel problems.

3.PEO/PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	P04	P05	P06
PEO1	2	3	2	2	3	3
PEO2	3	3	2	2	2	2
PEO3	3	3	3	3	3	3
PEO4	2	3	2	2	2	2
PEO5	2	3	2	2	2	2

4. MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME:

		Courses	PROGRAMME OUTCOMES					
			PO1	PO2	PO3	PO4	PO5	PO6
Year I	**Semester I**	Advanced Mathematics for Structural Engineering	3	2	3	1	-	1
		Theory of Elasticity and Plasticity	3	3	3	3	3	3
		Structural Dynamics and Earthquake Engineering	2.6	2.6	2.8	2.6	2.6	2.6
		Advanced Concrete Structures	2.8	2.4	2.8	2.8	2.8	2.8
		Structural Engineering Laboratory	2.2	1.4	3.0	3.0	3.0	2.0
		Structural Design and Drawing Laboratory	2.2	1.4	2.8	3.0	3.0	2.0
Year I	**Semester II**	Advanced Steel Structures	2.8	2.8	3.0	3.0	2.6	2.8
		Industrial Structures	2.6	2.6	2.8	2.8	2.4	1.0
		Experimental Techniques and Instrumentation	2.2	1.4	3.0	3.0	3.0	2.0
		Finite Element Analysis in Structural Engineering	3.0	2.4	2.6	2.6	2.4	2.2
		Structural Design Studio	2.2	1.4	3.0	3.0	3.0	2.0
Year II	**Semester III**	Research Methodology and IPR	-	-	-	-	-	-
		Technical Seminar	2.6	3.0	3.0	3.0	2.0	3.0
		Internship (4 Weeks)	2.8	1.2	1.8	2.4	2.0	2.0
		Project Work Phase - I	3.0	2.8	3.0	3.0	3.0	3.0
Year II	**Semester IV**	Project Work Phase - II	2.8	2.0	2.6	3.0	3.0	3.0

Professional Elective –I								
Year I	**Semester I, Elective I**	Non-linear Analysis of Structures	2.8	2.2	2.8	2.8	1.6	2.4
		Maintenance, Repair and Rehabilitation of Structures	2.6	3.0	3.0	2.0	2.6	2.4
		Wind and Cyclone Effects on Structures	2.6	2.6	2.8	2.8	2.8	2.8
		Reliability Analysis of Structures	2.6	2.8	2.8	2.8	2.6	2.6
Professional Elective -II								
Year I	**Semester I, Elective II**	Prefabricated Structures	2.8	2.4	3.0	2.6	2.6	2.0
		Mechanics of Fiber Reinforced Polymer Composite Materials	2.8	1.2	2.8	1.6	1.6	1.6
		Matrix Methods for Structural Analysis	3	2.4	2.2	2	2.6	1.6
		Design of Masonry Structures	2.8	1.8	2.4	2.6	2.0	1.2
Professional Elective -III								
Year I	**Semester II, Elective III**	Design of Steel-Concrete Composite Structures	2.8	1.8	2.6	2.6	2.6	1.8
		Computer Aided Analysis and Design	2.4	1.2	1.2	2.4	0.8	1
		Advanced Concrete Technology	2.8	2.4	2.8	2.8	2.8	2.8
		Design of Formwork	2.6	2.6	2.4	1.4	1.4	1.4
Professional Elective -IV								
Year I	**Semester II, Elective IV**	Analysis and Design of Tall Buildings	2.8	2.8	2.8	2.8	2.6	2.6
		Energy Efficient Buildings	2.6	1.6	2.6	2.8	2.6	2.6
		Advanced Prestressed Concrete	3.0	2.2	3.0	3.0	2.8	2.0
		Design of Offshore Structures	1.8	1.6	3.0	2.2	2.6	2.8
Professional Elective -V								
Year II	**Semester III, Elective V**	Structural Health Monitoring	2.4	1.2	1.2	2.4	1.2	1.2
		Performance of Structures with Soil-Structure Interaction	2.6	2.6	2.6	2.8	2.6	2.8
		Design of Bridges	2.8	2.8	2.6	2.6	2.6	2.8

		Design of Shell and Spatial Structures	2.4	2.8	3	2.6	2.4	1.0
Professional Elective -VI								
Year II	**Semester III, Elective VI**	Stability of structures	3	1.8	3	3	2.2	3
		Theory of Plates	3	2.4	2.2	2	2.6	1.6
		Design of Sub Structures	3	2.2	2	2.6	2.6	2.2
		Optimization of Structures	3.0	2.0	3.0	3.0	3.0	2.6

MA3129 ADVANCED MATHEMATICS FOR STRUCTURAL ENGINEERING

L T P C
4 0 0 4

COURSE OBJECTIVES:

- This course is to provide the mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering.
- This course covers Laplace Transform Techniques for Partial Differential Equations
- This course covers mathematical technique Fourier Transform for solving PDE.
- This course covers Calculus of Variations, Numerical solutions and Tensor Analysis.
- Application of these topics to the solution of problems in physics and engineering is stressed.

UNIT- I: LAPLACE TRANSFORM AND APPLICATIONS 12

Laplace transform: Definitions – Properties – Transform error function – Bessel's function – Convolution theorem – Inverse Laplace Transform - Solutions to partial differential equations: Heat equation – Wave equation.

UNIT - II: FOURIER TRANSFORMAND APPLICATIONS 12

Fourier transform: Definitions – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity – Solutions to partial differential equations: Heat equation – Wave equation.

UNIT-III : CALCULUS OF VARIATIONS 12

Euler's equation – Functional dependent on first and higher order derivatives – Functional dependent on functions of several independent variables – Direct methods – Ritz methods.

UNIT-IV : NUMERICAL SOLUTION OF WAVE AND HEAT EQUATION 12

Solution of two dimensional Laplace equation - One dimensional heat flow equation by explicit and implicit methods – One dimensional wave equation by explicit method.

UNIT - V: TENSOR ANALYSIS **12**

Summation convention – Contravariant and covariant vectors – Contraction of tensors – Inner product – Quotient law – Metric tensor – Christoffel symbols

.TOTAL: 60 PERIODS

COURSE OUTCOMES :

- Application of Laplace transforms and the initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
- Applications of Fourier Transform and its initial boundary value problems in Partial Differential Equations.
- To understand , identify, formulate, abstract, and solve problems in Calculus of Variations.
- Understand the concepts of solving solution of two dimensional Laplace's equations, wave and Heat Flow equation.
- Competently use tensor analysis as a tool in the field of applied sciences and related fields

REFERENCE BOOKS:

1. Andrews L.C. and Shivamoggi, B., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Elsgolc, L.D., "Calculus of Variations", Dover Publications Inc., New York, 2007.
3. Kay, D. C., "Tensor Calculus", Schaum's Outline Series, Tata McGraw Hill Edition, 2014.
4. Mathews, J. H., and Howell, R.W., "Complex Analysis for Mathematics and Engineering", 5th Edition, Jones and Bartlett Publishers, 2006.
5. Ramaniah. G. "Tensor Analysis", S. Viswanathan Pvt. Ltd., 1990.
6. Saff, E.B and Snider, A.D, "Fundamentals of Complex Analysis with Applications in Engineering, Science and Mathematics",3rd Edition, Pearson Education, New Delhi, 2014.
7. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	2	3	1	-	1
CO2	3	2	3	1	-	1
CO3	3	2	3	1	-	1
CO4	3	2	3	1	-	1
CO5	3	2	3	1	-	1
Avg	3	2	3	1	-	1

No Correlation - Low 1 Medium 2 High 3

ST3161 THEORY OF ELASTICITY AND PLASTICITY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To study the classical theory of linear elasticity for two and three dimensional state of stress.
- To obtain solutions for elasticity problems in rectangular and polar coordinates as well as torsion of prismatic bars.
- To gain knowledge on torsion of non-circular sections and thin walled sections.
- To gain knowledge about elastic foundation and strain energy.
- To understand the plastic stress strain relations, criteria of yielding and elasto-plastic problems.

UNIT-I: ELASTICITY 9

Analysis of stress and strain, Equilibrium Equations - Compatibility Equations – Stress-Strain Relationship. Generalized Hooke's law-Constitutive Equations.

UNIT-II: 2D STRESS STRAIN PROBLEMS 9

Plane stress and plane strain - Simple two-dimensional problems in Cartesian and Polar Coordinates – Axis symmetry problems.

UNIT-III: TORSION OF NON-CIRCULAR SECTION 9

St. Venant's approach - Prandtl's approach – Membrane analogy - Torsion of Thin Walled- Open and Closed sections-Design approach to open web section subjected to torsion.

UNIT-IV: ELASTIC FOUNDATION 9

Beams on Elastic foundation – Methods of analysis – Elastic line method – Idealization of soil medium – Winkler model – Infinite beams – Semi-infinite and finite beams – Rigid and flexible – Uniform Cross Section – Point load and UDL. Strain Energy due to shear and torsion - Maxwell - Betti reciprocal theorem.

UNIT-V: PLASTICITY 9

Physical Assumptions – Yield Criteria – Failure Theories – Plastic Stress Strain Relationship. Elasto-Plastic Problems in Bending – Torsion and thick cylinder.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

1. Analyse the stresses and strains
2. Solve the two dimensional problems in cartesian and polar coordinates
3. Analyse torsion of non-circular sections and thin walled sections.
4. Illustrate able elastic foundation and strain energy principles
5. Describe the basic concepts on the theory of plasticity

REFERENCES:

1. Ansel.C. Ugural and Saul.K.Fenster, "Advanced Strength and Applied Elasticity", Fourth Edition, Prentice Hall Professional technical Reference, New Jersey, 2003
2. Chakrabarthy.J, "Theory of Plasticity", Third Edition, Elsevier Butterworth – Heinmann UK, 2007.
3. Jane Helena H, "Theory of Elasticity and Plasticity", PHI Learning Pvt. Ltd., 2016.
4. Jai Shankar "Theory of Elasticity", Veda Lakshmi publishers 1977.
5. Sadhu Singh, "Theory of Elasticity and Metal Forming Processes", Khanna Publishers, 2005.
6. Sadhu Singh, "Theory of Plasticity", Khanna Publishers, 2007.
7. Timoshenko, S. and Goodier J.N. "Theory of Elasticity", McGraw Hill Book Co., New York, 2010

CO	PO					
	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	3	3	3	3	3
Avg	3	3	3	3	3	3

ST3162 STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on the following topics

- To train the learners understand the earthquake concepts and techniques of dynamic analysis of structures.
- To develop the ability about theory of vibrations and vibration parameters
- To make learners for designing the structures for wind, earthquake and other dynamic loads.
- To prepare them the behavior of dynamic loading and to analyse the dynamic forces caused by an earthquake.
- To introduce the design of buildings for blast and impact forces as per BIS codes of practice.

UNIT-I: PRINCIPLES OF VIBRATION ANALYSIS 9

Mathematical models of single degree of freedom systems - Free and forced vibration of SDOF systems, Response of SDOF to special forms of excitation, Effect of damping, Evaluation of damping, Transmissibility, vibration control, Tuned mass damper

UNIT-II: DYNAMIC RESPONSE OF MULTI-DEGREE OF FREEDOM SYSTEMS 9

Mathematical models of two-degree of freedom systems and multi-degree of freedom systems, free and forced vibrations of two-degree and multi-degree of freedom systems, normal modes of vibration, applications. Orthogonality of normal modes, free and forced vibrations of multi-degree of freedom systems, Mode superposition technique, Applications

UNIT-III: DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS 9

Mathematical models of continuous systems, Free and forced vibration of continuous systems, Rayleigh-Ritz method – Formulation using Conservation of Energy – Formulation using Virtual Work, Applications. Damping in MDOF systems, Nonlinear MDOF systems, and step-by-step numerical integration algorithms.

UNIT-IV: EARTHQUAKE GROUND MOTION AND ITS EFFECTS ON STRUCTURES **9**

Engineering Seismology Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Microzonation. Effect of Earthquake on Different Types of Structures - Lessons Learnt from Past Earthquakes -Evaluation of Earthquake Forces as per codal provisions - Response Spectra, Design Spectra

UNIT-V: EARTHQUAKE RESISTANT DESIGN OF MASONRY AND RC STRUCTURES **9**

Structural Systems - Types of Buildings - Causes of damage - Planning Considerations – effect of material of construction on the performance of structures - Philosophy and Principle of Earthquake Resistant Design - Guidelines for Earthquake Resistant Design - Earthquake Resistant Design of Masonry Buildings and R.C.C. Buildings. Design consideration - Rigid Frames – Shear walls - Lateral load analysis of structures- Capacity based Design and detailing

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, learners will be able to:

1. Do vibration analysis of system/structures with a single degree of freedom and can explain the method of damping the systems
2. Do the dynamic analysis of system/structures with Multi degrees of freedom under free and forced vibration
3. Derive a mathematical model of a continuous system and do a dynamic analysis under free and forced vibration
4. Explain the causes and effects of an earthquake
5. Design masonry and RC structures for the earthquake forces as per their commendations of IS codes of practice.

REFERENCE BOOKS:

1. Anil K.Chopra, Dynamics of Structures, Fifth edition, Pearson Education, 2020.
2. Leonard Meirovitch, Elements of Vibration Analysis, McGraw Hill, 2014.
3. Mario Paz, Structural Dynamics -Theory and Computation, Kluwer Academic Publishers, Fifth Edition, 2006.
4. Roy R.Craig, Jr, Andrew J. Kurdila, Fundamentals of Structural Dynamics, John Wiley & Sons, 2011.
5. Brebbia C. A.," Earthquake Resistant Engineering Structures VIII", WIT Press, 2015.
6. Mohiuddin Ali Khan "Earthquake-Resistant Structures: Design, Build and Retrofit", Elsevier Science& Technology, 2013.
7. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures", Prentice Hall of India, 2014.
8. Paulay.T and Priestley M.J.N., "Seismic Design of Reinforced Concrete and Masonry Buildings", John Wiley and Sons, 2013.
9. Duggal S K, "Earthquake Resistant Design of Structures", Oxford University Press, 2013.
10. Madhujit Mukhopadhyay," Structural Dynamics: Vibrations and Systems", Ane's Student Edition, 2017.

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	3	2	2
CO2	3	3	2	3	2	2
CO3	2	3	3	3	3	3
CO4	3	2	3	2	3	3
CO5	3	2	3	2	3	3
Avg	2.6	2.6	2.8	2.6	2.6	2.6

ST3163 ADVANCED CONCRETE STRUCTURES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To make the students be familiar with the limit state design of RCC beams and columns
- To design special structures such as Deep beams, Corbels, Deep beams, and Grid floors
- To make the students confident to design the flat slab as per Indian standard, yield line theory and strip method.
- To make the students confident to design inelastic behavior of concrete beams and columns.
- To design the beams based on limit analysis and detail the beams, columns and joints for ductility.

UNIT-I: DESIGN PHILOSOPHY 9

Limit state design - beams, slabs and columns according to IS Codes. Calculation of deflection and crack width according to IS Code.

UNIT-II: DESIGN OF SPECIAL RC ELEMENTS 9

Design of slender columns - Design of RC walls. Strut and tie method of analysis for corbels and deep beams, Design of corbels, Deep-beams and grid floors.

UNIT-III: FLAT SLABS AND YIELD LINE BASED DESIGN 9

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

UNIT-IV: INELASTIC BEHAVIOUR OF CONCRETE BEAMS AND COLUMNS 9

Inelastic behaviour of concrete beams and Baker's method, moment - rotation curves

UNIT-V: DUCTILE DETAILING 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

1. Students will able to familiar with the limit state design of RCC beams and columns
2. Students will able to design special structures such as Deep beams, Corbels, Deep beams, and Grid floors
3. Students will able to understanding design of flat slab and yield line theory
4. Students will able to understand inelastic behaviors of structural elements like beam and column using baker's method and moment-rotation curves
5. Students will able to design the ductile detailing for beams, columns, etc.,

REFERENCES:

1. Gambhir.M. L., "Design of Reinforced Concrete Structures", Prentice Hall of India, 2012

2. Purushothaman, P, "Reinforced Concrete Structural Elements: Behaviour Analysis and Design", Tata McGraw Hill, 1986

3. Unnikrishna Pillai and Devdas Menon "Reinforced Concrete Design', Third Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2007.

4. Varghese, P.C, "Advanced Reinforced Concrete Design", Prentice Hall of India, 2005.

5. Varghese, P.C., "Limit State Design of Reinforced Concrete", Prentice Hall of India,

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	3
CO2	3	2	3	3	3	3
CO3	3	2	3	3	2	3
CO4	3	3	2	2	3	3
CO5	3	3	3	3	3	2
Avg	2.8	2.4	2.8	2.8	2.8	2.8

ST3164	STRUCTURAL ENGINEERING LABORATORY	L T P C 0 0 4 2

COURSE OBJECTIVES:

- To understand the test procedure and flexural behavior of the RC beams.
- To gain knowledge on various NDT test.
- To study about the structural behaviour of steel sections.
- To understand the test procedure and Compressive behavior of the RC Columns.
- To understand the Fresh properties of Self Compacting Concrete.

LIST OF EXPERIMENTS

1. Concrete Mix Design- I.S. code Method
2. Fresh properties of Self Compacting Concrete using slump flow, L Box and V Funnel Tests
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. Non-Destructive Test on concrete
   i. Rebound hammer and
   ii. Ultrasonic Pulse Velocity Tester.
7. Determination of Impact Resistance of concrete
8. Measurement of Cracks

LIST OF EQUIPMENTS

1. Strong Floor
2. Loading Frame
3. Hydraulic Jack
4. Load Cell
5. Proving Ring

6. Demec Gauge
7. Electrical Strain Gauge with indicator
8. Rebound Hammer
9. Ultrasonic Pulse Velocity Tester
10. Dial Gauges
11. Clinometers
12. Vibration Exciter
13. Vibration Meter

TOTAL: 60 PERIODS

COURSE OUTCOMES:

1. On completion of this laboratory course students will be able to cast and test RC beams for strength and deformation behavior.
2. They will be able to test dynamic testing on steel beams
3. They will be able to static cyclic load testing of RC frames
4. They will be able to non-destruction testing on concrete.
5. Will have knowledge on various admixtures used in concrete mixes as per IS Code.

REFERENCES:

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

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	2
CO2	3	1	3	3	3	2
CO3	2	1	3	3	3	2
CO4	2	2	3	3	3	2
CO5	2	1	3	3	3	2
Avg	2.2	1.4	3.0	3.0	3.0	2.0

ST3165 STRUCTURAL DESIGN AND DRAWING LABORATORY **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To make the student be familiar with the design and drawing of RC structural members.
- To make the student be familiar with the design and drawing of special RC structural members.
- To understand and design and drawing of steel roof truss
- To understand and design and drawing of steel connection.
- To make the students to understand steel detailing RC members

LIST OF EXPERIMENTS:

1. Design and drawing of RC structural members.
2. Design and drawing of special RC Structural Members.
3. Design and drawing of RC T beam bridge
4. Design and drawing steel roof truss
5. Design and drawing of steel connections
6. Bar bending schedule

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. Students will able to familiar with the design and drawing of RC structural members.
2. Students will able to familiar with the design and drawing of Special RC structural members.
3. Students will able to understanding design and drawing of steel roof truss
4. Students will able to understand design and drawing of steel connection.
5. Students will able to understand steel detailing RC members.

REFERENCES:

1. Krishnaraju N, Structural Design and Drawing, Universities Press, 2009

2. Punmia B. C, Ashok Kumar Jain and Arun Kumar Jain, Comprehensive Design of Steel Structures, Laxmi Publications Pvt, Ltd.,2003

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	2
CO2	3	1	3	3	3	2
CO3	2	1	3	3	3	2
CO4	2	2	3	3	3	2
CO5	2	1	2	3	3	2
Avg	2.2	1.4	2.8	3.0	3.0	2.0

ST 3261	ADVANCED STEEL STRUCTURES	L T P C 3 0 0 3

COURSE OBJECTIVE:

- To make the students be familiar with the limit state design of steel structures.
- To study the behaviour of members, connections and industrial buildings.
- To study the analysis and design of Industrial buildings and roofs, chimneys.
- To study the plastic analysis of structures.
- To study the design of light gauge steel structures.

UNIT I: GENERAL **9**

Design Philosophies and Design Codes (IS, EC, AISC) – Stability Criteria –Beam-Columns and Frames (Sway and Non-Sway) – Design of members subjected to combined forces – Design of Purlins, Louver rails, Gable column and Gable wind girder.

UNIT II: DESIGN OF CONNECTIONS **9**

Types of connections – Welded and Bolted – Design of simple base, Gusseted base and Moment Resisting Base – Flexible Connections - Seated Connections – Unstiffened and Stiffened Seated Connections – Moment Resistant Connections– Clip angle Connections – Split beam Connections.

UNIT III: ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS **9**

Structural Configurations - Functional and Serviceability Requirements- Analysis and design of different types of trusses – Analysis and design of industrial buildings – Sway and non-sway frames–Gantry Girders –Earthquake resistant design of steel buildings.

UNIT IV: PLASTIC ANALYSIS OF STRUCTURES **9**

Introduction, Shape factor - Moment redistribution - Beam, Sway, Joint and Gable mechanisms - Combined mechanisms– Analysis of portal frames, Effect of axial force and shear force on plastic moment capacity, Connection Requirements– Moment resisting connections - Design of Straight Corner Connections –Design of continuous beams.

UNIT V: DESIGN OF LIGHT GAUGE STEEL STRUCTURES 9

Introduction to Direct Strength Method - Behaviour of Compression Elements - Effective width for load and deflection determination – Behaviour of Unstiffened and Stiffened Elements – Design of webs of beams – Flexural members – Lateral buckling of beams – Shear Lag – Flange Curling – Design of Compression Members – Wall Studs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

1. Design the steel members such as purlins, gable wind girders subjected to combined forces.
2. Explain and design different types of steel connections such as welded and bolted flexible as well as moment resisting connections.
3. Analyze and design industrial structures such as trusses and portal frames subjected to wind and seismic forces.
4. Explain the effect of axial force and shear force on steel structures and analyse continuous beams and frames using plastic theory.
5. Evaluate the behaviour and design of compression and flexural Cold-formed Steel members.

REFERENCES:

1. Lynn S. Beedle, Plastic Design of Steel Frames, John Wiley and Sons, 1997.
2. Narayanan.R.et.al., Teaching Resource on Structural steel Design, INSDAG, Ministry of Steel Publishing, 2000.
3. Subramanian. N, Design of Steel Structures, Oxford University Press, 2016.
4. Wie Wen Yu, Design of Cold-Formed Steel Structures, McGraw Hill Book Company, 2019
5. S.K. Duggal, Limit State Design of Steel Structures, McGraw Hill Book Company, 2017

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	3	2	3
CO2	3	3	3	3	3	3
CO3	3	2	3	3	2	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	2
Avg	2.8	2.8	3.0	3.0	2.6	2.8

ST 3262	INDUSTRIAL STRUCTURES	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To study the functional requirements, planning and design of Industrial structures.
- To disseminate knowledge about design of RCC and Steel Industrial structures.
- To analyze and design various power plant structures.
- To design various special structures and transmission line towers.
- To expose to the design of various foundations.

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 of Factories Act.

UNIT-II: INDUSTRIAL BUILDINGS 9

Steel and RCC - Gantry Girder, Crane Girders - Design of Corbels and Nibs – Design of Staircase.

UNIT-III: POWER PLANT STRUCTURES 9

Types of power plants – Containment structures - Cooling Towers - Bunkers and Silos - Pipe Rack and supporting structures.

UNIT-IV: TRANSMISSION LINE STRUCTURES AND CHIMNEYS 9

Analysis and design of steel monopoles, transmission line towers – Sag and Tension calculations, Methods of tower testing – Design of self-supporting and guyed chimney, Design of Chimney bases.

UNIT-V: FOUNDATION 9

Foundation for Towers, Chimneys and Cooling Towers –Design of Block foundations for machines - Design of Turbo Generator Foundation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

1. Develop the concept of planning & functional requirements of industrial standards.
2. Analyse and design Steel Gantry girders & Crane girders and RCC design of corbels, nibs and staircase.
3. Analyse & design cooling towers, bunkers, silos and pipe supporting structures.
4. Analyse and design Steel transmission line towers and chimneys.
5. Design foundations for cooling tower, chimneys and turbo generator.

REFERENCES:

1. Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, Industrial Buildings: A Design Manual, Birkhauser Publishers, 2004.
2. Santhakumar A.R. and Murthy S.S., Transmission Line Structures, Tata McGraw Hill,1992.
3. Swami saran, Analysis & Design of substructures, Limit state Design second Edition.2018.
4. .N.Subramaniyan, Design of Steel Structures, United Press, 2018.
5. N. Krishna Raju, Advanced Reinforced concrete Design, 3rd edition 2016.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	1
CO2	3	3	3	3	2	1
CO3	3	2	3	2	3	1
CO4	3	3	3	3	2	1
CO5	2	3	2	3	2	1
Avg	2.6	2.6	2.8	2.8	2.4	1.0

ST3263 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on basic concepts of measurements and related instruments.
- To offer theoretical knowledge and hands on training in the usage of strain gauge, load cell, LVDT and data acquisition systems.
- To learn the principles of measurements of static and dynamic response of structures and carryout the analysis of results.
- To impart students knowledge on working principle of non-destructive testing techniques and its usage in real time conditions.
- To expose students the theory and principles involved in model analysis.

UNIT-I: FORCES AND STRAIN MEASUREMENT 9

Choice of Experimental stress analysis methods, Errors in measurements - Strain gauge, principle, types, performance and uses. Photo elasticity - principle and applications - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines – Long-term monitoring – vibrating wire sensors– Fibre optic sensors.

UNIT-II: MEASUREMENT OF VIBRATION AND WIND FLOW 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 – wind tunnels – Flow meters – Venturimeter – Digital data Acquisition systems.

UNIT-III: DISTRESS MEASUREMENTS AND CONTROL 9

Diagnosis of distress in structures – Crack observation and measurements – corrosion of reinforcement in concrete – Half cell, construction and use – damage assessment –

controlled blasting for demolition – Techniques for residual stress measurements – Structural Health Monitoring.

UNIT-IV: 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, Impact echo, impulse radar techniques, GECOR ,Ground penetrating radar (GPR).

UNIT-V: MODEL ANALYSIS 9

Model Laws – Laws of similitude – Model materials – Necessity for Model analysis – Advantages – Applications – Types of similitude – Scale effect in models – Indirect model study-Direct model study - Limitations of models – investigations – structural problems – Usage of influence lines in model studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. At the end of this course students will know about measurement of strain, vibrations and wind blow.
2. They will be able to analyze the structure by non-destructive testing methods and model analysis.
3. Employ load cell, sensitive dial gauges and LVDT for different application areas and interpret the results.
4. Acquire load-deflection and load-strain behaviour using data acquisition systems.
5. Describe the importance of model analysis in predicting structural behaviour of large scale structures.

REFERENCES:

1. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2006.
2. Ganesan.T.P, "Model Analysis of Structures", University Press, India, 2000.
3. Ravisankar.K.and Chelapan.A., "Advanced course on Non-Destructive Testing and Evaluation of Concrete Structures", SERC, Chennai, 2007.
4. Sirohi.R.S., Radhakrishna.H.C, "Mechanical Measurements", New Age International (P) Ltd. 1997.
5. Dalley .J. W and Riley. W. F, "Experimental Stress Analysis", McGraw Hill Bok Company, N.Y. 1991.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	2
CO2	3	1	3	3	3	2
CO3	2	1	3	3	3	2
CO4	2	2	3	3	3	2
CO5	2	1	3	3	3	2
Avg	2.2	1.4	3.0	3.0	3.0	2.0

ST3264 FINITE ELEMENT ANALYSIS IN STRUCTURAL ENGINEERING **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce the fundamental concepts of finite element method and numerical tool for the solution of different classes of problems.
- To understand the elemental properties in 1-D, 2-D and 3-D Structural Engineering problems.
- To analyze beams and trusses using FE techniquies.
- To incorporate numerical evaluation of 2-D and 3-D problems using FEA.
- To expose the finite element applications and software to analyse the structural members.

UNIT- I: INTRODUCTION **9**

Introduction - Basic Concepts of Finite Element Analysis - Introduction to Elasticity- Steps in Finite Element Analysis - Finite Element Formulation Techniques. Approximate solutions of boundary value problems - Methods of weighted residuals, virtual work method, Modified Galerkin method, Boundary conditions and general comments- continuity, compatibility, convergence aspects - PSTP – Matrix algebra.

UNIT- II: ELEMENT PROPERTIES **9**

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

UNIT- III: ANALYSIS OF BEAMS AND RIGID FRAMES **9**

Discritization of a Structure - Shape Function - Analysis of Beams - Stiffness of Beam Members - Analysis of Truss - Stiffness of Truss Members.

Analysis of Rigid Frames - Finite Element Analysis of Continuous Beam - Plane Frame Analysis - Analysis of Grid and Space Frame - Assembling stiffness equations.

UNIT- IV: TWO AND THREE DIMENSIONAL SOLIDS **9**

Constant Strain Triangle - Linear Strain Triangle - Rectangular Elements- Numerical Evaluation of Element Stiffness - Computation of Stresses, Geometric Nonlinearity and Static Condensation - Axisymmetric Element - Finite Element Formulation of

Axisymmetric Element - Finite Element Formulation for 3 Dimensional Elements-Problems.

UNIT- V: APPLICATIONS OF FEM 9

Introduction to Plate Bending Problems - Finite Element Analysis of Thin Plate - Finite Element Analysis of Thick Plate - Finite Element Analysis of Skew Plate - Finite Strip Method - Finite Element Analysis of Shell -Finite Elements for Elastic Stability - Dynamic Analysis - Structure of a FEA Software Program.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

1. Formulate a finite element problem using basic mathematical principles.
2. Explain the various types of elements and select the appropriate element for modelling.
3. Analyse a frame using truss element.
4. Formulate and analyse the two- and three-dimensional solid finite element problems.
5. Analyse shells, thick and thin plates and explain the dynamic analysis using FEM.

REFERENCES:

1. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.
2. Logan D. L,A First Course in the Finite Element Method, Thomson- Engineering, 3rd edition, 2010.
3. Zienkiewicz, O.C. and Taylor, R.L., “The Finite Element Method”, Seventh Edition, McGraw – Hill, 2013.
4. Chandrupatla, R.T. and Belegundu, A.D., “Introduction to Finite Elements in Engineering”, Fourth Edition, Prentice Hall of India, 2015.
5. Moaveni, S., “Finite Element Analysis Theory and Application with ANSYS”, Prentice Hall Inc., 2020.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	3	2	2	2	2	2
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	2	3	3	2	3
Avg	3.0	2.4	2.6	2.6	2.4	2.2

ST3265	STRUCTURAL DESIGN STUDIO	L T P C 0 0 4 2

COURSE OBJECTIVES:

- To design a structure using modern software tools available like ETABS, STAAD, STRAP, etc. and present it in the form of a complete detailed drawing. Students have to work individually with standard codes, computational tools and software packages for analyzing, designing and detailing a structure. A detailed report on the work done shall be submitted by individual students in the form of a report and presentation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the student is expected to be able to

1. Understand the requirements of a structure and model it accordingly using computer software.
2. Analyze the structure for various loads and load combinations according to the relevant IS codes.
3. Design and detail structures using computer software/tools and check the correctness using manual approximate methods.
4. Prepare the complete structural drawings using computer software.
5. Observe the flow of forces in a structure and its response to it.

REFERENCES:

1. T.S.Sharma “Staad Pro V8i for Beginners With Indian Examples”,2014
2. ETABS FOR BEGINNERS: A Comprehensive Guide to Structural Analysis and Design, Kindle Edition,2023

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	3	3	2
CO2	3	1	3	3	3	2
CO3	2	1	3	3	3	2
CO4	2	2	3	3	3	2
CO5	2	1	3	3	3	2
Avg	2.2	1.4	3.0	3.0	3.0	2.0

BA3371 RESEARCH METHODOLOGY AND IPR **L T P C**
3 0 0 3

OBJECTIVES:

- To familiarise the students with the scientific methodology involved in research process.
- To help students to understand various concepts related to Research design and measurement.
- To learn to design and validate data collection tools.
- To give an idea about IPR, registration and its enforcement.
- To acquaint the students with basics of intellectual property rights

UNIT I – INTRODUCTION TO RESEARCH AND ITS DESIGN 9

The concept of research – Characteristics of good research – The hallmarks of scientific research – Building blocks of science in research – Concept of applied and Basic research – Quantitative and Qualitative Research techniques – Need for theoretical frame work – Hypothesis development and testing. Research design – Purpose of the study: Exploratory, Descriptive, Experimental Research Design, Hypothesis Testing, Measurement of variables - Scales and measurements of variables - Factorial Design in Research – Taguchi method in Research, Developing scales.

UNIT II – DATA COLLECTION METHODS AND ANALYSIS TECHNIQUES 9

Types of data – Primary Vs secondary data, Advantages and Disadvantages of various Data-Collection Methods, Sampling plan - Sampling Techniques – Probability and non-probability Sampling, Determination of Optimal sample size, Data Analysis – Factor Analysis – Cluster Analysis – Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical (SPSS) Software Package in Research.

UNIT III – REPORT WRITING AND CODE OF ETHICS FOR RESEARCH 9

Research report – Different types – Contents of report –Report format – Title of the report – Report Presentation – Proposal- purpose, Topic selection, types and structure – Recommendations and implementation section – Conclusions and Scope for future work

- Ethics in research – Ethical behaviour of research– subjectivity and objectivity in research - ethical issues relating to the researcher.

UNIT IV – INTELLECTUAL PROPERTY RIGHTS 9

Nature of Intellectual Property - Patents, Designs, Trade mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT.

UNIT V – INTELLECTUAL PATENT RIGHTS AND NEW DEVELOPMENT 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.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students will be able to:

1. Understand research problem and analyse different research techniques.
2. Develop survey instrument and use appropriate data collection method and use appropriate statistical techniques for data analysis
3. Prepare a detailed research report with the required details and follow research ethics.
4. Explain the ethical principles to be followed while patenting or obtaining copyright.
5. Apply for patent rights and demonstrate New developments in IPR

TEXT BOOKS:

1. C.R. Kothari, "Research Methodology Methods & Techniques", Second Edition, New Delhi: New Age International Publisher, 4th edition 2019.
2. T. Ramappa, "Intelluctual Property Rights under WTO", 2nd Edition, S. Chand, 2008.

REFERENCES:

1. Donald H. McBunny, Research Methods, Thomson Asia Pvt. Ltd. Singapore, 7th edition 2006.
2. Ranjit Kumar, "Researc Methodology – A Step by Step for Beginner's", 2nd Edition, Pearson, Education, 2016.

3. Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw – Hill Publishing Company Limited, New Delhi, 12th edition 2013.
4. G.W.Ticehurst and A.J.Veal, Business Research Methods, Longman, 1999.
5. Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.
6. Raymond-Alain Thie'tart, et. Al., Doing Management Research, Sage Publications, London, 1999.
7. Uma Sekaran, /research Methods for Business, John Wiley and Sons Inc., New York, 2000.
8. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

ST3341	TECHNICAL SEMINAR	L T P C 0 0 2 1

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.
- Seminar is an important component of learning where the student gets acquainted with preparing and presentation of a technical report.
- The students shall be required to present a technical report in PPT and submit a relevant report.
- Each student shall be given at least two opportunities to exhibit his/her presentation skills.

SYLLABUS:

The students will work for two 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.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

1. The students will be trained to face an audience and to tackle any problem during group discussion in the Interviews.
2. They are trained in tackling a practical field/industry orientated problem related to Structural Engineering.
3. To develop skills in facing and solving the field problems.
4. Training is an important component of learning where the student gets acquainted with preparing and presentation of a technical report.
5. Will have knowledge in different research works related to structural engineering.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	3
CO2	2	3	3	3	2	3
CO3	2	3	3	3	2	3
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	3
Avg	2.6	3.0	3.0	3.0	2.0	3.0

ST3342	INTERNSHIP (4 Weeks)	L T P C 0 0 0 3

COURSE OBJECTIVE:

- The students are advised to collect peer reviewed journal papers relevant to their proposed project work and prepare a report in consultation with a faculty having expertise in that field.
- Seminar is an important component of learning where the student gets acquainted with preparing and presentation of a technical report.
- Presentation schedules will be prepared by the course faculty in line with the academic calendar.
- The students shall be required to present a technical report in PPT and submit a relevant report.
- Each student shall be given at least two opportunities to exhibit his/her presentation skills.

SYLLABUS: The students individually undertake training in reputed engineering companies doing Structural Engineering during the summer vacation for a specified duration of four weeks. At the end of the training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

1. Describe the Structural Engineering organization
2. Realize the various functions of construction activities
3. Gain an understanding of groups and group dynamics
4. Participate in real-life construction projects.
5. Put to use the theoretical knowledge gained so far.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	3	3	3
CO2	3	-	-	2	-	-
CO3	2	1	2	2	1	1
CO4	3	1	3	3	3	3
CO5	3	2	3	2	3	3
Avg	2.8	1.2	1.8	2.4	2	2

ST3343	PROJECT WORK PHASE - I	L T P C 0 0 12 6

COURSE OBJECTIVE:

- 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.
- To prepare the final report of project work in standard format.
- To present the work in International/National conference or reputed journals.

SYLLABUS: The student individually works on a specific topic approved by the faculty member who is familiar with 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 a clear definition of the identified problem, detailed literature review related to the area of work and a 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.

TOTAL: 180 PERIODS

OUTCOMES:

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.
- Students are trained to face the delegates during their project presentation.
- Students will be trained to conduct research work on various materials used in structures.
- Students will have knowledge in design and analysis using various software.
- Able to handle the work individually.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Avg	3.0	2.8	3.0	3.0	3.0	3.0

ST3441	PROJECT WORK PHASE - II	L T P C 0 0 24 12

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 skills to analyze and discuss the test results, and make conclusions.
- To train the students in preparing project reports and to face reviews and viva voce examination.
- To prepare the final report of project work in standard format.
- To present the work in International/National conference or reputed journals.

SYLLABUS: The student should continue the phase I work on the selected topic as per the formulated methodology / Undergo internship. 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 based on the report and the viva-voce examination by a panel of examiners including one external examine

TOTAL: 360 PERIODS

COURSE OUTCOMES:

On completion of the project work

1. Students will be in a position to take up any challenging practical problem and find better solutions.
2. Students are trained to face the delegates during their project presentation.
3. Students will be trained to conduct research work on various materials used in structures.
4. Students will have knowledge in design and analysis using various software.
5. Students will be able to handle the work individually.

CO	PO					
	PO 1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	2	2	3	3	3
CO3	2	2	2	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	3	3	3	3
Avg	2.8	2.0	2.6	3.0	3.0	3.0

PROFESSIONAL ELECTIVE COURSES

PST101 NON-LINEAR ANALYSIS OF STRUCTURES

		L	T	P	C
PST101	**NON-LINEAR ANALYSIS OF STRUCTURES**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the fundamental concepts of nonlinear analysis.
- To study the concept of nonlinear behaviour and analysis of elements and simple structures.
- To understand the inelastic analysis of flexural members.
- To incorporate overview of vibration theory and analysis of flexural members and plates.
- To understand the nonlinear vibration and instability of beams.

UNIT-I: INTRODUCTION TO NONLINEAR ANALYSIS 9

Material nonlinearity, geometric nonlinearity; statically determinate and statically indeterminate bar systems of uniform and variable thickness.

UNIT-II: INELASTIC ANALYSIS OF FLEXURAL MEMBERS 9

Inelastic analysis of uniform and variable thickness members subjected to small deformations; inelastic analysis of bars of uniform and variable stiffness members with and without axial Restraints.

UNIT-III: VIBRATION THEORY AND ANALYSIS OF FLEXURAL MEMBERS 9

Vibration theory and analysis of flexural members; hysteretic models and analysis of uniform and variable stiffness members under cyclic loading.

UNIT-IV: ELASTIC AND INELASTIC ANALYSIS OF PLATES 9

Elastic and inelastic analysis of uniform and variable thickness plates.

UNIT-V: NONLINEAR VIBRATION AND INSTABILITY 9

Nonlinear vibration and Instabilities of elastically supported beams.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. At the end of this course student will have enough knowledge on inelastic and vibration analysis of Flexural members.
2. They will have knowledge about the difference between elastic and inelastic analysis of plates and Instabilities of elastically supported beams.
3. On completion of this course, the students will know the concept of finite element analysis and enable to analyze framed structure, Plate and Shells and modify using recent software.
4. Solve and establish classical solutions for various types of plates.
5. Analyse the various types of nonlinear vibrations and instabilities of elastically supported beams using recent software too.

REFERENCES:

1. Fertis, D.G, “Non-linear Mechanics”, CRC Press, 1999.
2. Reddy.J.N, “Non-linear Finite Element Analysis”, Oxford University Press, 2008.
3. Sathyamoorthy.M, “Nonlinear Analysis of Structures”, CRC Press, 2010.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	1	1
CO2	3	3	3	3	1	2
CO3	3	2	3	3	2	3
CO4	3	2	3	3	2	3
CO5	3	2	3	3	2	3
Avg	2.8	2.2	2.8	2.8	1.6	2.4

PST102	MAINTENANCE, REPAIR AND REHABILITATION OF STRUCTURES	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To assess the importance of maintenance of structures.
- To know about the strength and durability of concrete.
- To gain knowledge on various repair materials and special concretes.
- To gain knowledge about protection methods.
- To offer knowledge to students on repair, rehabilitation and retrofitting of structures and demolition methods.

UNIT-I: MAINTENANCE AND REPAIR STRATEGIES 9

Maintenance, Repair and Rehabilitation, retrofit and strengthening, need for rehabilitation of structures- Service life behaviour - importance of Maintenance, causes and effects of deterioration. Non-destructive Testing Techniques.

UNIT-II: STRENGTH AND DURABILITY OF CONCRETE 9

Quality assurance for concrete based on Strength, Durability and Microstructure of concrete - NDT techniques- Cracks- different types, causes – Effects due to Environment, Fire, Earthquake, Corrosion of steel in concrete, Mechanism, quantification of corrosion damage.

UNIT-III: REPAIR MATERIALS AND SPECIAL CONCRETES 9

Repair materials - Various repair materials, Criteria for material selection, Methodology of selection, Special mortars and concretes- Polymer Concrete and Grouting materials- Bonding agents-Latex emulsions, Epoxy bonding agents, Protective coatings-Protective coatings for Concrete and Steel, FRP sheets.

UNIT-IV: PROTECTION METHODS AND STRUCTURAL HEALTH MONITORING 9

Concrete protection methods – reinforcement protection methods- cathodic protection - Sacrificial anode - Corrosion protection techniques – Corrosion inhibitors, concrete coatings-Corrosion resistant steels, Coatings to reinforcement, Structural health monitoring.

UNIT-V: REPAIR, RETROFITTING AND DEMOLITION OF STRUCTURES 9

Various methods of crack repair, Grouting, Routing and sealing, Stitching, Dry packing, Autogenous healing, Repair to active cracks, Repair to dormant cracks. Repair of various corrosion damaged of structural elements (slab, beam and columns) Jacketing Techniques, Strengthening Methods for Structural Elements. Engineered Demolition - Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to:

1. Explain the importance of maintenance assessment and repair strategies
2. Acquire knowledge of strength and durability properties and their effects due to climate and temperature.
3. Gain knowledge of recent developments in repair.
4. Explain the techniques for repair and protection methods.
5. Explain the repair, rehabilitation and retrofitting of structures and demolition methods.

REFERENCES:

1. Dodge Woodson, Concrete Structures, Protection, Repair and Rehabilitation, Butterworth Heinemann, Elsevier, New Delhi 2012
2. Dov Kominetzky.M.S., - Design and Construction Failures, Galgotia Publications Pvt. Ltd., 2001.
3. Ravishankar.K., Krishnamoorthy. T.S, Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures, Allied Publishers, 2004.
4. Hand book on Seismic Retrofit of Buildings, CPWD and Indian Buildings Congress, Narosa Publishers, 2008.
5. Hand Book on “Repair and Rehabilitation of RCC Buildings” – Director General works CPWD, Govt of India, New Delhi – 2002.

6. BS EN 1504 - Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity.

CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	2	2	2
CO2	2	3	3	2	3	3
CO3	3	3	3	2	3	3
CO4	3	3	3	2	2	2
CO5	3	3	3	2	3	2
Avg	2.6	3.0	3.0	2.0	2.6	2.4

PST103 WIND AND CYCLONE EFFECTS ON STRUCTURES

L T P C	
3 0 0 3	

COURSE OBJECTIVES:

- To study the concept of wind effects on design of structures.
- To impart sufficient knowledge on the analysis of wind effects on structures.
- To familiarise on the modeling and designing the structures for wind and cyclone effects as per the codal recommendations.
- To understand the design philosophy of tall buildings, the loading and behaviour of structural systems.
- To study about the cyclone effect on design of structures.

UNIT-I: INTRODUCTION 9

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

UNIT-II: WIND TUNNEL STUDIES 9

Wind Tunnel Studies, Types of tunnels, - Prediction of acceleration – Load combination factors Wind tunnel data analysis – Calculation of Period and damping value for wind design - Modeling Requirements, Aero dynamic and Aero-elastic models-Recent advancements.

UNIT-III: EFFECT OF WIND ON STRUCTURES 9

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

UNIT-IV: DESIGN OF SPECIAL STRUCTURES 9

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

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- Cyclone case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, students will be able

1. To design high rise structures subjected wind load, even structures exposed to cyclone.
2. Students will be conversant with various code provisions for the design of structures for wind load.
3. Describe the concepts on the wind effects on structures.
4. Critically describe the behavior of various special structures due to wind loading.
5. Describe and perform the design of structures against cyclone.

REFERENCES:

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

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	3
CO2	3	3	3	3	3	3
CO3	2	3	3	3	2	3
CO4	3	3	3	2	3	3
CO5	3	2	2	3	3	2
Avg	2.6	2.6	2.8	2.8	2.8	2.8

PST104 RELIABILITY ANALYSIS OF STRUCTURES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To develop knowledge to solve structural analysis problems using reliability concepts.
- It describes different levels of reliability and their sequential developments
- Aims to explain the applications of these methods for code calibrations and reliability analysis under multiple failure modes.
- Able to introduce to the intricacies of different simulation techniques.
- Application of reliability methods for structural design optimization.

UNIT- I : DATA ANALYSIS 9

Graphical representation - Histogram, frequency polygon, Measures of central tendency - grouped and ungrouped data - measures of dispersion - measures of asymmetry - Curve fitting and Correlation: Fitting a straight line, curve of the form $y = ab^x$, and parabola, Coefficient of correlation

UNIT – II : PROBABILITY CONCEPTS 9

Random events-Sample space and events, Venn diagram and event space, Measures of probability interpretation, probability axioms, addition rule, multiplication rule, conditional probability, probability tree diagram, statistical independence, total probability theorem and Baye’s theorem

UNIT – III : RANDOM VARIABLES 9

Probability mass function, probability density function, Mathematical expectation, Chebyshev’s theorem. Probability distributions: Discrete distributions- Binomial and poison distributions, Continuous distributions, Normal, Log normal distributions

UNIT - IV : RELIABILITY ANALYSIS 9

Measures of reliability-factor of safety, safety margin, reliability index, performance function and limiting state. Reliability Methods-First Order Second Moment Method (FOSM), Point Estimate Method (PEM), and Advanced First Order Second Moment Method (Hasofer-Lind’s method).

UNIT - V : SYSTEM RELIABILITY **9**

Influence of correlation coefficient, redundant and non-redundant systems series, parallel and combined systems, Uncertainty in reliability assessments- Confidence limits, Bayesian revision of reliability.

Simulation Techniques: Monte Carlo simulation- Statistical experiments, sample size and accuracy, Generation of random numbers, random numbers with standard uniform distribution, continuous random variables, discrete random variables.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student is expected to be able to

1. Achieve the Knowledge of design and development of problem-solving skills.
2. Understand the principles of reliability.
3. Design and develop analytical skills.
4. Summarize the Probability distributions.
5. Understands the concept of System reliability.

REFERENCES:

1. A Papoulis, Probability, Random Variables and Stochastic Processes, McGraw-Hill, New York, 2017.
2. R E Melchers, Structural Reliability Analysis and Prediction, Third Edition, John Wiley & Sons Ltd, Chichester, England,2018.
3. O. Ditlevsen, H. O. Madsen, Structural Reliability Methods, Wiley, 1st Edition, 1996.
4. Srinivasan Chandrasekaran, Offshore Structural Engineering: Reliability and Risk Assessment, CRC Press, Florida, 2016. Jack R Benjamin, C. Allin Cornell, Probability

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	2	3
CO2	3	2	3	3	3	3
CO3	2	3	2	2	2	2
CO4	2	3	3	3	3	3
CO5	3	3	3	3	3	2
Avg	2.6	2.8	2.8	2.8	2.6	2.6

PST201 PREFABRICATED STRUCTURES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To Study the design principles, analysis and design of elements.
- To impart the knowledge on prefabricated construction.
- To impart required knowledge about the behavior of prefabricated RC structures.
- To demonstrate the concept and advantages of prefabricated structures.
- To know the problems in joints due to flexibility and Identify different types of joints adopted for structural connections.

UNIT-I: DESIGN PRINCIPLES 9

General Principles of Fabrication-General Civil Engineering requirements, specific requirements for planning and layout of prefabrication plant. IS Code specifications. 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: REINFORCED CONCRETE 9

Prefabricated structures - Long wall and cross-wall large panel buildings, one way and two way prefabricated slabs, Framed buildings with partial and curtain walls, -Connections – Beam to column , column to column and column to foundation.

UNIT-III: FLOORS, STAIRS AND ROOFS 9

Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab design, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long term loads, Ultimate strength calculations in shear and flexure.

UNIT-IV: WALLS 9

Types of wall panels, Blocks and large panels, Curtain, Partion and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behavior 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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. At the end of this course student will have god knowledge about the prefabricated elements and the technologies used in fabrication and erection.
2. They will be in a position to design floors, stairs, roofs, walls and industrial buildings, and various joints for the connections.
3. Discuss the usage of prefabricated structures in modern construction.
4. Create a panel and framed buildings with their connections of prefabricated RC structures.
5. Construct a prefabricated structural components for industrial buildings.

REFERENCES:

1. Koncz.T., “Manual of Precast Concrete Construction”, Vol.I I and I & IV Bauverlag, GMBH, 1971.
2. Laszlo Mok, “Prefabricated Concrete for Industrial and Public Structures”, Akademiai Kiado, Budapest, 2007.
3. Lewicki.B, “Building with Large Prefabricates”, Elsevier Publishing Company, Amsterdam/ London/New York, 1998.
4. Structural Design Manual, “Precast Concrete Connection Details, Society for the Studies in the use of Precase Concrete”, Netherland Betor Verlag, 2009.
5. Warszawski, A., “Industrialization and Robotics in Building - A managerial approach”, Harper and Row, 1990.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	3
CO2	3	2	3	3	3	2
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	2	2	3	2	2	1
Avg	2.8	2.4	3.0	2.6	2.6	2.0

PST202	MECHANICS OF FIBER REINFORCED POLYMER COMPOSITE MATERIALS	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To study the behaviour of composite materials and to investigate the failure and fracture characteristics
- To study the behaviour of stress strain relations for composite materials.
- To analysis the behaviour of laminated composites.
- To investigate the behaviour of failure and fracture of composites materials.
- To study the applications and design of composite materials.

UNIT-I: INTRODUCTION **9**

Introduction to composites - classifying composite materials, commonly used fiber and Matrix constituents - introduction to polymers - polymerization and classification - Mechanical behavior of polymers.

UNIT-II: STRESS STRAIN RELATIONS **9**

Concepts in solid mechanics - Stress-Strain Relations and Engineering Constants - Hooke's Law for orthotropic and anisotropic materials - Stiffness and Compliance Matrices – Micromechanics of Unidirectional Composites (Long Fiber Composites and Short Fiber Composites).

UNIT-III: ANALYSIS OF LAMINATED COMPOSITES **9**

Laminate Strains - Laminate Description System - Macromechanics Analysis of an Orthotropic Lamina - 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**

Fatigue - Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture – Impact - Mechanics of Composites, Sandwich Construction - Environmental-Interaction Effects - Experimental Characterization of Composites.

UNIT-V: APPLICATIONS AND DESIGN **9**

Meal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues - Emerging Composite Materials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to:

1. Explain the various types of composites and their constituents
2. Derive the constitutive relationship and determine the stresses and strains in a Composite material
3. Analyze a laminated plate
4. Explain the various failure criteria and fracture mechanics of composites
5. Design simple composite elements

REFERENCES:

1. Agarwal. B.D. Broutman. L.J. and Chandrashekara. K. “Analysis and Performance of FiberComposites”, Fourth Edition, John-Wiley and Sons, 2017

2. Daniel. I.M, and Ishai. O, “Engineering Mechanics of Composite Materials”, Second Edition, Oxford University Press, 2005.

3. Hyer M.W., and White S.R., “Stress Analysis of Fiber-Reinforced Composite Materials”,D.Estech Publications Inc., 2009

4. Jones R.M., “Mechanics of Composite Materials”, Taylor and Francis Group 1999.

5. Mukhopadhyay.M, “Mechanics of Composite Materials and Structures”, Universities Press,

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	1	2
CO2	3	1	3	1	1	1
CO3	3	1	3	1	1	1
CO4	3	1	3	2	2	1
CO5	3	2	3	3	3	3
Avg	2.8	1.2	2.8	1.6	1.6	1.6

PST203 MATRIX METHODS FOR STRUCTURAL ANALYSIS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To study the concepts, characteristics and transformation of structures using matrix approach.
- To understand the difference between matrix based flexibility and stiffness approaches in structural analysis.
- To impart knowledge to compute deflections and forces in statically determinate and indeterminate structures using matrix methods.
- To impart knowledge in computing deflection based on flexibility method.
- To impart knowledge in computing deflection based on 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 aij and kij – 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 STRUCTURES 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 superposition.

UNIT-IV: THE FLEXIBILITY METHOD 9

Statically Determinate Structures –Indeterminate Structures-Choice of Redundant Leading to Ill and Well-conditioned Matrices-Transformation to one set of redundant to another-Internal forces due to thermal expansion and Lack of Fit-reducing the size of

Flexibility Matrix- Application to Pin-Jointed Plane Truss-Continuous Beams-Frames-Grids.

UNIT-V: THE STIFFNESS METHOD 9

Introduction-Development of Stiffness Method- Stiffness Matrix for Structures with zero force at some coordinates-Analogy between Flexibility and Stiffness-Analysis due to thermal expansion and Lack of Fit- Application of Stiffness approach to Pin Jointed Plane Trusses-Continuous Beams- Frames-Grids-Space Trusses and Frames-Introduction only-Static Condensation Technique- Choice of Method-Stiffness or Flexibility.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. On completion of this course students will be able to use matrix approach for solving structural engineering problems.
2. Students will have a thorough understanding of both flexibility and stiffness approach of analysis.
3. Explain the transformation of forces and displacement through matrix method.
4. Apply the matrix flexibility method for planar trusses, beams, and frames.
5. Analyse the direct stiffness method for three dimensional framed structure.

REFERENCES:

1. Natarajan C and Revathi P., “Matrix Methods of Structural Analysis”, PHI Learning Private Limited, New Delhi, 2014
2. Devdas Menon., “Advanced Structural Analysis”, Narosa Publishing House, New Delhi, 2009
3. Pandit G.S. and Gupta S.P., “Structural Analysis-A Matrix Approach”, Tata McGraw- Hill Publishing Company Limited, New Delhi, 1997.
4. Wang C.K., “Intermediate Structural Analysis”, McGraw Hill International Editions, 1983.
5. Reddy C.S., “Basic Structural Analysis”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	2
CO2	3	3	-	2	2	-
CO3	3	2	3	2	3	2
CO4	3	2	3	2	3	2
CO5	3	3	2	2	3	2
Avg	3	2.4	2.2	2	2.6	1.6

PST204 **DESIGN OF MASONRY STRUCTURES** **L T P C**
3 0 0 3

COURSE OBJECTIVE:

- To design masonry unit and the various components.
- To elucidating theories on mechanical behaviour of masonry assemblages under different actions
- To introduces students to working stress and limit state approaches to analysis and design of unreinforced, reinforced, confined masonry structures for gravity and lateral loads.
- To briefly address behaviour of masonry infill walls.
- To understand the procedures for structural assessment and strengthening of existing masonry structures.

UNIT - I : INTRODUCTION **9**

Introduction – Masonry construction – National and International perspective – Historical development, Modern masonry, Material Properties – Masonry units: clay and concrete blocks, Mortar, grout and reinforcement, Bonding patterns, Shrinkage and differential movements.

UNIT – II : DESIGN OF COMPRESSION MEMBER **9**

Principles of masonry design, Masonry standards: IS 1905 and others - Masonry in Compression – Prism strength, Eccentric loading -Kern distance. Structural Wall, Columns and Plasters, Retaining Wall, Pier and Foundation – Prestressed masonry

UNIT – III : DESIGN OF MASONRY UNDER LATERAL LOADS **9**

Masonry under Lateral loads – In-plane and out-of-plane loads, Ductility of Reinforced Masonry Members Analysis of perforated shear walls, Lateral force distribution -flexible and rigid diaphragms. Behaviour of Masonry – Shear and flexure – Combined bending and axial loads – Reinforced and unreinforced masonry – Infill masonry

UNIT – IV : EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES **9**

Structural design of Masonry – Consideration of seismic loads –concepts of confined masonry – Cyclic loading and ductility of shear walls for seismic design -Code provisions-Working and Ultimate strength design – In-plane and out-of-plane design criteria for load-bearing and infills, connecting elements and ties. Modeling Techniques, Static Push Over Analysis and use of Capacity Design Spectra – use of Software.

UNIT - V : RETROFITTING OF MASONRY **9**

Seismic evaluation and Retrofit of Masonry – In-situ and non-destructive tests for masonry – properties – Repair and strengthening of techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

1. Explain the properties of a masonry unit and the various components
2. Design a masonry structure for compression
3. Design a masonry structure for lateral loads
4. Design an earthquake-resistant masonry wall
5. Suggest retrofitting techniques for existing masonry walls

REFERENCES:

1. Drysdale, R. G. Hamid, A. H. and Baker, L. R, “Masonry Structures: Behaviour & Design”, Prentice Hall Hendry, 1994.
2. A.W. Hendry, B.P. Sinha and Davis, S. R, “Design of Masonry Structures”, E & FN Spon, UK, 2017.
3. R.S. Schneider and W.L. Dickey, “Reinforced Masonry Design”, Prentice Hall, 3rd edition, 1994.
4. Paulay, T. and Priestley, M. J. N., “Seismic Design of Reinforced Concrete and Masonry Buildings”, John Wiley, 1992.
5. A.W. Hendry, “Structural Masonry”, 2nd Edition, Palgrave McMillan Press, 1998.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	1	1
CO2	3	2	2	3	2	1
CO3	3	2	2	3	2	1
CO4	3	2	3	3	2	1
CO5	3	2	3	3	3	2
Avg	2.8	1.8	2.4	2.6	2.0	1.2

PST301 DESIGN OF STEEL - CONCRETE COMPOSITE STRUCTURES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To develop an understanding of the behaviour and design concrete composite elements and structures.
- To introduce the behaviour of composite beams and columns.
- To study about the different types of connections in composite structures.
- To describe the composite structures using various theories.
- To understand the behaviour and design concepts of composite box girder bridges and composite trusses.

UNIT-I: INTRODUCTION 9

Introduction to steel - concrete composite construction – theory of composite structures – Codes - Composite action – Serviceability and Construction issues in design.

UNIT-II: DESIGN OF COMPOSITE MEMBERS 9

Design of composite beams, slabs, columns, beam – columns - Design of composite trusses.

UNIT-III: DESIGN OF CONNECTIONS 9

Shear connectors – Types – Design of connections in composite structures – Design of shear connectors – Partial shear interaction.

UNIT-IV: COMPOSITE BOX GIRDER BRIDGES 9

Introduction - behaviour of box girder bridges and its types - Design procedure & concepts.

UNIT-V: CASE STUDIES 9

Case studies on steel - concrete composite construction in buildings - seismic behaviour of composite structures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. At the end of this course students will be in a position to design composite beams, columns, trusses and box-girder bridges including the related connections.
2. Will be able to design the composite beams and columns.
3. Describe the connection in composite structures using various theories.
4. Will have knowledge in design procedure and concepts of box girders.
5. They will get exposure on case studies related to steel-concrete constructions of buildings.

REFERENCES:

1. Johnson R.P., "Composite Structures of Steel and Concrete Beams, Slabs, Columns and Frames for Buildings", Vol.I, Blackwell Scientific Publications, 2004.
2. Oehlers D.J. and Bradford M.A., "Composite Steel and Concrete Structural Members, Fundamental behavior", Pergamon press, Oxford, 1995.
3. Owens.G.W and Knowles.P, "Steel Designers Manual", Steel Concrete Institute(UK), Oxford Blackwell Scientific Publications, 1992.
4. David A.Nethrcot "Composite Construction" Spon Press, UK, 2003.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	1	1	1
CO2	3	2	3	3	3	2
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2
CO5	3	2	3	3	3	2
Avg	2.8	1.8	2.6	2.6	2.6	1.8

PST302 COMPUTER AIDED ANALYSIS AND DESIGN

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn the principles of computer graphics.
- To make the students to understand the concept of nonlinear analysis using software packages.
- To learn the design of RC and steel structural members.
- Students make to understand the structural optimization Techniques.
- Students to study the artificial intelligence supported by software tools.

UNIT I COMPUTER GRAPHICS 9

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

UNIT II STRUCTURAL ANALYSIS 9

Computer method of structural analysis – Simulation and Analysis of steel sections I, channel and Angle –PEB Elements – RCC and Composite members - Nonlinear Analysis through software packages

UNIT III STRUCTURAL DESIGN 9

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

UNIT IV OPTIMIZATION 9

Introduction to Optimization – Applications of Linear programming – Simplex Algorithm – Post Optimality Analysis – Project scheduling – CPM and PERT Applications.

UNIT V ARTIFICIAL INTELLIGENCE 9

Introduction – Heuristic Research – Knowledge based Expert Systems – Architecture and Applications – Rules and Decision tables – Inference Mechanisms – Simple Applications – Genetic Algorithm and Applications – Principles of Neural Network – Expert system shells.

TOTAL : 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

1. Students will able to familiar principles of computer graphics.
2. Students will able to understand the concept of nonlinear analysis using software packages.
3. On completion of this course, students will be able to design of RC and steel structural members using software packages.
4. Students will be able to understand the concept of structural optimization Techniques.
5. On completion of this course, students will be able to understand artificial intelligence supported by software tools

REFERENCES:

1. Krishnamoorthy C.S and Rajeev S., “Computer Aided Design”, Narosa Publishing House, New Delhi, 1991.

2 GrooverM.P.and Zimmers E.W. Jr.," CAD/CAM, Computer Aided Design and Manufacturing", Prentice Hall of India Ltd, New Delhi, 1993.

3. Harrison H.B., “Structural Analysis and Design Vol.I and II”, Pergamon Press, 1991

4. Rao. S.S., "Optimisation Theory and Applications ", Wiley Eastern Limited, New Delhi, 2009.

5. Richard Forsyth (Ed.), “Expert System Principles and Case Studies”, Chapman and Hall, 1996.

6. Shah V.L. “Computer Aided Design in Reinforced Concrete” Structural Publishers, 2014.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	2	-	1
CO2	2	1	3	2	2	2
CO3	2	-	-	3	-	-
CO4	3	2	3	2	2	2
CO5	3	3	-	3	-	-
Avg	2.4	1.2	1.2	2.4	0.8	1

PST303 **ADVANCED CONCRETE TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To study the properties of various concrete constituent materials.
- To introduce the fundamentals of concrete mix design.
- To study about the various concreting methods.
- To provide knowledge on durability properties of concrete and different types of special concretes.
- To gain knowledge on fresh and hardened properties of concrete.

UNIT-I: CONCRETE MAKING MATERIALS 9

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

UNIT-II: MIX DESIGN 9

Principles of concrete mix design, Methods of concrete mix design, IS Method, ACI Method, DOE Method – Mix design for special concretes- changes in Mix design for special materials.

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 CONCRETES 9

Light weight concrete 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: TESTS ON CONCRETE **9**

Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage – Durability of concrete. Non-destructive Testing Techniques - microstructure of concrete.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to:

1. Develop knowledge on various materials needed for concrete manufacture.
2. Apply the rules to do mix designs for concrete by various methods.
3. Develop the methods of manufacturing of concrete.
4. Explain about various special concrete.
5. Explain various tests on fresh and hardened concrete.

REFERENCES:

1. Gupta.B.L., Amit Gupta, “Concrete Technology, Jain Book Agency, 2017
2. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi, 2019.
3. Gambhir.M.L., Concrete Technology, McGraw Hill Education, 2006.
4. Neville, A.M., Properties of Concrete, Prentice Hall, 1995, London.
5. Job Thomas., Concrete Technology, Cencage learning India Private Ltd, New Delhi, 2015.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	3
CO2	3	2	3	3	3	3
CO3	3	2	3	3	2	3
CO4	3	3	2	2	3	3
CO5	3	3	3	3	3	2
Avg	2.8	2.4	2.8	2.8	2.8	2.8

PST304 **DESIGN OF FORMWORK** **L T P C**

3 0 0 3

COURSE OBJECTIVE:

- To study the materials associated with formwork and design aspects of formwork under various requirements.
- To study the planning and erection aspects of form work with few special types of forms.
- To study the design of formworks for substructure such as Foundation & Footing.
- To study and understand the detailed planning of formwork and special structures, Design of forms for various elements such as, slabs, beams, columns and walls.
- To Study and understand the Formwork failures.

UNIT I: INTRODUCTION 9

General objectives of formwork building - Development of a Basic System - Key Areas of costreduction - Requirements and Selection of Formwork.

UNIT II: FORMWORK MATERIALS AND TYPES 9

Timber, Plywood, Steel, Aluminium, Plastic, and Accessories. Horizontal and Vertical FormworkSupports. Flying Formwork, Table Form, Tunnel Form, Slip Form, Formwork for Precast Concrete,

UNIT III: FORMWORK DESIGN 9

Concepts, Formwork Systems and Design for Foundations, Walls, Columns, Slab and Beams.

UNIT IV: FORMWORK DESIGN FOR SPECIAL STRUCTURES 9

Shells, Domes, Folded Plates, Overhead Water Tanks, Natural Draft Cooling Tower, Bridges.

UNIT V: FORMWORK FAILURES 9

Formwork Management Issues – Pre- and Post-Award. Formwork Failures: Causes and Case studies in Formwork Failure, Formwork Issues in Multi story Building Construction.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

1. Select proper formwork, accessories and material
2. Design the form work for Beams, Slabs, columns, Walls andFoundations
3. Design the form work for Special Structures
4. Describe the working of flying formwork.
5. Judge the formwork failures through case studies

REFERENCES:

1. Formwork for Concrete Structures, R.L.Peurifoy, McGraw Hill India, 2010.
2. Formwork for Concrete Structures, Kumar NeerajJha, Tata McGraw Hill Education, 2012.
3. IS 14687: 1999, False work for Concrete Structures - Guidelines, BIS.
4. Hurd, M.K., Formwork for Concrete, Special Publication No.4, American Concrete Institute, Detroit, 1996.
5. Michael P. Hurst, Construction Press, London and New York, 2003.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	3	2	1
CO2	3	3	2	1	2	1
CO3	2	3	3	1	1	1
CO4	3	3	3	1	1	2
CO5	3	2	3	1	1	2
Avg	2.6	2.6	2.4	1.4	1.4	1.4

PST401 ANALYSIS AND DESIGN OF TALL BUILDING L T P C

3 0 0 3

COURSE OBJECTIVES:

- To study the behaviour, analysis and design of tall buildings with respect to different loads.
- To provide the fundamental information pertinent to tall buildings.
- To gain knowledge on the behaviour, analysis and design of various structural systems.
- To impart knowledge on stability of tall buildings and also on dynamic analysis of wind and earthquake loadings.
- To understand the problems associated with large heights of structures with respect to different loads.

UNIT-I: LOADING AND DESIGN PRINCIPLES 9

Loading- sequential loading, Gravity loading, Wind loading, Earthquake loading, - Equivalent lateral force, modal analysis - combination of loading, – Static and Dynamic approach - Analytical and wind tunnel experimental methods - Design philosophy - working stress method, limit state method and plastic design. High Rise building – Introduction Structural systems Load resisting systems Codes requirements conforming to Indian Standard Load Calculation(Dead, Live, Wind).

UNIT-II: BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS 9

Factors affecting growth, height and structural form. High rise behaviour, Rigid frames, braced frames, In filled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger - braced and hybrid mega systems.

UNIT-III: ANALYSIS AND DESIGN 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. Case studies on industrial projects.

UNIT-IV: 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. Design of concrete frames Design of Steel frame elements- Modeling and design of shear walls.

UNIT-V: DUCTILE DETAILING **9**

Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P-Delta analysis, Translational, Torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course students will be able

1. To know the behavior of tall buildings due to various types of loads.
2. To analyze and design such buildings by approximate, accurate and simplified methods.
3. To analyze the response of wind and seismic motions on tall structures.
4. To classify and use appropriate types of structural systems in tall structures.
5. To Manipulate the second order effects of gravity loading, translational and torsional instability in the analysis of tall structures

REFERENCES:

1. Beedle.L.S., "Advances in Tall Buildings", CBS Publishers and Distributors, Delhi, 1986.
2. Bryan Stafford Smith and Alexcoull, "Tall Building Structures - Analysis and Design", John Wiley and Sons, Inc., 2005.
3. Gupta.Y.P.,(Editor), "Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities", New Age International Limited, New Delhi,1995.

4. Lin T.Y and Stotes Burry D, “Structural Concepts and systems for Architects and Engineers”, John Wiley, 1988.
5. Taranath B.S., “Structural Analysis and Design of Tall Buildings”, McGraw Hill, 1988.

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	3	2
CO2	2	3	2	3	2	3
CO3	3	2	3	2	3	3
CO4	3	3	3	3	2	2
CO5	3	3	3	3	3	3
Avg	2.8	2.8	2.8	2.8	2.6	2.6

PST402 **ENERGY EFFICIENT BUILDINGS** **L T P C**

3 0 0 3

COURSE OBJECTIVE:

- To understand the concept of reduction in energy consumption through low energy building design
- To Understand the sources of Renewable Energy
- To Highlight strategies to integrate daylighting and low energy heating/cooling in buildings
- To Model air flow and Ventilation
- To know illumination requirements artificial lighting and factors affecting day lighting

UNIT I GREEN BUILDINGS, ENERGY AND ENVIRONMENT 9

Green Buildings within the Indian Context, Types of Energy, Energy Efficiency and Rebound Effect, Pollution, Better Buildings, Reducing energy consumption, Low energy design.

UNIT II RENEWABLE ENERGY SOURCES 9

Solar energy, Passive Solar Heating, Passive Solar collection, Wind and other renewables. A passive solar strategy: Direct gain - Trombe wall, convective air loop, Photovoltaics, Climate and Energy, Macro and Microclimate - Indian Examples.

UNIT III HEATING AND COOLING 9

Building Form Surface area and Fabric Heat Loss, utilizing natural energy, Internal Planning, Grouping of buildings – Robin's Spatial Proportion – Orientation of building – Heat transmission through buildings –Thermal properties of building materials – Thermal Comfort – Psychrometric Chart –Heat transfer – Cosine Effect - Insulation - Cooling buildings, passive cooling, and mechanical cooling – Measurement of heating and cooling loads.

UNIT IV VENTILATION AND INFILTRATION 9

Natural ventilation and forced ventilation in commercial buildings, passive cooling, modelling air flow and ventilation – stack effect - ventilation calculation – Mass effect

UNIT V DAY LIGHTING AND ARTIFICIAL LIGHTING 9

Illumination requirements - Concepts of daylight factors and day lighting, daylight assessment, sky dome - sun path diagram, sky exposure angle, sun protection, shading coefficient, visualizing day lighting: Source-Path-Target and apparent size, illuminance calculation, penetration and spread of sky component, artificial lighting, efficacy, Radiant barriers - new light sources –luminaries - light shelves - Supplementary artificial lighting design – light distribution – electric lighting control

TOTAL: 45 PERIODS

COURSE OUTCOME

On completion of this course student will be able to

1. To know the concept of reduction in energy consumption through low energy
2. building design
3. To know the sources of Renewable Energy
4. To Model air flow and Ventilation
5. To know illumination requirements artificial lighting and factors affecting daylighting

REFERENCES:

1. Charles Eley (2016), Design Professional's Guide to Zero Net Energy Buildings, Island Press.

2. Ian M. Shapiro (2016), Energy Audits and Improvements for Commercial Buildings, John Wiley & Sons.

3. Moncef Krarti (2016), Energy Audit of Building Systems: An Engineering Approach, Second Edition.

4. EngHwa Yap., (2017), Energy Efficient Building, Published by InTech.Crotia.

5. Lal Jayamaha (2006), Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance, McGraw Hill Professional.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2	2	2
CO2	3	2	2	3	2	3
CO3	3	2	3	3	3	3
CO4	2	1	3	3	3	3
CO5	2	2	3	3	3	2
Avg	2.6	1.6	2.6	2.8	2.6	2.6

PST403 **ADVANCED PRESTRESSED CONCRETE** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To develop an understanding of the philosophy of design of prestressed concrete
- To impart knowledge to analyze and design prestressed concrete flexural and shear members.
- To expand knowledge to design of prestressed concrete continuous and cantilever beams.
- To be able to design prestressed concrete tension and compression members.
- To design the prestressed concrete bridge and composite sections.

UNIT-I: PRINCIPLES AND BEHAVIOUR OF PRESTRESSING 9

Basic concepts of Prestressing - Types and systems of prestressing - Analysis methods, losses of prestress – Short and Long term deflections – Cable layouts.

UNIT- II: DESIGN OF 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 prestressed concrete elements- Transfer of prestress - Camber, deflection and crack control.

UNIT- III: DESIGN OF CONTINUOUS AND CANTILEVER BEAMS 9

Analysis and design of continuous beams - 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 - Analysis and design of cantilever 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 – its application in the design of piles, flag masts and similar structures–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. Design of pre- tensioned and post tensioned girder bridges - Partial prestressing - advantages and applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

1. Identify the various methods of prestressing and estimate the loss
2. Design the beams for flexure, shear, bond and torsion
3. Design the continuous beams and composite beams
4. Design the water tank, piles and masts
5. Analyze and design the prestressed concrete bridge

REFERENCES:

1. Arthur H. Nilson, "Design of Prestressed Concrete", John Wiley and Sons Inc, New York, 2004.
2. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill Publishing Co., New Delhi, 6th Edition, 2018.
3. Lin.T.Y. and Burns.H "Design of Prestressed Concrete Structures", John Wiley and Sons Inc, New York, 3 rd Edition, 2010.
4. Rajagopalan.N, "Prestressed Concrete", Narosa Publications, New Delhi.
5. Sinha.N.C.and.Roy.S.K, "Fundamentals of Prestressed Concrete", S.Chand and Co.,1998.
6. Johnson Victor, D., Essentials of Bridge Engineering, Oxford and IBH Publishing Co., New Delhi 2019

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	2	3	3	3	2
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	2
CO5	3	2	3	3	3	2
Avg	3.0	2.2	3.0	3.0	2.8	2.0

PST404 **DESIGN OF OFFSHORE STRUCTURES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To study the concept of wave theories, forces and design of jacket towers, pipes and Cables.
- To understand the forces on offshore structure.
- To expand the idea on foundation and structural modeling and analysis on offshore structures.
- To impart knowledge on wave generalized process and wave theories.
- To design of offshore structures with failure probability.

UNIT-I: WAVE THEORIES **9**

Wave generation process, small, finite amplitude and nonlinear wave theories.

UNIT-II: FORCES OF OFFSHORE STRUCTURES **9**

Wind forces, wind forces on vertical, inclined cylinders, structures - current forces and use of Morrison equation.

UNIT-III: OFFSHORE SOIL AND STRUCTURE MODELLING **9**

Different types of offshore structures, foundation modeling, fixed jacket platform structural modeling.

UNIT-IV: ANALYSIS OF OFFSHORE STRUCTURES **9**

Static method of analysis, foundation analysis and dynamics of offshore structures.

UNIT-V: DESIGN OF OFFSHORE STRUCTURES **9**

Design of platforms, helipads, Jacket tower, analysis and design of mooring cables and pipelines. Corrosion and Fatigue Failure.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. On completion of this course students will be able to determine the forces due to ocean Waves.
2. Solve various types of forces due to ocean waves.
3. Describe the foundation for offshore structures.
4. Perform and analyze the dynamics of offshore structures.
5. Design offshore structures like platform, helipads, jackets, towers etc.,

REFERENCES:

1. API RP 2A-WSD, "Planning, Designing and Constructing Fixed Offshore Platforms – Working stress Design" - API Publishing Services, 2005
2. Chakrabarti, S.K., "Handbook of Offshore Engineering" by, Elsevier, 2005.
3. Chakrabarti, S.K., "Hydrodynamics of Offshore Structures", WIT press, 2001.
4. Dawson.T.H., "Offshore Structural Engineering", Prentice Hall Inc Englewood Cliffs, N.J. 1983.
5. James F. Wilson, "Dynamics of Offshore Structures", John Wiley & Sons, Inc, 2003.
6. Reddy, D.V. and Arockiasamy, M., "Offshore Structures", Vol.1 and Vol.2, Krieger Publishing Company, 1991.
7. Reddy.D.V and Swamidas A.S.J., "Essential of offshore structures".CRC Press.2013
8. Turgut Sarpkaya, "Wave Forces on Offshore Structures", Cambridge University Press, 2010.
9. Wiegel .R.L, "Oceano graphical Engineering", Prentice Hall Inc. Englewood, Cliffs, N.J. 1964.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	1	2	3
CO2	1	1	3	1	2	2
CO3	2	2	3	3	3	3
CO4	2	2	3	3	3	3
CO5	2	2	3	3	3	3
AVG	1.8	1.6	3.0	2.2	2.6	2.8

PST501 STRUCTURAL HEALTH MONITORING L T P C

3 0 0 3

COURSE OBJECTIVE:

- To make the students familiar with various structural health monitoring tools and techniques.
- To study the behaviour sensors and instrumentation for SHM.
- To study the behaviour static and dynamic measurement techniques for SHM
- To investigate the damage detection of structures.
- To study the data processing and case studies.

UNIT I: INTRODUCTION TO STRUCTURAL HEALTH MONITORING 9

Need for SHM, Structural Health Monitoring versus Non-Destructive Evaluation, Methods of SHM Local & Global Techniques for SHM, Short & Long-Term Monitoring, Active &Passive Monitoring, Remote Structural Health Monitoring- Advantages of SHM - Challenges in SHM

UNIT II: SENSORS AND INSTRUMENTATION FOR SHM 9

Sensors for measurements: Electrical Resistance Strain Gages, Vibrating Wire Strain Gauges, Fiber Optic Sensors, Temperature Sensors, Accelerometers, Displacement Transducers, Load Cells, Humidity Sensors, Crack Propagation Measuring Sensors, Corrosion Monitoring Sensors, Pressure Sensors, Data Acquisition – Data Transmission- Data Processing – Storage of processed data Knowledgeable information processing

UNIT III: STATIC AND DYNAMIC MEASUREMENT TECHNIQUES FOR SHM 9

Static measurement - Load test, Concrete core trepanning, Flat jack techniques, Static response measurement, Dynamic measurement -Vibration based testing- Ambient Excitation methods, Measured forced Vibration-Impact excitation, step relaxation test, shaker excitation method.

UNIT IV: DAMAGE DETECTION 9

Damage Diagnostic methods based on vibrational response- Method based on modal frequency/shape/damping, Curvature and flexibility method, Modal strain energy method

Sensitivity method, Baseline-free method, Cross-correlation method, Damage Diagnostic methods based on wave propagation Methods-Bulk waves/Lamb waves, Reflection and transmission, Wave tuning/mode selectivity, Migration imaging, Phased array imaging, Focus in array/ SAFT imaging

UNIT V: DATA PROCESSING AND CASE STUDIES 9

Advanced signal processing methods -Wavelet, Hilbert-Huang transform, Support Vector Machine Principal component analysis, Outlier analysis. Applications of SHM on bridges and buildings, case studies of SHM in Civil/ Structural engineering.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student is expected to be able to

1. Understand the need, advantages and challenges of SHM
2. Know the different types of sensors and instrumentation techniques
3. Gain knowledge of the static and dynamic measurement techniques
4. Compare the various damage detection techniques
5. Know the various data processing methods through case studies

REFERENCES

1. Daniel Balageas, Peter Fritzen, Alfredo Guemes, Structural Health Monitoring, John Wiley &Sons,2006.
2. Douglas E Adams, Health Monitoring of Structural Materials and Components Methods with Applications, Wiley Publishers, 2007
3. Hua-Peng Chen, Structural Health Monitoring of Large Civil Engineering Structures, Wiley Publishers, 2018
4. Ansari, F Karbhari, Structural health monitoring of civil infrastructure systems, V.M,Woodhead Publishing, 2009
5. J. P. Ou, H. Li and Z. D, “Duan Structural Health Monitoring and Intelligent Infrastructure”, Vol1,Taylor and Francis Group, London, UK, 2006.
6. Victor Giurglutiu, “Structural Health Monitoring with Wafer Active Sensors”, Academic Press Inc, 2007.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	2	-	-
CO2	2	1	3	2	2	2
CO3	2	-	-	3	-	-
CO4	3	2	3	2	2	2
CO5	3	3	-	3	2	2
Avg	2.4	1.2	1.2	2.4	1.2	1.2

PST502 PERFORMANCE OF STRUCTURES WITH SOIL STRUCTURE INTERACTION **L T P C 3 0 0 3**

COURSE OBJECTIVE:

- To study the concept of soil-structure – interaction in the analysis and design of structures.
- To study the concept of beam on elastic foundation- soil models.
- To study the concept of plates on elastic continuum.
- To study the concept of analysis of axially and laterally loaded piles and pile groups.
- To study the concept of ground-foundation-structure interaction.

UNIT I SOIL-FOUNDATION INTERACTION **9**

Introduction to soil-foundation interaction problems – Soil behaviour – Foundation behaviour Interface behaviour - Scope of soil foundation interaction analysis- soil response models–Elastic continuum- Two parameter elastic models - Elastic-plastic behaviour- Time dependent behaviour.

UNIT II BEAM ON ELASTIC FOUNDATION- SOIL MODELS **9**

Infinite beam – Two-parameters models – Isotropic elastic half space model – Analysis of beams of finite length – combined footings.

UNIT III PLATES ON ELASTIC CONTINUUM **9**

Thin and thick rafts – Analysis of finite plates - Numerical analysis of finite plates.

UNIT IV ANALYSIS OF AXIALLY AND LATERALLY LOADED PILES AND PILE GROUPS **9**

Elastic analysis of single pile – Theoretical solutions for settlement and load distributions Analysis of pile group – Interaction analysis – Load distribution in groups with rigid cap – Load deflection prediction for laterally loaded piles – Subgrade reaction and elastic analysis – Interaction analysis – Pile-raft system.

UNIT V GROUND-FOUNDATION-STRUCTURE INTERACTION **9**

Effect of structure on ground-foundation interaction – Static and dynamic load Contact pressure and its estimation – Estimation of the settlement from the constitutive laws Free-field response –Kinetic interaction – Inertial interaction

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

1. Explain the concept of soil structure interaction.
2. Do a static analysis of infinite and finite beams resting on elastic foundation
3. Analyse finite thin and thick plates
4. Do a static and dynamic analysis of soil structure interaction problems
5. Analyze ground foundation and structure interaction problems

REFERENCES:

1. John P. Wolf, (1985) Soil-structure interaction, Prentice Hall, 1987.
2. Bowels, J.E., "Analytical and Computer methods in Foundation" McGraw Hill Book Co., NewYork., 1974
3. Desai C.S. and Christian J.T., "Numerical Methods in Geotechnical Engineering" McGrawHill Book Co. New York,1977.
4. Soil Structure Interaction, the real behaviour of structures, Institution of Structural Engineers,1989.
5. A.P.S. Selvadurai, Elastic Analysis of Soil Foundation Interaction, Developments in Geotechnical Engg.vol-17, Elsevier Scientific Publishing Co., 1979.
6. Prakash, S., and Sharma, H. D., "Pile Foundations in Engineering Practice."John Wiley & Sons, New York, 1990.
7. Rolando P. Orense, Nawawi Chouw & Michael J. Pender – Soil-Foundation-Structure Interaction, CRC Press, Taylor & Francis Group, London, UK, 2010.

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	3	3	2	3
CO2	3	3	3	3	3	3
CO3	3	2	2	2	3	2
CO4	2	3	3	3	2	3
CO5	3	3	2	3	3	3
Avg	2.6	2.6	2.6	2.8	2.6	2.8

PST503 **DESIGN OF BRIDGES** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- Design of bridges is a specialized area in structural engineering practice. In this course, the students are taught the IRC loading standards and analysis and design of different types of bridges.
- To offer knowledge on design of short span bridges, design of T-Beam and slab bridges, prestressed concrete bridges and plate girder bridges.
- To describe the concepts of prestressed concrete bridges.
- To give exposure to design principles of continuous, box girder and balanced cantilever bridges.
- To get knowledge on different types of bearings and design of sub structures.

UNIT-I: GENERAL INTRODUCTION AND SHORT SPAN RC BRIDGES **9**

Types of bridges and IRC loading standards - Choice of type - I.R.C. specifications for road bridges – Design of RCC solid slab bridges - analysis and design of slab culverts.

UNIT-II: LONG SPAN RC BRIDGES **9**

Tee beam and slab bridges- General features-Pigeaurd's Curve-Courbon's theory – Continuous girder bridges, box girder bridges, balanced cantilever bridges – Arch bridges – Box culverts – Segmental bridges-Advantages-General features-Design principles only.

UNIT-III: PRESTRESSED CONCRETE BRIDGES **9**

Pre-stressed concrete bridges-Preliminary dimensions-Flexural and torsional parameters – Design of girder section – maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable Zone in girder – check for stresses at various sections – check for diagonal tension – Diaphragms – End block – short term and long term deflections.

UNIT-IV: STEEL BRIDGES **9**

General – Railway loadings – dynamic effect – Railway culvert with steel beams – Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners.

UNIT-V: BEARINGS AND SUBSTRUCTURES **9**

Bridge bearings – Plate, Roller and Rocker bearings-Elastomeric bearings – Design of piers and abutments of different types – Types of bridge foundations – Design of foundations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course students will be able

1. To design slab culverts and T-beam bridge superstructure for the IRC loading conditions. To design different types of RCC bridges.
2. To Steel bridges and pre-stressed concrete bridges with the bearings and substructures.
3. To design post tensioned prestressed T-beam bridge superstructure for the IRC loading.
4. To design steel plate girder bridge superstructure based on IRS loading conditions.
5. To design steel rocker cum roller bearing and substructure for pile foundation and well foundation as per IRC.

REFERENCES:

1. Jagadesh.T.R. and Jayaram.M.A., "Design of Bridge Structures", Prentice Hal of India Pvt. Ltd. 2004.
2. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. New Delhi, 2001.
3. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, 2008.
4. Raina V.K. "Concrete Bridge Practice" Tata McGraw Hill Publishing Company, New Delhi, 1911.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	2	2
CO2	3	3	3	3	3	3
CO3	3	2	3	2	3	3
CO4	3	3	3	3	3	3
CO5	3	3	2	3	2	3
Avg	2.8	2.8	2.6	2.6	2.6	2.8

PST504 DESIGN OF SHELL AND SPATIAL STRUCTURES L T P C
3 0 0 3

COURSE OBJECTIVES:

- Study the behaviour and design of shells.
- To impart knowledge on the behavior of folded plates.
- To understand the behaviour analysis and design of space frames.
- To provide students with a rational basis for the analysis and design of thin shells.
- To apply the numerical techniques and tools for the complex problems in shells.

UNIT-I: CLASSIFICATION OF SHELLS 9

Classification of shells, types of shells, structural action, - Design of circular domes, conical roofs, circular cylindrical shells by ASCE Manual No.31. Application to design of shell roofs of water tanks (membrane analyses).

UNIT-II: FOLDED PLATES 9

Folded Plate structures, structural behaviour, types, design by ACI - ASCE Task Committee method – pyramidal roof.

UNIT-III: INTRODUCTION TO SPACE FRAME 9

Space frames - configuration - types of nodes - Design Philosophy - Behaviour.

UNIT-IV: ANALYSIS AND DESIGN 9

Analysis of space frames – Design of Nodes – Pipes - Space frames – Introduction to Computer Aided Design.

UNIT-V: SPECIAL METHODS 9

Application of Formex Algebra, FORMIAN for generation of configuration.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. On completion of this course students will be able to analyze and design various types of shells, folded plates and space frames manually and also using computer Aided design and software packages.
2. Illustrate the characteristics on different types of shells and develop equilibrium equations and force displacement relations.
3. Will have knowledge in configuration and design philosophy of space frames.
4. Analyse the various types of shells under different loading conditions using CAD.
5. Design the various types of shells structures by special methods.

REFERENCES:

1. ASCE Manual No.31, “Design of Cylindrical Shells”.
2. Billington.D.P, “Thin Shell Concrete Structures”, McGraw Hill Book Co., New York, 1982.
3. Ramasamy, G.S., “Design and Construction of Concrete Shells Roofs”, CBS Publishers, 1986.
4. Subramanian.N , “Principles of Space Structures”, Wheeler Publishing Co. 1999.
5. Varghese.P.C., “Design of Reinforced Concrete Shells and Folded Plates”, PHI Learning Pvt. Ltd., 2010.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	3	1
CO2	3	3	3	3	2	1
CO3	3	2	3	2	3	1
CO4	2	3	3	3	2	1
CO5	2	3	3	3	2	-
Avg	2.4	2.8	3	2.6	2.4	1.0

PST601	STABILITY OF STRUCTURES	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- To study the concept of buckling and analysis of structural elements.
- To impart students sufficient knowledge about basic concepts of elastic structural stability, analytical approaches to stability and analysis of inelastic buckling of columns.
- To understand the design procedure in Column and plate analysis
- To study the concepts regarding tall buildings.
- To give exposure on the stability analysis of beam columns and frames using FEM and other methods and analysis of buckling of beams and thin plates.

UNIT-I: BUCKLING OF COLUMNS 9

States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkins approach - 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 and several concentrated loads, distributed load-Columns on elastic foundation- 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

Tensional buckling – Combined Tensional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. 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 - Eccentrically loaded inelastic column. Isotropic rectangular plates -Inelastic buckling of plates - Post buckling behaviour of plates.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. On completion of this course student will know the phenomenon of buckling of columns.
2. They are in a position to calculate the buckling load on column, beam – column, frames and plates using classical and approximate methods.
3. Will have knowledge about the Torsional and lateral buckling of beams.
4. Lateral buckling analysis of columns can be performed.
5. Will be able to analyze inelastic behavior of structures.

REFERENCES:

1. Ashwini Kumar, “Stability Theory of Structures”, Allied publishers Ltd., New Delhi, 2003.
2. Chajes, A. “Principles of Structures Stability Theory”, Prentice Hall, 1974.
3. Gambhir, “Stability Analysis and Design of Structures”, springer, New York, 2004.
4. Iyenger.N.G.R., “Structural stability of columns and plates”, Affiliated East West Press,1986.
5. Timoshenko.S.P, and Gere.J.M, “Theory of Elastic Stability”, McGraw Hill Book Company, 1963.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	2	3	3	2	3
CO3	3	1	3	3	2	3
CO4	3	2	3	3	2	3
CO5	3	2	3	3	2	3
Avg	3	1.8	3	3	2.2	3

PST602	THEORY OF PLATES	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- To study the behaviour and analysis of thin plates in cartesian and polar coordinates.
- To understand the behaviour of reinforced concrete plate elements at material level, element level and system level.
- To understand about the various finite element methods for plate analysis.
- To equip the students with analysis and design procedures for folded plate structures.
- To design the structures using various plate theory and codes.

UNIT-I: INTRODUCTION TO PLATES THEORY 9

Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions.

UNIT-II: RECTANGULAR PLATES 9

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge conditions, plates on elastic foundation. Moody's chart (for analysis of plates with various boundary conditions or loading).

UNIT-III: CIRCULAR PLATES 9

Symmetrical bending of circular plates.

UNIT-IV: SPECIAL AND APPROXIMATE METHODS 9

Energy methods, Finite difference and Finite element methods.

UNIT-V: ANISOTROPIC PLATES AND THICK PLATES 9

Orthotropic plates and grids, moderately thick plates.

TOTAL: 45 PERIODS

COURSE OUTCOME:

At the end of this course students will be able

1. To analyze different types of plates (Rectangular and circular) under different boundary connections by various classical methods and approximate methods.
2. They will also know behavior of orthotropic and thick plates and grids.
3. Describe the behaviour of thin and thick circular plates.
4. Solve and establish classical solutions for various types of plates.
5. Analyse the various types of anisotropic and thick plates under different loading conditions.

REFERENCES:

1. Ansel C.Ugural, “Stresses in plate and shells”, McGraw Hil International Edition, 1999.
2. Bairagi, “Plate Analysis”, Khanna Publishers, 1996.
3. Bulson.P.S., “Stability Of Flat Plates”, American Elsevier Publisher. Co.,1969.
4. Chandrashekahara, K. “Theory of Plates”, University Press (India) Ltd., Hyderabad, 2001.
5. Reddy J N, “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Company, 2006.
6. Szilard, R., “Theory and Analysis of Plates – classical and numerical methods”, Prentice Hall Inc., 2004.
7. Timoshenko.S.P, and Krieger S.W. “Theory of Plates and Shells”, McGraw Hill Book Company, New York, 2003.

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	2	2	2
CO2	3	3	-	2	2	-
CO3	3	2	3	2	3	2
CO4	3	2	3	2	3	2
CO5	3	3	2	2	3	2
Avg	3	2.4	2.2	2	2.6	1.6

PST603 **DESIGN OF SUB STRUCTURES** **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 familiarize the students for the geotechnical design of pile foundations.
- To understand the concepts in designing well, machine and special foundations.
- To plan and execute a detailed site investigation to select geotechnical design parameters and type of foundation.

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 –pile driving and construction–configuration of piles- different shapes of piles cap – structural design of pile cap – Under-reamed pile foundation.

UNIT-III: WELL FOUNDATIONS **9**

Types of well foundation – Grip length – load carrying capacity – construction of wells – Design aspects – Failures and Remedies – Design principles 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 –Construction aspects–vibration isolation.

UNIT-V: SPECIAL FOUNDATIONS **9**

Foundation on expansive soils – choice of foundation – Foundation for concrete Towers and chimneys – Reinforced earth retaining walls - Marine Foundations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. On completion of this course students will be able to select appropriate foundation type based on available soil conditions.
2. They will be in a position to determine the load carrying capacity of deep foundation.
3. Design the well foundations for construction engineering structures.
4. Understand the theory of vibrations and Design the well foundations for construction Engineering structures.
5. Analyze the soil foundation on expansive soils and to design foundation for special structures.

REFERENCES:

1. Varghese.P.C, "Design of Reinforced Concrete Foundations" – PHI learning private limited, New Delhi – 2009.
2. Bowles .J.E., "Foundation Analysis and Design", McGraw Hill Publishing co., New York, 1997.
3. Swamy Saran, "Analysis and Design of substructures" Oxford and IBH Publishing Co. Pvt. Ltd., 2006.
4. Tomlinson.M.J, "Foundation Design and Construction", Longman, Sixth Edition, New Delhi, 1995.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	3	3	2	2	3	2
CO3	3	2	2	3	3	3
CO4	3	2	2	3	2	2
CO5	3	2	2	2	3	2
Avg	3	2.2	2	2.6	2.6	2.2

PST604	OPTIMIZATION OF STRUCTURES	L T P C 3 0 0 3

COURSE OBJECTIVES:

- To study the optimization methodologies applied to structural engineering.
- To impart sufficient knowledge on basic concepts of optimization and classical methods.
- To give detailed overview of queuing theory, exposure to various optimization techniques for design of structural elements.
- Linear and nonlinear programming methods for plastic design.
- To understand the methods for optimal design of structural elements.

UNIT-I: BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES 9

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

UNIT-II: LINEAR AND NON-LINEAR PROGRAMMING 9

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

NON LINEAR PROGRAMMING: One Dimensional minimization methods: Unidimensional - Unimodal function - Exhaustive and unrestricted search - Dichotomous search - Fibonaci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques.

UNIT-III: GEOMETRIC PROGRAMMING 9

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

UNIT-IV: DYNAMIC PROGRAMMING 9

Bellman's principle of optimality –Representation of a multi stage decision problem - Concept of sub -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 multistory buildings, water tanks and bridges.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. On completion of this course students will have sufficient knowledge on various optimization techniques like linear programming, non-linear programming, geometric and dynamic programming.
2. They will also in a position to design various structural elements for minimum weight.
3. Execute different optimization techniques for the design of structural elements.
4. Appropriately use the computer search methods for the analysis of structures.
5. Describe the various optimization theorems for the analyzing of structures.

REFERENCES:

1. Iyengar.N.G.R and Gupta.S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 197
2. Rao,S.S. "Optimization theory and applications", Wiley Eastern (P) Ltd., 1984
3. Spunt, "Optimization in Structural Design", Civil Engineering and Engineering

Mechanics Services, Prentice-Hal, New Jersey 1971.
4. Uri Krish, “Optimum Structural Design”, McGraw Hil Bok Co. 1981
5. Belegundu, A.D.and Chandrapatla,T.R., “Optimisation Concepts and Applications in Engineering”, Pearson Education, 2011.
6. Deb K., “Optimisation for Engineering Design”, Algorithms and examples, Prentice Hall, New Delhi, 2012.
7. Arora J.S., “Introduction to Optimum Design”, McGraw –Hill Book Company, 2011.
8. Taha, H.A., “Operations Research – An Introduction”, Prentice Hall of India, 2004.

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	2
CO2	3	2	3	3	3	3
CO3	3	2	3	3	3	2
CO4	3	2	3	3	3	3
CO5	3	2	3	3	3	3
Avg	3.0	2.0	3.0	3.0	3.0	2.6