ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M. E. STRUCTURAL ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABUS
SEMESTER I

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4153	Advanced Mathematical Methods	FC	4	0	0	4	4
2.	ST4101	Theory of Elasticity and Plasticity	PCC	3	1	0	4	4
3.	ST4102	Structural Dynamics and Earthquake Engineering	PCC	3	1	0	4	4
4.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Audit Course I*	AC	2	0	0	2	0
PRACTICALS								
7.	ST4161	Advanced Construction Engineering and Experimental Techniques Laboratory	PCC	0	0	4	4	2
8.	ST4111	Technical Seminar	EEC	0	0	2	2	1
			TOTAL	**17**	**2**	**6**	**25**	**20**

*** Audit Course is optional**

SEMESTER II

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ST4201	Advanced Steel Structures	PCC	3	1	0	4	4
2.	ST4202	Advanced Concrete Structures	PCC	3	1	0	4	4
3.	ST4203	Finite Element Analysis in Structural Engineering	PCC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Audit Course II*	AC	2	0	0	2	0
PRACTICALS								
7.	ST4211	Numerical and Finite Element Analysis Laboratory	PCC	0	0	4	4	2
8.	ST4212	Structural Design Studio	PCC	0	0	4	4	2
			TOTAL	**17**	**2**	**8**	**27**	**21**

*** Audit Course is optional**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective IV	PEC	3	0	0	3	3
2.		Professional Elective V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	ST4311	Practical Training (4 Weeks)	EEC	0	0	0	0	2
5.	ST4312	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**17**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	ST4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 70

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4153	Advanced Mathematical Methods	4	0	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	ST4101	Theory of Elasticity and Plasticity	3	1	0	4	1
2.	ST4102	Structural Dynamics and Earthquake Engineering	3	1	0	4	1
3.	ST4161	Advanced Construction Engineering and Experimental Techniques Laboratory	0	0	4	2	1
4.	ST4201	Advanced Steel Structures	3	1	0	4	2
5.	ST4202	Advanced Concrete Structures	3	1	0	4	2
6.	ST4203	Finite Element Analysis in Structural Engineering	3	0	0	3	2
7.	ST4211	Numerical and Finite Element Analysis Laboratory	0	0	4	2	2
8.	ST4212	Structural Design Studio	0	0	4	2	2
					TOTAL CREDITS	**25**	

LIST OF PROFESSIONAL ELECTIVE COURSES [PEC]

SEMESTER I, ELECTIVE I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ST4001	Non-linear Analysis of Structures	PEC	3	0	0	3	3
2.	ST4002	Structural Stability	PEC	3	0	0	3	3
3.	ST4003	Wind and Cyclone Effects on Structures	PEC	3	0	0	3	3
4.	ST4004	Prefabricated Structures	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CN4071	Advanced Concrete Technology	PEC	3	0	0	3	3
2.	ST4071	Advanced Prestressed Concrete	PEC	3	0	0	3	3
3.	ST4005	Reliability Analysis of Structures	PEC	3	0	0	3	3
4.	ST4006	Design of Formwork	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ST4073	Maintenance, Repair and Rehabilitation of Structures	PEC	3	0	0	3	3
2.	ST4007	Mechanics of Fiber Reinforced Polymer Composite Materials	PEC	3	0	0	3	3
3.	ST4008	Design of Steel Concrete Composite Structures	PEC	3	0	0	3	3
4.	ST4009	Design of Masonry Structures	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ST4010	Design of Industrial Structures	PEC	3	0	0	3	3
2.	ST4011	Advanced Design of Foundation Structures	PEC	3	0	0	3	3
3.	ST4012	Optimization of Structures	PEC	3	0	0	3	3
4.	ST4013	Structural Health Monitoring	PEC	3	0	0	3	3

SEMESTER III, ELCTIVE V

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ST4014	Design of Offshore Structures	PEC	3	0	0	3	3
2.	ST4015	Performance of Structures with Soil Structure Interaction	PEC	3	0	0	3	3
3.	ST4072	Design of Bridge Structures	PEC	3	0	0	3	3
4.	ST4016	Design of Shell and Spatial Structures	PEC	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1
					TOTAL CREDITS	**2**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	ST4111	Technical Seminar	0	0	2	1	1
2.	ST4311	Practical Training (4 Weeks)	0	0	0	2	3
3.	ST4312	Project Work I	0	0	12	6	3
4.	ST4411	Project Work II	0	0	24	12	4
					TOTAL CREDITS	**21**	

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX4091	English for Research Paper Writing	2	0	0	0	**1/2**
2.	AX4092	Disaster Management	2	0	0	0	
3.	AX4093	Constitution of India	2	0	0	0	
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0	

SUMMARY

Sl. No.	Name of the Programme: M.E STRUCTURAL ENGINEERING					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	10	15	00	00	25
3.	PEC	03	06	06	00	15
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	01	00	08	12	21
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	**TOTAL CREDIT**	**20**	**21**	**17**	**12**	**70**

MA4153 **ADVANCED MATHEMATICAL METHODS** **L T P C**
4 0 0 4

OBJECTIVES :

- The main objective of this course is to provide the student with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering. This course covers a broad spectrum of mathematical techniques such as Laplace Transform, Fourier Transform, Calculus of Variations, Conformal Mapping and Tensor Analysis. Application of these topics to the solution of problems in physics and engineering is stressed.

UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS **12**

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

UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS **12**

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

UNIT III CALCULUS OF VARIATIONS **12**

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

UNIT IV CONFORMAL MAPPING AND APPLICATIONS **12**

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

UNIT V TENSOR ANALYSIS **12**

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

TOTAL : 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
- Maximizing and minimizing the functional that occur in various branches of Engineering Disciplines.
- Construct conformal mappings between various domains and use of conformal mapping in studying problems in physics and engineering particularly to fluid flow and heat flow problems.
- Understand tensor algebra and its applications in applied sciences and engineering and develops ability to solve mathematical problems involving tensors.
- Competently use tensor analysis as a tool in the field of applied sciences and related fields.

REFERENCES:

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. Mathews, J. H., and Howell, R.W., "Complex Analysis for Mathematics and Engineering", 6th Edition, Jones and Bartlett Publishers, 2011.
4. Kay, D. C., "Tensor Calculus", Schaum's Outline Series, Tata McGraw Hill Edition, 2014.
5. Naveen Kumar, "An Elementary Course on Variational Problems in Calculus ", Narosa Publishing House, 2005.
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", 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
8. Spiegel, M.R., "Theory and Problems of Complex Variables and its Applications", Schaum's Outline Series, McGraw Hill Book Co., 1981.
9. Ramaniah. G. "Tensor Analysis", S. Viswanathan Pvt. Ltd., 1990.

ST4101 THEORY OF ELASTICITY AND PLASTICITY L T P C
3 1 0 4

OBJECTIVE:

- To develop the ability to use the principles of theory of elasticity in engineering problems and to introduce theoretical fundamentals of theory of plasticity

UNIT I ELASTICITY 12

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

UNIT II 2D STRESS STRAIN PROBLEMS 12

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

UNIT III TORSION OF NON-CIRCULAR SECTION 12

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 - Finite Difference Method

UNIT IV BEAMS ON ELASTIC FOUNDATIONS 12

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 – Solution by Finite Differences.

UNIT V PLASTICITY 12

Physical Assumptions – Yield Criteria – Failure Theories –Thick Cylinder – Plastic Stress Strain Relationship - Bending and Torsion in Elasto-Plastic Materials -Strain hardening Materials

TOTAL :60 PERIODS

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

- **CO1** Derive and write the fundamental equations of elasticity describing the linear behavior of element and develop constitutive models based on material behavior
- **CO2** Demonstrate the application of plane stress and plane strain in a given situation in both cartesian and polar coordinate systems
- **CO3** Solve torsion problems in circular and non-circular cross-sections
- **CO4** Analyse beams resting on elastic foundations
- **CO5** Solve analytically the simple boundary value problems with elasto-plastic and strain hardening properties

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. Chakrabarty.J, “Theory of Plasticity”, Third Edition, Elsevier Butterworth - Heinmann – UK, 2007.
3. Jane Helena H, "Theory of Elasticity and Plasticity", PHI, New Delhi 2017.
4. Slater R.A.C, “Engineering Plasticity”, John Wiley and Son, New York, 1977.
5. Timoshenko, S. and GoodierJ.N."Theory of Elasticity", Third Edition, McGraw Hill Book Co., New York, 2017.

ST4102 STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING L T P C
3 1 0 4

OBJECTIVE:
- To make the students understand the basics of structural dynamics and earthquake engineering and to develop the ability to design a earthquake resistant structure ,

UNIT I PRINCIPLES OF VIBRATION ANALYSIS 12
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 12
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 12
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 12
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 12

Structural Systems - Types of Buildings - Causes of damage - Planning Considerations – effect of material of construction on 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: 60 PERIODS

OUTCOMES:

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

CO1 Do vibration analysis of system/structures with single degree of freedom and can explain the method of damping the systems

CO2 Do dynamic analysis of system/structures with Multi degrees of freedom under free and forced vibration

CO3 Derive a mathematical model of continuous system and do a dynamic analysis under free and forced vibration

CO4 Explain the causes and effect of earthquake

CO5 Design masonry and RC structures to the earthquake forces as per there commendations of IS codes of practice

REFERENCES:

1. Anil K.Chopra, Dynamics of Structures, Fifth edition, Pearson Education, 2017.
2. Leonard Meirovitch, Elements of Vibration Analysis, McGraw Hill, 1986, IOS Press, 2006.
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, 2011
6. Mohiuddin Ali Khan "Earthquake-Resistant Structures: Design, Build and Retrofit", Elsevier Science& Technology, 2012
7. Pankaj Agarwal and Manish Shrikhande, "Earthquake Resistant Design of Structures",Prentice Hall of India, 2009.
8. Paulay.T and Priestley M.J.N., "Seismic Design of Reinforced Concrete and MasonryBuildings", John Wiley and Sons, 1992.
9. Duggal S K, "Earthquake Resistant Design of Structures", Oxford University Press, 2007.
10. Madhujit Mukhopadhyay ," Structural Dynamics: Vibrations and Systems",Ane's Student Edition,2008

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL:30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

ST4161 ADVANCED CONSTRUCTION ENGINEERING AND EXPERIMENTAL TECHNIQUES LABORATORY

L	T	P	C
0	0	4	2

A) ADVANCED CONSTRUCTION ENGINEERING LABORATORY

OBJECTIVE:

- To provides a thorough knowledge of material selection through the material testing based on specification

LIST OF EXPERIMENTS

1. Mix design of concrete as per IS, ACI & BS methods for high performance concrete.
2. Flow Characteristics of Self Compacting concrete.
3. Effect of minerals and chemical admixtures in concrete at fresh and hardened state with relevance to workability, strength and durability.
4. NDT on hardened concrete - UPV, Rebound hammer and core test.
5. Permeability test on hardened concrete (RCPT) – Demonstration

TOTAL : 30 PERIODS

OUTCOMES:

On completion of the course the student will be able to

CO1 Do the mix proportion using IS and ACI codal provisions.

CO2 Test the concrete in a non-destructive manner using rebound hammer.

CO3 Know the permeability characteristics of concrete.

B) EXPERIMENTAL TECHNIQUES LABORATORY

OBJECTIVE:

- To provide a detailed account of modern experimental techniques in construction Engineering research.
- To introduce the basic working principles, the operational know how, and the strength and limitations of the techniques.

LIST OF EXPERIMENTS

1. Determination of elastic constants – Hyperbolic fringes
2. Determination of elastic constants – Elliptical fringes
3. Strain gauge meter – Determination of Young's modulus of a metallic wire
4. Ultrasonic interferometer – ultrasonic velocity in liquids
5. Electrical conductivity of metals and alloys with temperature-four probe method
6. Resistivity measurements
7. NDT – Ultrasonic flaw detector
8. Calibration of Proving Ring and LVDT

TOTAL : 30 PERIODS

OUTCOMES:

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

CO1 Gain practical knowledge by applying the experimental methods to correlate with the theory.
CO2 Learn the usage of electrical and optical systems for various measurements.
CO3 Apply the analytical techniques and graphical analysis to interpret the experimental data

ST4111 TECHNICAL SEMINAR **L T P C**
0 0 2 1

OBJECTIVE:

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

SYLLABUS: The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to Structural Engineering and to engage in dialogue with the audience. A brief copy of their talk 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 also answer the queries on the topic. The students as audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

TOTAL: 30 PERIODS

OUTCOMES:

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

CO1 Identify latest developments in the field of Structural Engineering
CO2 Acquire technical writing abilities for seminars, conferences and journal publications
CO3 Use modern tools to present the technical details

ST4201 ADVANCED STEEL STRUCTURES L T P C
3 1 0 4

OBJECTIVE:

- To study the behaviour of members, connections and industrial buildings

UNIT I GENERAL 12

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 12

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 12

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 12

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 12

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: 60 PERIODS

OUTCOMES:

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

CO1 Design the steel members such as purlins, gable wind girders subjected to combined forces

CO2 Explain and design different types of steel connections such as welded and bolted flexible as well as moment resisting connections

CO3 Analyze and design industrial structures such as trusses and portal frames subjected to wind and seismic forces

CO4 Explain the effect of axial force and shear force on steel structures and analyse continuous beams and frames using plastic theory

CO5 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, 1990.
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, 1996
5. S.K. Duggal, Limit State Design of Steel Structures, McGraw Hill Book Company, 2017

ST4202 ADVANCED CONCRETE STRUCTURES L T P C
3 1 0 4

OBJECTIVE:

- To make the students be familiar with behaviour of RCC beams and columns and to design special structural members with proper detailing

UNIT I BEHAVIOUR AND DESIGN OF R.C. BEAMS 12

Properties and behaviour of concrete and steel – Behaviour and design of R.C. beams in flexure, shear and torsion - modes of failure - calculations of deflections and crack width as per IS 456.

UNIT II BEHAVIOUR AND DESIGN OF R.C. COLUMNS 12

Behaviour of short and long columns - behaviour of short column under axial load with uniaxial and bi-axial moments - construction of P_u - M_u interaction curves - Design of slender columns -

UNIT III DESIGN OF SPECIAL R.C. ELEMENTS 12

Design of RC walls - design of corbels - strut and tie method - design of simply supported and continuous deep beams - analysis and design of grid floors.

UNIT IV FLAT SLABS AND YIELD LINE BASED DESIGN 12

Design of flat slabs according to IS method – Check for shear - Design of spandrel beams - Yield line theory and design of slabs - virtual work method - equilibrium method.

UNIT V INELASTIC BEHAVIOUR OF CONCRETE STRUCTURES 12

Inelastic behaviour of concrete beams - Moment-curvature curves - moment redistribution - Concept of Ductility – Detailing for ductility – Design of beams, columns for ductility - Design ofcast-in-situ joints in frames.

TOTAL: 60 PERIODS

OUTCOMES:

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

CO1 Explain structural behaviour of flexural members and columns
CO2 Design compression members and construct interaction diagrams
CO3 Design the special elements like corbels, deep beams and grid floors
CO4 Design flat slab and spandrel beams
CO5 Predict the moment curvature behavior and design and detail concrete elements based on ductility

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, 2017.
4. Varghese, P.C, “Advanced Reinforced Concrete Design”, Prentice Hall of India, 2005.
5. Sinha.S.N., Reinforced Concrete Design", Tata McGraw Hill publishing company Ltd.2014

ST4203 FINITE ELEMENT ANALYSIS IN STRUCTURAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To make the students understand the basics of the Finite Element Technique, and to cover the analysis methodologies for 1-D, 2-D and 3-D Structural Engineering problems.

UNIT I INTRODUCTION 9

Introduction - Basic Concepts of Finite Element Analysis - Introduction to Elasticity- Steps in Finite Element Analysis - Finite Element Formulation Techniques - Virtual Work and Variational Principle - Galerkin Method - Finite Element Method: Displacement Approach - Stiffness Matrix and Boundary Conditions

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 FRAME STRUCTURES 9

Stiffness of Truss Members-Analysis of Truss-Stiffness of Beam Members-Finite Element Analysis of Continuous Beam-Plane Frame Analysis-Analysis of Grid and Space Frame

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 -Introduction to Finite Strip Method - Finite Element Analysis of Shell -Finite Elements for Elastic Stability - Dynamic Analysis

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Formulate a finite element problem using basic mathematical principles
CO2 Explain the various types of elements and select the appropriate element for modelling
CO3 Analyse a frame using truss element
CO4 Formulate and analyse two and three dimensional solid finite element problems
CO5 Analyse shells, thick and thin plate and explain dynamic analysis in FEM

REFERENCES:

1. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
2. Logan D. L.,A First Course in the Finite Element Method, Thomson- Engineering, 3rd edition, 2001.
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., 1999.

ST4211 NUMERICAL AND FINITE ELEMENT ANALYSIS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To introduce the solving of mathematical equations and finite element analysis with computational like MATLAB and Finite element software like ANSYS, ABAQUS etc

EXPERIMENTS/ EXERCISES

1. Dynamic analysis of frame using mathematical computational software
2. Finite Element Analysis of 2D truss and 3D space trusses
3. Modelling and Finite Element Analysis of RC beams and slabs
4. Finite Element Analysis of thin and thick plates
5. Stability analysis using FEM

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course the student will be able to carry out

CO1 Dynamic analysis of frames
CO2 Analysis of thin and thick plates
CO3 Stability Analysis

ST4212 STRUCTURAL DESIGN STUDIO L T P C
0 0 4 2

OBJECTIVE:

- To design a structure using modern software tools available like ETABS, STAAD, STRAP etc. and present it in the form of complete detail 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 student in the form of a report and presentation.

TOTAL: 60 PERIODS

OUTCOMES:

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

CO1 Analyze the structure for various loads and load combination according to the relevant IS codes
CO2 Design and detail structures using computer software/tools and check the correctness using manual approximate methods
CO3 Prepare the complete structural drawings using computer software

ST4311 PRACTICAL TRAINING (4 Weeks) L T P C
0 0 0 2

OBJECTIVE:

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to Structural Engineering in carrying out engineering tasks.

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 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.

OUTCOME:

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

CO1 Describe the Structural Engineering organization
CO2 Realize the various functions of construction activities
CO3 Gain understanding of groups and group dynamics

ST4312 **PROJECT WORK I** **L T P C**
0 0 12 6

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.

SYLLABUS:

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

TOTAL: 180 PERIODS

OUTCOME:

- On completion of the course, the student will be able to

CO1 Apply the knowledge gained from theoretical and practical courses in solving problems
CO2 Recognize the importance of literature review
CO3 Report and present the findings of the work conducted.

ST4411 **PROJECT WORK II** **L T P C**
0 0 24 12

OBJECTIVES:

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

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 examiner.

TOTAL: 360 PERIODS

OUTCOME:

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

CO1 Discover potential research areas in the field of Structural Engineering.

CO2 Apply the knowledge gained from theoretical and practical courses to be creative, well planned, organized and coordinated

CO3 Report and present the findings of the work conducted.

ST4001 NON-LINEAR ANALYSIS OF STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To study the concept of non-linear behaviour and analysis of elements and simple structures.

UNIT I INTRODUCTION TO NON-LINEAR ANALYSIS 9

Material non-linearity, geometric non-linearity; 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 geometric and material non-linearity; 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 NON-LINEAR VIBRATION AND INSTABILITY 9

Nonlinear vibration and Instabilities of elastically supported beams.

TOTAL: 45 PERIODS

OUTCOME:

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

CO1 Analyze bar system considering material and geometric nonlinearity

CO2 Perform inelastic analysis flexural members

CO3 Perform vibration analysis of flexural members

CO4 Perform elastic and inelastic analysis of Plates

CO5 Perform nonlinear and instability analysis of elastically supported beams

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.

ST4002 **STRUCTURAL STABILITY** **L T P C**
3 0 0 3

OBJECTIVE:

- To study the concept of buckling and analysis of structural elements

UNIT I BUCKLING OF COLUMNS **9**

States of equilibrium - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis. Governing equation for column buckling - critical load using Equilibrium, Energy methods - Approximate methods - Rayleigh Ritz, Galerkins approach - Numerical Techniques - Finite difference method.

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 and end couples - Analysis of rigid jointed frames with and without sway – Use of stability function to determine the critical load.

UNIT III TORSIONAL AND LATERAL BUCKLING **9**

Torsional buckling – Combined Torsional and flexural buckling - Local buckling - Buckling of Open Sections - Lateral buckling of beams - simply supported and cantilever beams.

UNIT IV BUCKLING OF PLATES **9**

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

UNIT V INELASTIC BUCKLING **9**

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

TOTAL: 45 PERIODS

OUTCOME:

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

- **CO1** explain the phenomenon of buckling of columns and calculate the buckling load on column by various approaches
- **CO2** estimate the buckling load of beam – columns and frames
- **CO3** explore the concepts of torsional and lateral buckling of thin walled members
- **CO4** explain the phenomenon of buckling of plates
- **CO5** analyze the inelastic buckling of columns and plates

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.M.L, "Stability Analysis and Design of Structures", springer, New York, 2013.
4. Simitser.G.J and Hodges D.H, "Fundamentals of Structural Stability", Elsevier Ltd., 2006.
5. Timoshenko.S.P, and Gere.J.M, "Theory of Elastic Stability", McGraw Hill Book Company,1963

ST4003 **WIND AND CYCLONE EFFECTS ON STRUCTURES** **L T P C**
3 0 0 3

OBJECTIVE:

- To study the concept of wind and cyclone effects for the analysis and design of structures.

UNIT I INTRODUCTION **9**

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

UNIT II EFFECT OF WIND ON STRUCTURES 9

Classification of structures – Rigid and Flexible – Effect of wind on structures –Vortex shedding, translational vibration of structures - Static and dynamic effects on Tall buildings – Chimneys

UNIT III DESIGN OF SPECIAL STRUCTURES 9

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

UNIT IV 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.

UNIT V WIND TUNNEL STUDIES 9

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

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to
  - **CO1** Explain the characteristics of wind
  - **CO2** Evaluate the intensity of wind on structures
  - **CO3** Design some special structures subjected to wind loading
  - **CO4** Design of structures for cyclone
  - **CO5** Model and analyse a structure in a wind tunnel

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.

ST4004 PREFABRICATED STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To study the design principles, analysis and design of Prefabricated structures.

UNIT I DESIGN PRINCIPLES 9

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.

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 and column to column.

UNIT III FLOORS, STAIRS AND ROOFS 9

Types of floor slabs, analysis and design example of cored and panel types and two-way systems, Design analysis for product manufacture, handling and erection, staircase slab, 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, Partition and load bearing walls, Hoisting and placing,load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design,Leak prevention, joint sealants, sandwich wall panels, Lateral load resistance, Location and types of shear walls, 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. Cylindrical, Folded plate and paraboloid shells, Erection and jointing of components in industrial buildings.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to
  - **CO1** Explain the design principles involved in prefabrication
  - **CO2** Detail the different types of connection
  - **CO3** Design for stripping forces during manufacture
  - **CO4** Determine the forces in shear walls
  - **CO5** Identify the different roof trusses used in industrial buildings

REFERENCES:

1. Hubert Bachmann and Alfred Steinle , Precast Concrete Structures, 2012.
2. Koncz.T. Manual of Precast Concrete Construction, Vol.I II and III & IV Bauverlag, GMBH, 1971.
3. Laszlo Mokk, Prefabricated Concrete for Industrial and Public Structures, AkademiaiKiado, Budapest, 2007.
4. Lewicki.B, Building with Large Prefabricates, Elsevier Publishing Company, 1988.
5. Structural Design manual, Precast concrete connection details, Society for studies in the use of Precast concrete, Netherland BetorVerlag, 2009.

CN4071 ADVANCED CONCRETE TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE:

- To study the properties of concrete making materials, tests, mix design, special concretes and various methods for making 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

OUTCOME:

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

- **CO1** Develop knowledge on various materials needed for concrete manufacture
- **CO2** Apply the rules to do mix designs for concrete by various methods
- **CO3** Develop the methods of manufacturing of concrete.
- **CO4** Explain about various special concrete
- **CO5** Explain various tests on fresh and hardened concrete

REFERENCES:

1. Gambhir.M.L. Concrete Technology, Fifth Edition, McGraw Hill Education, 2017.
2. Gupta.B.L., Amit Gupta, "Concrete Technology, Jain Book Agency, 2010.
3. Neville, A.M., Properties of Concrete, Prentice Hall, 1995, London.
4. Shetty M.S., Concrete Technology, Revised Edition, S.Chand and Company Ltd. Delhi, 2006.
5. Job Thomas., Concrete Technology, Cencage learning India Private Ltd, New Delhi, 2015.

ST4071 ADVANCED PRESTRESSED CONCRETE L T P C
3 0 0 3

OBJECTIVE:

- Principle of prestressing, analysis and design of prestressed concrete structures**.**

UNIT I PRINCIPLES OF PRESTRESSING 9

Basic concepts of Prestressing – Types and systems of prestressing – Need for High Strength materials, Analysis methods, losses of prestress – Short and Long term deflections – Cable layouts.

UNIT II DESIGN OF FLEXURAL MEMBERS 9

Behaviour of flexural members, determination of ultimate flexural strength – Various Codal provisions – Design of flexural members, Design for shear, bond and torsion. Transfer of prestress – Box girders.

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 – Analysis and design of cantilever beams.

UNIT IV DESIGN OF TENSION AND COMPRESSION MEMBERS 9

Design of tension members – application in the design of prestressed pipes and prestressed concrete cylindrical water tanks – Design of compression members with and without flexure – its application in the design piles, flag masts and similar structures.

UNIT V DESIGN OF COMPOSITE MEMBERS 9

Composite beams – analysis and design, ultimate strength – their applications. Partial prestressing – its advantages and applications.

TOTAL: 45 PERIODS

OUTCOME:

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

CO1 Identify the various methods of prestressing
CO2 Design the beams for shear, bond and torsion
CO3 Design the continuous beams
CO4 Design the water tank, piles and masts
CO5 Analyze and design the composite beams

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.andBurns.H "Design of Prestressed Concrete Structures", John Wiley and Sons Inc, 3rd Edition, 2010.
4. Rajagopalan.N, "Prestressed Concrete", Narosa Publications, New Delhi, 2014.
5. Sinha.N.C.and.Roy.S.K, "Fundamentals of Prestressed Concrete", S.Chand and Co., 1998.

ST4005 RELIABILITY ANALYSIS OF STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To develop knowledge to solve structural analysis problems using reliability concepts.

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

OUTCOME:

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

- **CO1** Achieve Knowledge of design and development of problem solving skills.
- **CO2** Understand the principles of reliability.
- **CO3** Design and develop analytical skills.
- **CO4** Summarize the Probability distributions
- **CO5** Understands the concept of System reliability.

REFERENCES:

1. A Papoulis, Probability, Random Variables and Stochastic Processes, McGraw-Hill, New York, 1993.
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.
5. Jack R Benjamin, C. Allin Cornell, Probability, Statistics, and Decision for Civil Engineers, Dover Publications, New York, 2014.

ST4006 DESIGN OF FORMWORK L T P C
3 0 0 3

OBJECTIVE:

- To study and understand the detailed planning of formwork, Design of forms for various elements such as foundation, slabs, beams, columns and walls.

UNIT I INTRODUCTION 9

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

UNITII FORMWORK MATERIALS AND TYPES 9

Timber, Plywood, Steel, Aluminium, Plastic, and Accessories. Horizontal and Vertical Formwork Supports. 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

OUTCOME:

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

CO1 Select proper formwork, accessories and material
CO2 Design the form work for Beams, Slabs, columns, Walls and Foundations
CO3 Design the form work for Special Structures
CO4 Describe the working of flying formwork.
CO5 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.

ST4073 MAINTENANCE, REPAIR AND REHABILITATION OF STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To study the damages, repair and rehabilitation of structures

UNIT I MAINTENANCE AND REPAIR STRATEGIES 9

Maintenance, Repair and Rehabilitation, retrofit and strengthening, need for rehabilitation of structures Facets of Maintenance, importance of Maintenance, routine and preventive maintenance, causes of deterioration. Non-destructive Testing Techniques

UNIT II STRENGTH AND DURABILITY OF CONCRETE 9

Quality assurance for concrete based on Strength and Durability - Thermal properties, microstructure of concrete – packing density- Cracks, different types, causes – Effects due to climate, temperature, Sustained elevated temperature, Corrosion

UNIT III REPAIR MATERIALS AND SPECIAL CONCRETES 9

Repair materials-Various repair materials, Criteria for material selection, Methodology of selection, Health and safety precautions for handling and applications of repair materials, Special mortars and concretes- Polymer Concrete and Mortar, Quick setting compounds, Grouting materials-Gas forming grouts, Sulfoalumate grouts, Polymer grouts, Acrylate and Urethane grouts, 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- self regulating anode - Corrosion protection techniques – Corrosion inhibitors, concrete coatings-Corrosion resistant steels, Coatings to reinforcement, cathodic protection, Structural health monitoring.

UNIT V REPAIR, REHABILITATION AND RETROFITTING OF STRUCTURES 9

Various methods of crack repair, Grouting, Routing and sealing, Stitching, Dry packing, Autogenous healing, Overlays, Repair to active cracks, Repair to dormant cracks. Corrosion of embedded steel in concrete, Mechanism, Stages of corrosion damage, Repair of various corrosion damaged of structural elements (slab, beam and columns) Jacketing, Column jacketing, Beam jacketing, Beam Column joint jacketing, Reinforced concrete jacketing, Steel jacketing, FRP jacketing, Strengthening, Beam shear strengthening, Flexural strengthening

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Explain the importance of maintenance assessment of distressed structures
CO2 Apply the knowledge on Quality assurance for concrete based on Strength and Durability
CO3 Identify various repair materials and advancements in concrete
CO4 Explain the knowledge on Concrete protection methods Structural health monitoring
CO5 Select Various strengthening and repair methods for different cases

REFERENCES:

1. Dodge Woodson, Concrete Structures, Protection, Repair and Rehabilitation, Butterworth-Heinemann,Elsevier,New Delhi 2012
2. DovKominetzky.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

ST4007 MECHANICS OF FIBER REINFORCED POLYMER COMPOSITE MATERIALS

L T P C
3 0 0 3

OBJECTIVE:

- To study the behaviour of composite materials and to investigate the failure and fracture characteristics.

UNIT I INTRODUCTION **9**

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

UNIT II STRESS STRAIN RELATIONS **9**

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

UNIT III ANALYSIS OF LAMINATED COMPOSITES **9**

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

UNIT IV FAILURE AND FRACTURE OF COMPOSITES **9**

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

UNIT V APPLICATIONS AND DESIGN 9

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

TOTAL: 45 PERIODS

OUTCOME:

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

- **CO1** Explain the various types of composites and its constituents
- **CO2** Derive the constitutive relationship and determine the stresses and strains in a composite material
- **CO3** Analyze a laminated plate
- **CO4** Explain the various failure criteria and fracture mechanics of composites
- **CO5** Design simple composite elements

REFERENCES

1. Agarwal.B.D. Broutman.L.J. and Chandrashekara.K. “Analysis and Performance of Fiber Composites”, 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, India, 2005.

ST4008 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To develop an understanding of the behaviour and design concrete composite elements and structures.

UNIT I INTRODUCTION 9

Introduction to steel – concrete composite construction – 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 –Design concepts of box girder bridges and corrugated web girder bridges

UNIT V CASE STUDIES 9

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

TOTAL: 45 PERIODS

OUTCOME:

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

CO1 Explain composite action
CO2 Design composite elements
CO3 Design connections
CO4 Explain the concept of design of composite box girder bridges
CO5 Study and evaluate case studies

REFERENCES:

1. Johnson R.P., "Composite Structures of Steel and Concrete Beams, Slabs, Columns and Frames for Buildings", Vol.I, Fourth Edition, Blackwell Scientific Publications, 2018
2. Oehlers D.J. and Bradford M.A., "Composite Steel and Concrete Structural Members, Fundamental behaviour", Revised Edition, Pergamon press, Oxford, 2000.
3. Owens.G.W and Knowles.P, "Steel Designers Manual", Seventh Edition, Steel Concrete Institute(UK), Oxford Blackwell Scientific Publications, 2011.
4. Narayanan R, "Composite steel structures – Advances, design and construction", Elsevier, Applied science, UK, 1987
5. Teaching resource for, "Structural Steel Design," Volume 2 of 3, Institute for Steel Development and Growth (INSDAG), 2002.

ST4009 DESIGN OF MASONRY STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To design, detail and retrofit a masonry structure

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

OUTCOMES:

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

CO1 Explain the properties of a masonry unit and the various components
CO2 Design a masonry structure for compression
CO3 Design a masonry structure for lateral loads
CO4 Design a earthquake resistant masonry wall
CO5 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, 1997.
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.

ST4010 DESIGN OF INDUSTRIAL STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To disseminate knowledge about planning and design of RCC and Steel Industrial structures**.**

UNIT I PLANNING AND FUNCTIONAL REQUIREMENTS 9

Classification of Industries and Industrial structures - planning for Layout Requirements regarding Lighting, Ventilation and Fire Safety - Protection against noise and vibration - Guidelines 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

OUTCOME:

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

CO1 Develop the concept of planning & functional requirement of industrial standards.
CO2 Analyse and design of Steel Gantry girders & Crane girders and RCC design of corbels, nibs and staircase.
CO3 Analyse & design of cooling towers, bunker, silos and pipe supportingstructures.
CO4 Analyse and design of Steel transmission line towers and chimneys.
CO5 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.2006.
4. N.Subramaniyan, Design of Steel Structures, United Press, 2016
5. N. Krishna Raju, Advanced Reinforced concrete Design, 3rd edition 2016,

ST4011 ADVANCED DESIGN OF FOUNDATION STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To design various types of foundations to fulfill the required criteria.

UNIT I SHALLOW FOUNDATIONS 9

soil investigation – Types of foundations and their specific applications – depth of foundation – bearing capacity and settlement estimates – structural design of isolated, strip, rectangular and trapezoidal and combined footings – strap – raft foundation.

UNIT II PILE FOUNDATIONS 9

Types of Pile foundations and their applications – Load Carrying capacity – pile load test – Settlements – Group action – pile cap – structural design of piles and pile caps – undreamed pile foundation.

UNIT III WELL FOUNDATION 9

Types of well foundations – grip length – load carrying capacity – construction of wells – failure and remedies – structural design of well foundation – lateral stability.

UNIT IV MACHINE FOUNDATIONS 9

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

UNIT V SPECIAL FOUNDATIONS 9

General requirements and design criteria – Foundations for towers, Chimneys and Silos – design of anchors

TOTAL: 45 PERIODS

OUTCOME:

On completion of this course student will be able to

CO1 Design shallow and deep foundations for various types of structures
CO2 Design piles and pile caps
CO3 Design well foundation for bridge piers and related structures
CO4 Gain knowledge on design and construction of machine foundation
CO5 Design foundations for bridges, towers and chimneys

REFERENCES:

1. Tomlinson, M.J. and Boorman. R., Foundation Design and Construction, ELBS Longman, Seventh Edition, 2001.
2. Nayak, N.V., Foundation Design manual for Practicing Engineers, Dhanpat Rai and Sons, 2012.
3. Brain J. Bell and M.J. Smith, Reinforced Concrete Foundations, George Godwin Ltd., 1981.
4. Braja M. Das, Principles of Foundations Engineering, Eighth Edition, Thomson Asia (P) Ltd., 2015.
5. Bowels J.E., Foundation Analysis and Design, Fifth Edition, McGraw-Hill International Book Co., 2017.

ST4012 OPTIMIZATION OF STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To study the optimization methodologies applied to structural engineering

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

UNIT III GEOMETRIC PROGRAMMING 9

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

UNIT IV DYNAMIC PROGRAMMING 9

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

UNIT V STRUCTURAL APPLICATIONS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Apply the knowledge of engineering fundamentals to formulate and solve the engineering problems by classical optimization techniques.
CO2 Identify, formulate and solve engineering problems by linear and non-linear programming.
CO3 Analyse the problem and reducing G.P.P to a set of simultaneous equations.
CO4 Apply the Engineering knowledge to understand the concept of dynamic programming
CO5 Design various structural elements with minimum weight.

REFERENCES:

1. Iyengar.N.G.R and Gupta.S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997
2. Rao,S.S. "Engineering Optimization: Theory and Practice", Fourth Edition, Wiley Eastern (P) Ltd., 2013.
3. Spunt, "Optimization in Structural Design", Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey 1971.
4. Uri Kirsch, "Optimum Structural Design", McGraw Hill Book Co. 1981.
5. Haftka, R. T. and Gurdal, Z., Elements of Structural Optimization, Springer, 3 rd Edition, 1992

ST4013 STRUCTURAL HEALTH MONITORING L T P C
3 0 0 3

OBJECTIVE:

- To make the students familiar with various structural health monitoring tools and techniques.

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, Focusing array/SAFT imaging

UNIT V DATA PROCESSING AND CASE STUDIES 9

Advanced signal processing methods -Wavelet, Hilbert-Huang transform, Neural networks, 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

OUTCOME:

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

- **CO1** Understand the need, advantages and challenges of SHM
- **CO2** Know the different types of sensors and instrumentation techniques
- **CO3** Gain knowledge on the static and dynamic measurement techniques
- **CO4** Compare the various damage detection techniques
- **CO5** 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.

ST4014 DESIGN OF OFFSHORE STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge about the concept of wave theories, forces, offshore foundation, analysis and design of jacket towers, pipes and cables**.**

UNIT I WAVE THEORIES 9

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

UNIT II FORCES OF OFFSHORE STRUCTURES 9

Wind forces, wave forces on small bodies and large bodies - current forces - Morison equation.

UNIT III OFFSHORE SOIL AND STRUCTURE MODELLING 9

Different types of offshore 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.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, the student is expected to be able to
  - **CO1** Develop the concept of wave theories
  - **CO2** Apply the knowledge of wave forces and offshore structures
  - **CO3** Explain the modeling for offshore structure and its foundation
  - **CO4** Analyse offshore structures by means of static and dynamic methods
  - **CO5** Design of jacket towers, mooring cables and pipelines

REFERENCES:

1. Chakrabarti, S.K., Handbook of Offshore Engineering by, Elsevier, 2005.
2. Chakrabarti, S.K., Hydrodynamics of Offshore Structures, Springer – Verlag, 2003.
3. Chakrabarti, S.K. 1994, Offshore Structure Modelling: World Scientific
4. Chandrasekaran, S. 2017. Dynamic analysis and design of ocean structures.
5. B. Gou, S.Song, J Chacko and A. Ghalambar, offshore pipelines, GPP publishers, 2006.

ST4015 PERFORMANCE OF STRUCTURES WITH SOIL STRUCTURE INTERACTION **L T P C**
3 0 0 3

OBJECTIVE:

- To study the concept of soil-structure – interaction in the analysis and design of structures.

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.

UNITIII 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

UNITV GROUND-FOUNDATION-STRUCTURE INTERACTION **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to
  - **CO1** Explain the concept of soil structure interaction.
  - **CO2** Do a static analysis of infinite and finite beams resting on elastic foundation
  - **CO3** Analyse finite thin and thick plates
  - **CO4** Do a static and dynamic analysis of soil structure interaction problems
  - **CO5** 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., New York., 1974
3. Desai C.S. and Christian J.T., "Numerical Methods in Geotechnical Engineering" McGraw Hill 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.

ST4072 DESIGN OF BRIDGE STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To study the loads, forces on bridges and design principles of several types of bridges.

UNIT I INTRODUCTION 9

Introduction-Selection of Site and Initial Decision Process - Classification of Bridges- General Features of Design- Standard Loading for Bridge Design as per different codes - Road Bridges – Railway Bridges - Design Codes - Working Stress Method- Limit State Method of Design

UNIT II SUPERSTRUCTURES 9

Selection of main bridge parameters, design methodologies -Choices of superstructure types - Orthotropic plate theory, load distribution techniques - Grillage analysis - Finite element analysis Different types of superstructure (RCC and PSC); Longitudinal Analysis of Bridge - Transverse Analysis of Bridge

UNIT III BRIDGE DESIGN PRINCIPLES 9

Analysis and Design of RCC solid slab culverts -Design of RCC Tee beam and slab bridges - Design principles of continuous girder bridges, box girder bridges, balanced cantilever bridges – Arch bridges – Box culverts – Segmental bridges–Design principles only

UNIT IV SUBSTRUCTURE, BEARINGS AND DECK JOINTS 9

Design of bridge bearings and substructure

UNIT V PRESTRESSED CONCRETE BRIDGES & STEEL BRIDGES 9

Design principles of PSC bridges – PSC girders –Design principles of steel bridges - Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of this course student will be able to

CO1 Explain the different types of bridges and design philosophies
CO2 Design a RC solid slab culvert bridge
CO3 Design a RC Tee Beam and Slab bridge
CO4 Design the bridge bearings and substructure
CO5 Explain the design principles of PSC bridges, box girder bridges, truss bridges

REFERENCES:

1. Jagadeesh.T.R. and Jayaram.M.A., “Design of Bridge Structures”, Second Edition, Prentice Hall of IndiaPvt. Ltd. 2009.
2. Johnson Victor, D. “Essentials of Bridge Engineering”, Sixth Edition, Oxford and IBH Publishing Co. New Delhi, 2018.
3. Ponnuswamy, S., “Bridge Engineering”, Third Edition, Tata McGraw Hill, 2017.
4. Raina V.K.” Concrete Bridge Practice” Tata McGraw Hill Publishing Company, New Delhi,1991.
5. Design of Highway Bridges, Richard M. Barker & Jay A. Puckett, John Wiley & Sons, Inc., 2007

ST4016 DESIGN OF SHELL AND SPATIAL STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- Study the behaviour and design of shells, folded plates, space frames and application of FORMIAN software.

UNITI 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.

UNIT II FOLDED PLATES 9

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

OUTCOME:

- On completion of this course, the student is expected to be able to
  - **CO1** Explain the different forms of shells and design the domes and shells
  - **CO2** Evaluate the structural behaviour and design of folded plate structures
  - **CO3** Explain the various functional configurations of space frames
  - **CO4** Design of space frames and apply the knowledge of CAD for the analysis of space structures
  - **CO5** Analyse the configurations of space structures using FORMIAN software

REFERENCES

1. Billington.D.P, “Thin Shell Concrete Structures”, McGraw Hill Book Co., New York, ASCE Manual No.31, Design of Cylindrical Shells,1982.
2. Varghese.P.C., Design of Reinforced Concrete Shells and Folded Plates, PHI Learning Pvt. Ltd., 2010.
3. Subramanian.N,” Space Structures: Principles and Practice”, Multi-Science Publishing Co. Ltd. 2008.
4. Ramasamy, G.S., “Analysis, Design and Construction of Steel Space Frames”, Thomas Telford Publishing, 2002.
5. Wilby.C “Concrete Folded Plate Roofs”, Elsevier, 1998.

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

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

AX4092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX4093 CONSTITUTION OF INDIA L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

- The Constitution of India,1950(Bare Act),Government Publication.
- Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094 நற்றமிழ் இலக்கியம்

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UNIT I சங்க இலக்கியம் **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை
   (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
   சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

UNIT V **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
- தமிழின் முதல் புதினம்,
- தமிழின் முதல் சிறுகதை,
- கட்டுரை இலக்கியம்,
- பயண இலக்கியம்,
- நாடகம்.
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,

6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்