PAAVAI ENGINEERNG COLLEGE

(Autonomous)

M.E. - STRUCTURAL ENGINEERING

REGULATIONS 2023

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

(For the candidates admitted during the Academic Year 2023-24)

SEMESTER I

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	FC	PMA23102	Advanced Mathematical Methods	3	1	0	4
2	MC	PEN23101	Research Methodology and IPR	3	0	0	3
3	PC	PSE23101	Matrix methods of structural analysis	3	1	0	4
4	PC	PSE23102	Theory of Elasticity and Plasticity	3	0	0	3
5	PC	PSE23103	Advanced Design of Reinforced Concrete Structures	3	0	0	3
6	PE	PSE23* **	Professional Elective I	3	0	0	3
7	AC	PAC23101	English for Research Paper Writing (Audit Course I)	2	0	0	0
Practical							
8	PC	PSE23104	Advanced Structural Engineering Laboratory	0	0	4	2
			TOTAL	**20**	**2**	**4**	**22**

SEMESTER II

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	PSE23201	Experimental Techniques and Instrumentation	3	1	0	4
2	PC	PSE23202	Structural Dynamics	3	0	0	3
3	PC	PSE23203	Advanced Steel Structures	3	0	0	3
4	PC	PSE23204	Finite Element Method	3	0	0	3
5	PE	PSE23***	Professional Elective II	3	0	0	3
6	PE	PSE23***	Professional Elective III	3	0	0	3
7	AC	PAC23201	Pedagogy Studies (Audit Course II)	2	0	0	0
Practical							
8	PC	PSE23205	Structural Design Studio	0	0	4	2
			TOTAL	**20**	**2**	**6**	**21**

SEMESTER III

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	PSE23301	Advanced Prestressed Concrete Structures	3	0	0	3
2	PE	PSE23***	Professional Elective IV	3	0	0	3
3	OE	PSE23901	Open Elective I	3	0	0	3
Practical							
4	EE	PSE23302	Practical Training (4 weeks)	0	0	2	1
5	EE	PSE23303	Technical Seminar	0	0	2	1
6	EE	PSE23304	Project Work (Phase I)	0	0	12	6
			TOTAL	**9**	**0**	**16**	**17**

SEMESTER IV

S.No.	Category	Course Code	Course Title	L	T	P	C
Practical							
1	EE	PSE23401	Project Work (Phase II)	0	0	24	12
			TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS: 72

LIST OF PROFESSIONAL ELECTIVES

S.NO	Category	Course Code	Course Title	L	T	P	C
1	PE	PSE23151	Structural Optimization	3	0	0	3
2	PE	PSE23152	Fracture Mechanics	3	0	0	3
3	PE	PSE23153	Advanced Concrete Technology	3	0	0	3
4	PE	PSE23154	Corrosion Engineering	3	0	0	3
5	PE	PSE23155	Design of Bridge Structures	3	0	0	3
6	PE	PSE23156	Structural Health Monitoring	3	0	0	3
7	PE	PSE23157	Performance of structures with Soil-Structure Interaction	3	0	0	3
8	PE	PSE23158	Rehabilitation and Retrofitting of Structures	3	0	0	3
9	PE	PSE23159	Design of Sub Structures	3	0	0	3
10	PE	PSE23160	Mechanics of Composite Materials	3	0	0	3
11	PE	PSE23161	Design of Shell and Spatial structures	3	0	0	3
12	PE	PSE23162	Design of Offshore Structures	3	0	0	3
13	PE	PSE23163	Industrial Structures	3	0	0	3
14	PE	PSE23164	Prefabricated Structures	3	0	0	3
15	PE	PSE23165	Design of Formwork	3	0	0	3
16	PE	PSE23166	Analysis and Design of Tall Buildings	3	0	0	3
17	PE	PSE23167	Stability of Structures	3	0	0	3
18	PE	PSE23168	Energy Efficient Buildings	3	0	0	3
19	PE	PSE23169	Earthquake Analysis and Design of Structures	3	0	0	3
20	PE	PSE23170	Wind and Cyclone Effects on Structures	3	0	0	3

OPEN ELECTIVE I

S.NO	Category	Course Code	Course Title	L	T	P	C
1	OE	PSE23901	Climate change and Adaptation	3	0	0	3
2	OE	PED23901	Industrial Safety	3	0	0	3
3	OE	PCS23901	Design of Digital Elements	3	0	0	3
4	OE	PCE23901	Big Data Analytics	3	0	0	3
5	OE	PPS23901	Alternate Energy Sources	3	0	0	3

PMA23102 **ADVANCED MATHEMATICAL METHODS** **3 1 0 4**

OBJECTIVES

To enable the students to

- study Laplace Transforms of various standard functions, periodic functions and understand the techniques of solving partial differential equations using Laplace Transform methods.
- study Fourier Transforms of various standard, periodic functions and understand the techniques of solving partial differential equations using Fourier Transform techniques.
- recognize the concept of calculus of variations applied in engineering disciplines
- understand the differential calculus of conformal mappings and bilinear transformations
- study tensor analysis as a tool in the field of applied sciences and related fields

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 dependent on first and higher order derivatives – Functional dependent on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems – Direct methods – Ritz and Kantorovich methods.

UNIT IV CONFORMAL MAPPING AND APPLICATIONS **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 PERIODS: 60

OUTCOMES

At the end of the course, the students will be able to

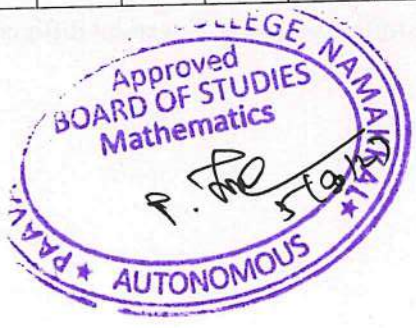
- application of Laplace and Fourier transforms to the initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
- maximizing and minimizing the functions that occur in various branches of Engineering disciplines.
- construct conformal mappings between various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

REFERENCE BOOKS

1. Sankara Rao, K., "Introduction to Partial Differential Equations", 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
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", 6 th Edition, Jones and Bartlett Publishers, 2011.
4. Naveen Kumar, "An Elementary Course on Variational Problems in Calculus ", Narosa Publishing House, 2005.
5. Murray R.Spiegel, "Complex Variables", II Edition, Schaum's outlines, 2009.

CO/PO Mapping:

Mapping of Course Outcomes with Programme Outcomes (3/2/1 indicates strength of correlation) 3- Strong, 2-Medium, 1-Weak														
COs	Programmes Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS O1	PS O2
CO1	3	3	2	2	-	-	-	-	-	-	-	3	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	2	-	-	-	-	-	-	-	3	-	-



PEN23101 **RESEARCH METHODOLOGY AND IPR** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the formulation of research problem
- be familiar with data collection and literature survey process
- know the statistical concepts in experimentation
- acquire knowledge in writing research proposal
- learn about patent rights and its importance

UNIT I RESEARCH PROBLEM FORMULATION **9**

Meaning of research, Objectives of Research, Types of research, Significance of Research, Research process, Selecting the problem, Necessity of defining the problem, Meaning of Research design, Need for research design, features of a good design, Different research designs.

UNIT II LITERATURE SURVEY **9**

Quantitative and Qualitative data, Scaling, Scaling Techniques, Experiments and Surveys, Collection of primary and secondary data, Data preparation process. Research problems, Effective literature studies approaches, Survey for existing literature, Procedure for reviewing the literature, Analysis and assessment.

UNIT III DESIGN OF EXPERIMENTS **9**

Strategy of Experimentation - Typical applications of experimental design, Guidelines for designing experiments; Basic statistical concepts - Statistical concepts in experimentation, Regression approach to analysis of variance.

UNIT IV RESEARCH PROPOSAL AND WRITING **9**

Contents of a research proposal, Writing a research report - Research writing in general, Referencing, Writing a bibliography, Presentation and assessment by a review committee, Plagiarism, Research ethics.

UNIT V INTELLECTUAL PROPERTY RIGHTS **9**

Intellectual Property - Definition, WTO, Fundamentals of Patent, Copyright, Rights of the owner, Term of copyright, Register of trademark, Procedure for trade mark, Term of trademark; New Developments in IPR- Administration of patent system, IPR of Biological Systems, Computer Software.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- identify research problems.
- collect and prepare suitable data for research.
- design experiments for different statistical concepts.
- write research proposals and reports.
- apply the research work for patent through IPR.

REFERENCES

1. C.R Kothari and Gaurav Garg, "Research Methodology Methods and Techniques", 4th Edition, New Age International Publishers, 2019.
2. Ranjit Kumar, "Research Methodology": A step by Step Guide for beginners, 2nd Edition, Pearson Education, 2010.
3. Douglas C. Montgomery, "Design and Analysis of Experiments", 9th edition, Wiley Publishers, 2017.
4. Neeraj Pandey and Khushdeep Dharni, "Intellectual Property Rights", Prentice Hall India Learning, 2014.

CO/PO Mapping:

Mapping of course outcome with Programme outcomes (1/2/3 indicates strength of correlation1-Low; 2-Medium ; 3-High)														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	1	-	-	1	-	2	-	-	3	2	2
CO2	3	3	-	1	2	-	1	-	2	3	-	3	2	2
CO3	3	3	3	2	2	-	-	-	3	2	1	3	2	2
CO4	3	3	-	-	1	1	-	3	2	3	-	3	2	2
CO5	3	-	-	2	2	3	1	3	3	-	2	2	2	2

PSE23101 MATRIX METHODS OF STRUCTURAL ANALYSIS 3 1 0 4

COURSE OBJECTIVE

To enable the students to

- apply the energy concept in the structural members.
- know about the various characteristics of structures
- understand about the transformation of coordinate systems
- employ the flexibility method for analyzing structural elements
- understand about stiffness method in the analysis of structural elements.

Prerequisite: Nil

UNIT I ENERGY CONCEPTS IN STRUCTURES 12

Strain Energy - Symmetry of the stiffness and flexibility matrices, Strain energy in terms of stiffness and flexibility matrices, Stiffness and flexibility coefficients in terms of strain energy, Additional properties of [a] and [k], another interpretation of coefficients aij and kij; Betti's law - Applications of betti's law, Forces not at the coordinates - Strain energy in systems and in elements.

UNIT II CHARACTERSTICS OF STRUCTURES - STIFFNESS AND FLEXIBILITY 12

Coordinates - Structure with Single Coordinate, Two Coordinates, Flexibility and stiffness matrices in coordinates, Examples; Symmetric Nature of Matrices - Stiffness and Flexibility Matrices in Constrained Measurements, Stiffness and Flexibility of Systems and Elements; Computing displacements and forces form virtual work - Computing stiffness and flexibility coefficients.

UNIT III TRANSFORMATION OF INFORMATION IN STRUCTURES 12

Determinate and indeterminate structures - Transformation of system forces to element forces, Element flexibility to system flexibility, system displacement to element displacement, Element stiffness to system stiffness, Transformation of forces and displacements in general, Stiffness and flexibility in general; Normal coordinates and orthogonal transformation; Principle of contragradience.

UNIT IV FLEXIBILITY METHOD 12

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

UNIT V STIFFNESS METHOD 12

Development of stiffness method - Stiffness matrix for structures with zero force at some coordinates, Analogy between flexibility and stiffness, Lack of Fit, Stiffness matrix with rigid motions; Application of stiffness approach to Pin jointed plane trusses, Continuous beams, Frames, Grids; Choice of Method - Stiffness or Flexibility.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of the course, the students will be able to

- analyze the structural members using energy concept.
- describe about the various structural characteristics
- analyze the structural elements by transferring the information from system to element and vice versa.
- analyze various structural elements using flexibility method.
- analyze various structural elements using stiffness method.

REFERENCES

1. Mcguire and Gallagher R.H., "Matrix Structural Analysis", 2nd Edition, John Wiley, 2015.
2. Rajasekaran S. and Sankarasubramanian G., "Computational Structural Mechanics", Published by Asoke K.Ghosh, PHI Learning Private Limited, 2015.
3. Natarajan C. and Revathi P.,"Matrix Method of Structural Analysis", 1st Edition, PHI, New Delhi 2014.
4. Devdas Menon., "Advanced Structural Analysis", Narosa Publishing House, New Delhi, 2009.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	1	1	1	1	2	1	2	1	1	2
CO2	3	2	3	2	2	1	1	1	1	1	2	1	1	1
CO3	3	2	3	2	2	1	1	1	1	1	2	1	1	2
CO4	2	2	3	2	2	1	1	1	1	1	2	1	1	1
CO5	2	2	3	2	2	1	1	1	1	1	2	1	1	2

PSE23102 THEORY OF ELASTICITY AND PLASTICITY 3 0 0 3

COURSE OBJECTIVE

To enable the students to

- study the stresses and strains for two and three dimensional elements.
- obtain solutions for elasticity problems in Cartesian co-ordinates
- understand the compatibility conditions in polar coordinates
- solve the problems on Torsion for different shaped bars
- familiarize students with the concepts of plasticity and yield criteria

Prerequisite: Nil

UNIT I INTRODUCTION TO ELASTICITY 9

Basic concepts of deformation of deformable bodies - Displacement, Analysis of stress and strain, Plane stress and plane strain problems with practical examples, Equilibrium equations, Compatibility equations, Stress strain relationship, Generalized Hooke's law, Lame's constant.

UNIT II TWO DIMENSIONAL PROBLEMS IN CARTESIAN COORDINATES 9

Airy's stress function, Polynomials, Direct method of determining Airy's stress function; Two dimensional problems in cartesian coordinates - Bending of a cantilever loaded at free end, Bending of a beam under uniform loading; Solution of Bi harmonic equation; St. Venant principle.

UNIT III TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES 9

Equations of Equilibrium and compatibility conditions in Polar Coordinates - Stress distribution symmetrical about an axis; Pure bending of curved bars; Strain components in polar coordinates; Displacements for symmetrical stress distribution; Rotating Disc; Bending of a curved bar by force at the end.

UNIT IV TORSION AND ENERGY THEORY 9

General solutions of the problem by displacement (St. Venant's warping function) and force (Prandtl's stress function) approaches - Membrane analogy, Torsion of shafts of circular and non-circular (elliptic, triangular, and rectangular) cross-sectional shapes, Torsion of hollow thin-walled single and multicelled sections; Energy Methods - Principle of Virtual Work; Energy Theorems - Rayleigh's method, Rayleigh-Ritz method.

UNIT V PLASTICITY AND THEORY OF FAILURE 9

Introduction to plasticity - Reasons for plasticity; Strain hardening - Idealized stress, Strain curve; Yield criteria - Von Misses yield criterion, Tresca yield criterion; Plastic stress - Strain relations, Flow rules (associated and non-associated), Plastic problems of beams in bending and torsion.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- analyze the stresses and strains for elasticity approach.
- know the induced stress in the two dimensional problems in Cartesian coordinates.
- interpret the induced stress in the two dimensional problems in polar coordinates.
- solve the problems on Torsion for different shaped bars.
- determine the physical behavior of yield criteria of materials.

REFERENCES

1. Timeshenko.S.P and Goodier.J.N, "Theory of Elasticity", McGraw Hill International Edition, 2013.
2. Sadhu Singh, "Theory of Elasticity" & "Theory of Plasticity", Khanna Publishers, NewDelhi, 2005.
3. Chandramouli P.N., "Theory of Elasticity", 1st Edition, Yesdee Publishing Pvt. Ltd., Chennai, 2017.
4. Chakrabarthy J, 'Theory of Plasticity', McGraw Hill Co., 2012.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	2	2	1	1	1	1	1	1	2
CO2	3	2	2	1	1	2	2	1	1	1	1	1	1	2
CO3	3	2	2	1	1	2	2	1	1	1	1	1	1	2
CO4	3	2	2	1	1	2	2	1	1	1	1	1	1	2
CO5	3	2	2	1	1	2	2	1	1	1	1	1	1	2

PSE23103	ADVANCED DESIGN OF REINFORCED CONCRETE STRUCTURES	3	0	0	3

COURSE OBJECTIVE

To enable the students to

- design the flexural members as per IS code.
- explain the behaviour of compression members under different loading conditions.
- design the special R.C. elements with proper detailing.
- explain the concept of yield line theory and design of flat slabs using IS codes.
- understand the concept of inelastic behaviour of concrete beams and concept of ductility.

Prerequisite: Nil

UNIT I BEHAVIOUR AND DESIGN OF R.C. BEAMS 9

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 456:2000.

UNIT II BEHAVIOUR AND DESIGN OF R.C. COLUMNS 9

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 9

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 9

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 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- explain the structural behaviour of flexural members.
- design the compression members and construct interaction diagrams.
- design the special elements like corbels, deep beams and grid floors.
- design flat slab and spandrel beams.
- predict the moment curvature behaviour of concrete elements.

REFERENCES

1. Gambhir.M. L., "Design of Reinforced Concrete Structures", Prentice Hall of India, 2012.
2. Sinha.S.N., "Reinforced Concrete Design", Tata McGraw Hill publishing company Ltd.2017.
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, 2020.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	1	1	1	1	2	1	1	1	1	2
CO2	3	2	3	1	2	1	1	1	1	1	1	1	1	1
CO3	3	2	3	1	2	1	1	1	1	1	1	1	1	2
CO4	2	2	3	1	2	1	1	1	1	1	1	1	1	1
CO5	2	2	3	1	2	1	1	1	1	1	1	1	1	2

PAC23101 **ENGLISH FOR RESEARCH PAPER WRITING** **2 0 0 0**

COURSE OBJECTIVES

To enable the students to

- improve the writing skills and level of readability.
- learn about what to write in each section and to understand the skills required to develop a title.
- choose a topic of interest and paraphrase, summarize, using correct attribution and following documentation guidelines.
- craft a research paper in their discipline.
- ensure the good quality of a research paper at first-time submission.

UNIT I PLANNING AND PREPARATION **6**

Precision of Words; Breaking up long sentences; Structuring Paragraphs and Sentences; Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness. Expressing independent thought with grace, clarity and force.

UNIT II LITERATURE REVIEWS AND CITATIONS **6**

Key skills required - write a title, an abstract, write an introduction, write the review of the literature, conduct a literature review of all current research in their field; Review of the Literature; Methods; Results; Discussion and Conclusions; citing references correctly and avoiding plagiarism.

UNIT III WRITING STANDARDS **6**

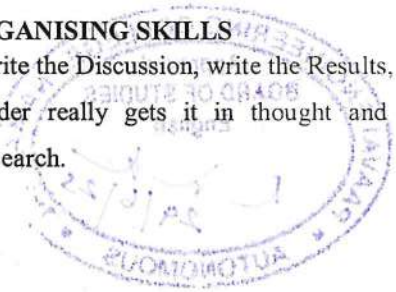
Useful phrases - to ensure paper is as good as it could possibly be the first-time submission - first draft, second draft, final draft of research report; journal article; literature review; chapters, grant proposal; Avoid inadequate support of generalizations, slipshod or hurried style, poor attention to detail, straying from directions, mechanical errors, underwritten and/or marred by confused purpose, lack of organization, repetition of ideas, improper use of words, and frequent grammatical, spelling and punctuation errors.

UNIT IV STRUCTURE OF A PAPER **6**

Details of all the parts, Clarifying Who Did What; Highlighting the Findings; Hedging and Criticizing; Skills to identify something we really need to know, some ways to find a topic; to venture out across the swamp of research without losing our bearings; Paraphrasing; Sections of a Paper - Abstract, Introduction to Free writing.

UNIT V EDITING AND ORGANISING SKILLS **6**

Skills required - write the Methods, write the Discussion, write the Results, write Conclusions; write about what we've learned truthfully so the reader really gets it in thought and expression, demonstrating a clear understanding and execution of the research.



TOTAL PERIODS: 30

COURSE OUTCOMES

At the end of the course, the students will be able to

- plan and write a research paper in their discipline
- understand the basics of citations, avoiding plagiarism and literature reviews
- write paraphrase, results and conclusions.
- culminate the actual crafting and revising of a research paper
- use suitable vocabulary, grammar and punctuation to write flawless piece of writing

REFERENCES

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

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	2	-	1	-	-	3	-	1	-	-	-
CO2	-	3	-	2	2	2	-	1	3	3	2	-	-	-
CO3	-	1	-	-	-	-	2	3	3	-	-	-	-	-
CO4	-	-	-	3	-	-	-	2	3	-	-	-	-	-
CO5	-	2	2	3	-	-	-	-	3	-	-	2	-	-

PSE23104 ADVANCED STRUCTURAL ENGINEERING LABORATORY 0 0 4 2

COURSE OBJECTIVE

To enable the students to

- perform advanced laboratory experiments that emphasizes the structure - property relationship.
- calculate mix proportions for various mix designs using relevant code books.
- cast and test RC beams for strength and deformation behaviour
- carry out the non-destructive testing on concrete.

Prerequisite: Nil

LIST OF EXPERIMENTS

1. Mix design of concrete as per IS codal method.
2. Determination of
    i. Cube strength of concrete.
    ii. Cylinder strength of concrete.
    iii. Split tensile strength of concrete.
    iv. Modulus of rupture of concrete.
3. Experimental study on the behavior of beam under flexure and shear.
4. Determination of stress-strain curve of high strength concrete.
5. Flow Characteristics of Self Compacting concrete.
6. NDT on hardened concrete - UPV, Rebound hammer and core test.
7. Testing of simply supported steel beam for strength and deflection behavior.
8. Water absorption, Permeability test on hardened concrete (RCPT)

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of the course, the students will be able to

- understand the structure - property relationship.
- explain the mix proportions for various mix designs.
- carry out the test on RC beams for strength and deformation behaviour.
- test the non-destructive testing on concrete.

REFERENCES

1. Gambhir.M. L., "Design of Reinforced Concrete Structures", Prentice Hall of India, 2012.
2. Job Thomas, "Concrete Technology", CL India, 2015, ISBN :-9788131526682
3. Concrete Technology, Shetty M. S., S. Chand and Co., 2006.
4. Properties of Concrete, Neville A. M., 5th Edition, Prentice Hall, 2012.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	1	1	1	1	2	1	2	1	1	1
CO2	3	2	3	1	2	1	1	1	1	1	2	1	1	1
CO3	3	2	3	1	2	1	1	1	1	1	2	1	1	1
CO4	2	2	3	1	2	1	1	1	1	1	2	1	1	1

SEMESTER II

PSE23201 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION 3 1 0 4

COURSE OBJECTIVE

To enable the students to

- define the errors in measurement and the principles of measurement using various electronic and physical testing machines.
- dramatize with vibrating measuring instruments and digital and electronic display using different sensors.
- understand the wind flow measurement and pressure measurement and scale different model using direct model study and indirect model study.
- measure the distress in concrete structures using various electrical and electronic machineries.
- test various civil engineering structures using Non Destructive Testing methodologies.

Prerequisite: Nil

UNIT I FORCES AND STRAIN MEASUREMENTS 12

Choice of Experimental stress analysis methods - Errors in measurements; Strain gauge - Principle, Types, performance and uses; Hydraulic jacks and pressure gauges; Electronic load cells; Proving Rings - Calibration of testing machines; Long-term monitoring - Vibrating wire sensors, Fibre optic sensors.

UNIT II VIBRATION MEASUREMENTS 12

Characteristics of structural vibrations - Linear variable differential Transformer (LVDT), Transducers for velocity and acceleration measurements; Vibration meter - Seismographs, Vibration analyzer, Electro-Dynamic exciters, Display and recording of signals; Cathode Ray Oscilloscope - XY Plotter, Chart Plotters; Digital data and Acquisition systems - Principles and applications.

UNIT III ACOUSTICS AND WIND FLOW MEASURES 12

Principles of Pressure and flow measurement - Pressure transducers, Sound level meter venturimeter and flow meters; Wind tunnel and its use in structural analysis - Structural modelling, Direct Model Study and Indirect Model study.

UNIT IV DISTRESS MEASUREMENTS AND CONTROL 12

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

UNIT V NON DESTRUCTIVE TESTING METHODS 12

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

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of the course, the students will be able to

- choose the methodology of measuring errors and strains and calibrate the machineries and equipment used in the laboratory.
- operate various vibration measuring instruments and analyze the structures using digital display unit.
- indicate the model using direct and indirect model analysis (Using Buckingham PI Theorem).
- measure distress in the structures using various electronic equipment.
- employ advanced NDT methods in accessing the load testing of structures.

REFERENCES

1. Sadhu Singh, 'Experimental Stress Analysis', Khanna Publishers, New Delhi, 2009.
2. Rangan C S et al., 'Instrumentation - Devices and Systems', Tata McGraw-Hill Publishing Co.,Ltd., New Delhi, 2017.
3. Ganesan T.P., "Model Analysis of Structures", Universities Press (India) Ltd 2005.
4. Dally J W and Riley W.F, 'Experimental stress Analysis', McGraw-Hill Inc. New York, 1991.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	2	2	1	2	2	2	2	1	2
CO2	3	2	3	2	3	2	2	1	2	2	2	2	1	2
CO3	3	2	3	2	3	2	2	1	2	2	2	2	1	2
CO4	3	2	3	2	3	2	2	1	2	2	2	2	1	2
CO5	3	2	3	2	3	2	2	1	2	2	2	2	1	2

PSE23202 **STRUCTURAL DYNAMICS** **3 0 0 3**

COURSE OBJECTIVE

To enable the students to

- impart knowledge on vibration analysis of single degrees of freedom under free and forced vibration.
- gain knowledge on vibration analysis of two degrees of freedom under free and forced vibration.
- impart knowledge on dynamic analysis of multi degrees of freedom under free and forced vibration.
- gain knowledge on dynamic analysis of continuous system under free and forced vibration.
- know about the direct integration method for dynamic analysis.

Prerequisite: Nil

UNIT I PRINCIPLES OF VIBRATION ANALYSIS **9**

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

UNIT II TWO DEGREE OF FREEDOM SYSTEMS **9**

Mathematical models of two degree of freedom systems - Free and forced vibrations of two degree of freedom systems, normal modes of vibration, Applications.

UNIT III DYNAMIC RESPONSE OF MULTI-DEGREE OF FREEDOM SYSTEMS **9**

Mathematical models of Multi-degree of freedom systems - Orthogonality of normal modes, Free and forced vibrations of multi degree of freedom systems, Mode superposition technique, Response spectrum method, Applications.

UNIT IV DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS **9**

Mathematical models of continuous systems - Free and forced vibration of continuous systems; Rayleigh - Ritz method - Formulation using conservation of energy, Formulation using virtual work, Applications.

UNIT V DIRECT INTEGRATION METHODS FOR DYNAMIC RESPONSE **9**

Introduction - Damping in MDOF systems, Nonlinear MDOF systems, Step-by-step numerical integration algorithms, Substructure technique, Applications.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- explain about vibration analysis of system/structures with single degree of freedom and can explain the method of damping systems
- describe about dynamic analysis of system/structures with two degrees of freedom under free and forced vibration

- explain about dynamic analysis of system/structures with multi-degrees of freedom under free and forced vibration
- derive a mathematical model of continuous system and do a dynamic analysis under free and forced vibration
- understand about the direct integration method for dynamic response.

REFERENCES

1. Anil K.Chopra, "Dynamics of Structures", 5th edition, Pearson Education, 2017
2. Mario Paz, "Structural Dynamics -Theory and Computation", Kluwer Academic Publishers, 5th Edition, 2013.
3. Madhujit Mukhopadhyay, "Structural Dynamics - Vibrations and Systems", ANE Books Publisher, 2008.
4. Roy R.Craig, Jr, Andrew J. Kurdila, "Fundamentals of Structural Dynamics", John Wiley & Sons, 2011.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	1	2	2	2	1	1	1	3	3	2
CO2	3	2	2	3	1	2	2	2	1	1	1	3	3	2
CO3	3	2	2	3	1	2	2	2	1	1	1	3	3	2
CO4	3	2	2	3	1	2	2	2	1	1	1	3	3	2
CO5	3	2	2	3	1	2	2	2	1	1	1	3	3	2

PSE23203 **ADVANCED STEEL STRUCTURES** **3 0 0 3**

COURSE OBJECTIVE

To enable the students to

- understand the concepts of limit state design, working stress design and design philosophies of tension and compression members.
- study the various connections (welded and riveted), seated connections (Unstiffened and Stiffened connections) and to design them.
- design the components of industrial building elements.
- study the plastic analysis of steel structures.
- Know about the design concepts of light gauge steel structures.

Prerequisite: Nil

UNIT I DESIGN METHODOLOGIES **9**

Concept of design methodologies - Philosophies of Limit State Design, Working stress design, LRFD; Tension members - Net sectional area for concentrically and eccentrically loaded members, Tension splices, Bending of tension members, Stress concentrations; Compression members - Practical end conditions and effective length factors, Elastic compression member, Restrained compression members, Torsional buckling, Built up compression members with lacings and Battens, Column splices.

UNIT II DESIGN OF CONNECTIONS **9**

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

UNIT III INDUSTRIAL BUILDINGS **9**

Loads on structures - Roof trusses, Roof and side coverings; Design of truss elements - Design of purlins, louver Rails, gable column, gable wind girder and end bracings of industrial buildings, Analysis and design of gable frame; Earthquake resistant design of steel buildings.

UNIT IV PLASTIC ANALYSIS OF STRUCTURES **9**

Introduction - Shape factor; Moment redistribution - Beam, Sway, Joint and Gable mechanisms, Combined mechanisms; Analysis of portal frames - Effect of axial force, Effect of shear force on plastic moment; Connections requirement - Moment resisting connections, Design of straight corner connections, Haunched connections; Design of continuous beams.

UNIT V DESIGN OF LIGHT GAUGE STEEL STRUCTURES **9**

Cold formed light gauge section - Type of cross sections, Stiffened, Multiple stiffened and unstiffened element, Flat width ratio, Effective design width; Design of light gauge compression member - Wall Studs, Effective width for load and deflection determination; Design of flexural members - Shear lag, Flange curling.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- design various tension and compression members.
- explain different types of steel connections and joints.
- understand the design of purlin, gable column and gable wind girder
- apply the knowledge of plastic analysis in steel design
- design various light gauge steel structures in Civil Engineering field.

REFERENCES

1. Subramania.N, "Design of Steel Structures", Oxford University Press, New Delhi, 2011.
2. Dayaratnam.P "Design of Steel Structures", 3rd Edition, S. Chand & Company, New Delhi,2013.
3. Jayagopal.L.S., and Tensing.D, "Design of Steel Structures", Vikas Publishing, 2015.
4. Bhavikatti.S.S "Design of Steel Structures by Limit State Method", International Publishing House Pvt. Ltd, 2012.
5. IS: 800-2007, "Indian Standard Code of Practice for general construction in steel".

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	1	2	1	2	2	1	1	2	1	2
CO2	3	2	3	2	2	2	1	2	1	1	1	2	1	2
CO3	3	2	3	2	2	2	1	2	1	1	1	2	1	2
CO4	2	2	3	2	2	2	1	2	1	1	1	2	1	2
CO5	2	2	3	2	2	2	1	2	1	1	1	2	1	2

PSE23204 **FINITE ELEMENT METHOD** **3 0 0 3**

COURSE OBJECTIVE

To enable the students to

- understand the basics of the Finite Element Techniques.
- know about the various types of element properties
- understand about the design concept in analysis of frame using truss element.
- know about the methodologies for 2D and 3D structural engineering problems.
- understand the applications of FEA in the industry

Prerequisite: Nil

UNIT I INTRODUCTION **9**

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**

Triangular element - 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 PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- formulate a finite element problem using basic mathematical principles.
- explain the various types of elements and select the appropriate element for modeling.
- analyze a frame using truss element.

- formulate and analyze the two- and three-dimensional solid finite element problems.
- analyze shells, thick and thin plates and explain the dynamic analysis using FEM.

REFERENCES

1. S.S.Bhavikatti, "Finite Element Analysis", New Age International Pvt. Ltd., New Delhi, 2007.
2. C.S.Krishnamoorthy, "Finite Element Analysis : Theory and Programming", Tata McGraw Hill, 2008.
3. Zienkiewicz,O.C. and Taylor,R.L., "The Finite Element Method",McGraw-Hill,2005.
4. Reddy. J.N., "An Introduction to the Finite Element" , Rajasekaran, S., "Finite Element Methods in Engineering Design", S.Chand & Co Ltd.,

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1	2	2	1	1	1	2	2	1	2
CO2	3	2	1	2	1	2	2	1	1	1	2	2	1	2
CO3	3	2	1	2	1	2	2	1	1	1	2	2	1	2
CO4	3	2	1	2	1	2	2	1	1	1	2	2	1	2
CO5	3	2	1	2	1	2	2	1	1	1	2	2	1	2

PAC23201 **PEDAGOGY STUDIES** **2 0 0 0**

COURSE OBJECTIVES

To enable the students to

- understand the aims, objectives and educational philosophies of education.
- acquire the knowledge of Instructional objectives of teaching and teaching skills.
- apply the knowledge of methods and strategies of teaching in real classroom situation.
- utilize the instructional aids and tools for effective classroom teaching.
- acquaint with the knowledge of professional development of teachers.

UNIT I EDUCATION AND ITS PHILOSOPHY **6**

Education- Definition, Aims, Objectives, Scope, Educational philosophy of Swami Vivekananda, Mahatma Gandhi, Rabindranath Tagore, Sri Aurobindo and J.Krishnamoorthy, Montessori, Jean - Jacques Rousseau, Friedrich Froebel and John Dewey. Current trends and issues in Education - Educational reforms and National policy on Education - 1968 and 1986 - its objectives and features.

UNIT II INSTRUCTIONAL OBJECTIVES AND DESIGN **6**

Instructional Objectives: Taxonomy of Educational objectives - Writing of general and specific objectives. Instructional design: Planning and designing the lesson, Writing of lesson plan: meaning, its need and importance, format of lesson plan. Types of lesson plan Skills of teaching: various ways of introducing lessons, explaining skills, problem solving skills, illustrative skills, scaffolding skills, integrating ICT skills, questioning skills, Reinforcement skills, skill of probing questions, skill of Stimulus variation and computation skills.

UNIT III INSTRUCTIONAL METHODS AND STRATEGIES **6**

Instructional strategies Lecture, demonstration, laboratory, Inductive method, Deductive method, Inquiry method, seminar, panel discussion, symposium, problem solving, project based learning (PBL), Learning by doing, workshop, role - play (socio-drama), Recent trends: Constructivist learning - Problem - based learning - Brain - based learning - Collaborative learning - Flipped learning - Blended learning - e-Learning trends - Videoconferencing.

UNIT IV INSTRUCTIONAL MEDIA **6**

Key concepts in the selection and use of media in education, Developing learning resource material using different media, Instructional aids - types, uses, selection, preparation, utilization. Dale cone of Experience, Teacher's role in procuring and managing instructional Aids - Projected and non-projected aids, multimedia, video - teleconferencing etc.

UNIT V TEACHER PREPARATION **6**

Teacher - roles and responsibilities, functions, characteristics, competencies, qualities, Preparation of Professional teacher, Organizing professional aspects of teacher preparation programs, Professional Development of teachers - In-service training, Refresher programmes, workshop and higher studies.

TOTAL PERIODS: 30

PRACTICUM

- Writing of three lesson plans
- Practice teaching for 15 days
- Preparation of one teaching aid
- A seminar on one educational philosophy
- Assignment on any of these five units

COURSE OUTCOMES

At the end of the course, the students will be able to

- explain the educational philosophies of education.
- write instructional and specific objectives in lesson plan.
- utilize the teaching skills and methods effectively.
- use instructional media efficiently.
- update themselves in the area of professional development.

REFERENCE

1. National Policy on Education 1968 and 1986- National Policy on Education 1986-Programme of Action1992.
2. Benjamin S.Bloometal.(1987).Taxono my of educational objectives. Longman Group.
3. Siddiqui, Mujibul Hasan(2005). Techniques of classroom teaching A.P.H.
4. Jeffrey Bennett(2014).On Teaching Science: Principles and Strategies That Every Educator Should Know. Big Kid Science: Boulder, CO
5. Bawa,M.S.&Nagpal,B.M.(2010).Developing teaching competencies. New Delhi: Viva Book House.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	2	-	3	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	3	2	3	-	3	-	-
CO4	-	-	-	-	1	-	-	-	3	3	-	3	-	-
CO5	-	-	-	-	-	-	-	3	3	3	-	3	-	-

PSE23205 **STRUCTURAL DESIGN STUDIO** **0 0 4 2**

COURSE OBJECTIVE

To enable the students to

- design a structure using modern software tools.
- work individually with standard codes and computational tools.
- analyse the structure for various loading combinations by using relevant IS codes.
- prepare the complete structural detailing drawings using computer software.

Prerequisite: Nil

SYLLABUS

Planning, Analysis and Design of Industrial structures, Multi storeyed buildings, Bridges, Towers, Storage structures, Special structures. Geotechnical aspects in foundation design. Special emphasis on Earthquake resistant design. Design, detailing and preparation of drawings.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of the course, the students will be able to

- understand the requirements of a structure and model it accordingly using computer software
- analyse the structure for various loads and load combinations according to the relevant IS codes
- design and detailing the structures using computer software/tools and check the correctness using manual approximate methods
- prepare the complete structural drawings using computer software

REFERENCES

1. IS 456-2000: "Indian Standard Code of Practice for Plain and Reinforced Concrete".
2. SP 16: "Design Aids for Reinforced Concrete".
3. IS 1904-2006: "Code of practice for design and construction of foundations in soils : General requirements"
4. IS 1893-2002: "Criteria for earthquake resistant design of structures".

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	2	2	2	1	1	1	1	2	1	2
CO2	3	2	1	2	2	2	2	1	1	1	1	2	1	2
CO3	3	2	1	2	2	2	2	1	1	1	1	2	1	2
CO4	3	2	1	2	2	2	2	1	1	1	1	2	1	2

LIST OF PROFESSIONAL ELECTIVES

PSE23151 STRUCTURAL OPTIMIZATION 3 0 0 3

COURSE OBJECTIVE

To enable the students to

- understand the principles and classical optimization techniques.
- solve engineering problems by linear and non-linear programming.
- understand the concept of geometric programming.
- understand the concept of dynamic programming.
- know the structural applications of various elements

Prerequisite: Nil

UNIT I BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES 9

Definition - 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 multi-storey buildings, water tanks and bridges.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- apply the knowledge of engineering fundamentals to formulate and solve engineering problems by classical optimization techniques.
- identify, formulate and solve engineering problems by linear and non-linear programming.
- analyze the problem and reduce G.P.P to a set of simultaneous equations.
- apply the engineering knowledge to understand the concept of dynamic programming.
- design various structural elements with minimum weight.

REFERENCES

1. Rao S.S., "Engineering Optimization: Theory and Practice", 1st Edition, New Age International Pvt. Ltd., New Delhi, 2013.
2. Hadley G., "Linear Programming", Narosa Publishing House, New Delhi, 2002.
3. Iyengar. N.G.R and Gupta. S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997.
4. Uri Kirsch, "Optimum Structural Design", McGraw Hill Book Co. 1981.

CO PO MAPPING:

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Cos	Programme Outcomes (POs)												
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CO3	3	2	2	1	1	1	1	1	1	1	1	1	3	3
CO4	2	2	2	1	1	1	1	1	1	1	1	1	2	2
CO5	2	2	2	1	1	1	1	1	1	1	1	1	2	2

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PSE23152 **FRACTURE MECHANICS** **3 0 0 3**

COURSE OBJECTIVE

To enable the students to

- impart knowledge on fracture failure parameters.
- understand the concepts of linear elastic fracture mechanics.
- understand the concepts of elastic plastic fracture mechanics.
- gain knowledge about residual life of fatigue crack growth in structure.
- know about suitable crack arrest parameters.

Prerequisite: Nil

UNIT I INTRODUCTION **9**

Review of Engineering Failure Analysis - Modes of fracture failure, The Griffith energy Balance Approach; Crack tip Plasticity; Fracture toughness.

UNIT II LINEAR ELASTIC FRACTURE MECHANICS **9**

Elastic crack tip theory - Stress and displacement fields in isotropic elastic materials; Westergaard's approach (opening mode); Feddersen approach - Determination of R curve, Energy released rate for DCB specimen; K1c Test techniques - Various test specimens; Critical energy release rate.

UNIT III ELASTIC PLASTIC FRACTURE MECHANICS **9**

Limitation of K approach - Approximate shape and size of the plastic zone, Effective crack length, Elastic plastic fracture concept; Crack tip opening displacement - Dugdale approach, Path independence; Critical J integral - Evaluation of CTOD, Relationship between CTOD, K1 and G1 for small scale yielding.

UNIT IV FATIGUE CRACK GROWTH **9**

Fatigue crack growth - methods to determine J1c mechanism of fatigue, Fatigue crack propagation; Paris law - Crack closure mechanism, Residual stresses at crack tip, Retardation effect on fatigue crack growth test; Stress intensity factor - factors affecting stress intensity, Variable amplitude service loading, Interaction effects.

UNIT V CRACK ARREST AND NUMERICAL METHODS **9**

Principles of crack arrest - crack arrest in practice, K-R Curves, Crack resistance curve; Numerical Methods and Approaches in Fracture Mechanics - Methods to determine fracture parameters.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- articulate the fracture failure parameters
- determine the linear elastic fracture mechanics problems
- interpret the concept of elastic plastic fracture mechanics
- determine the residual life of fatigue crack growth in structure
- find out suitable crack arrest parameters and prediction of fracture using numerical methods

REFERENCES

1. Simha K. R. Y, "Fracture Mechanics for Modern Engineering Design," University Press (India) Ltd, Hyderabad, 2001.
2. Gdoutos E. E., "Fracture Mechanics – An introduction," Kluwer Academic Publishers, Dordrecht, 2005.
3. David Broek, "Elementary Engineering Fracture Mechanics, " Martinus Nijhoff Publishers, The Hague, 1982.
4. George C. Sih A. DiTommaso ,"Fracture mechanics of concrete: Structural application and numerical calculation", 1985.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
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CO1	3	2	1	3	1	2	2	2	1	1	2	3	3	2
CO2	3	2	1	3	1	2	2	2	1	1	2	3	3	2
CO3	3	2	1	3	1	2	2	2	1	1	2	3	3	2
CO4	3	2	1	3	1	2	2	2	1	1	2	3	3	2
CO5	3	2	1	3	1	2	2	2	1	1	2	3	3	2

PSE23153 **ADVANCED CONCRETE TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVE

To enable the students to

- understand the roles of constituent materials and their effects on concrete.
- study the concrete mix design using different methods.
- know the concept of different concreting methods.
- gain the knowledge on special concretes.
- perform various tests on fresh and hardened concrete.

Prerequisite: Nil

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 CONCRETE 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 PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- develop knowledge on various materials needed for concrete manufacture.
- apply the rules to do mix designs for concrete by various methods.
- understand the methods of manufacturing of concrete.

- explain about various special concrete.
- explain various tests on fresh and hardened concrete.

REFERENCES

1. Gupta.B.L., Amit Gupta, "Concrete Technology, Jain Book Agency, 2017.
2. Shetty.M.S., "Concrete Technology", S. Chand and Company Ltd, New Delhi, 2017.
3. Neville.A.M.,Brooks.J.J., "Concrete Technology", Pearson Education, New Delhi,2008.
4. Gambir.M.L., "Concrete Technology", Tata Mc-Graw Hill-Education, New Delhi, 2009.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	3	2	2	1	2	1	2	2	1	2
CO2	3	1	3	2	3	2	2	1	1	1	2	3	1	2
CO3	3	1	1	2	3	2	2	1	1	1	2	2	1	2
CO4	2	1	1	2	3	2	2	1	1	1	2	2	1	2
CO5	2	2	1	3	3	2	2	1	1	1	2	3	1	2

PSE23154 **CORROSION ENGINEERING** **3 0 0 3**

COURSE OBJECTIVE

To enable the students to

- acquire knowledge about the underlying causes, mechanisms and different types of corrosion.
- understand the principles and applications of non-destructive testing methods.
- explore and evaluate a range of corrosion prevention techniques.
- gain knowledge about the impact of different environments on corrosion.
- identify and assess corrosion-related issues in diverse industries.

Prerequisite: Nil

UNIT I INTRODUCTION **9**

Mechanism of corrosion - Electrochemical corrosion of metals, Galvanic cells, Corrosion rates (kinetics), Types of corrosion with properties and phenomenon - Oxidation metals.

UNIT II CORROSION TESTING **9**

Importance classification materials and specimens - Surface preparation, Measuring and weighing, Exposure techniques, Duration - Planned interval tests.

UNIT III CORROSION PREVENTION **9**

Material selection - Modification of metal, Alternate of environment; Design - Cathodic and anodic protection, Coatings (metallic, inorganic, non-metallic and organic).

UNIT IV CORROSION IN SELECTED ENVIRONMENT **9**

Atmospheric corrosion - Corrosion in automobiles, Corrosion in soils, Corrosion of steel in concrete, Corrosion in water, Microbiologically induced corrosion, Corrosion in the body.

UNIT V CORROSION IN INDUSTRIES **9**

Corrosion in the petroleum industry, Corrosion in the aircraft industry, Corrosion in the microelectronics industry.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- understand the causes and mechanism of various types of corrosion.
- conduct various tests for corrosion measurement.
- apply suitable techniques for corrosion prevention.
- familiarize with the occurrence of corrosion under different environment.
- able to identify corrosion related issues in various industries.

REFERENCES

1. Jones, D.A. "Principles and Prevention of Corrosion", 2nd Edition, Macmillan Publishing Co., 1995
2. Balasubramanian, M.R., Krishnamoorthy, S. and Murugesan, V., "Engineering Chemistry", Allied Publisher Limited., Chennai, 1993.
3. Sadasivam, V. "Modern Engineering Chemistry - A Simplified Approach",Kamakya Publications, Chennai, 1999.
4. Kuriakose, J.C. and Rajaram J. "Chemistry in Engineering and Technology", Vol. I and II, Tata McGraw-Hill Publications Co. Ltd., New Delhi, 1996.

CO PO MAPPING:

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CO3	3	2	3	2	2	1	1	1	1	1	1	1	1	1
CO4	2	2	3	2	2	1	1	1	1	1	1	1	1	1
CO5	2	2	3	2	2	1	1	1	1	1	1	1	1	2

PSE23155 **DESIGN OF BRIDGE STRUCTURES** **3 0 0 3**

COURSE OBJECTIVE

To enable the students to

- understand the basic concept of design of bridges.
- design the short span bridges and slab culverts.
- design the large span girder bridges.
- analyses the prestressed concrete bridges
- know about the design concept of bearings and maintenance of bridges

Prerequisite: Nil

UNIT I INTRODUCTION **9**

Classification - Investigations and planning, Choice of type, I.R.C. Specifications for road bridges, Standard live loads, Other forces acting on bridges, General design considerations.

UNIT II SHORT SPAN BRIDGES **9**

Load distribution theories - Analysis and design of slab culverts; Tee beam and slab bridges, Design problems.

UNIT III LONG SPAN GIRDER BRIDGES **9**

Design principles of continuous bridges - Box girder bridges, Bow string girder bridges, Balanced cantilever bridges.

UNIT IV DESIGN OF PRESTRESSED CONCRETE BRIDGES **9**

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

UNIT V BEARINGS, CONSTRUCTION AND MAINTENANCE OF BRIDGES **9**

Bearings - Steel rocker and roller bearings, Reinforced concrete rocker and roller bearings, Elastomeric bearings, Expansions joints; Design of abutments and piers; Bridge Construction and Maintenance; Types of bridge foundations - Design of foundations.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- acquire basic knowledge on the planning and design aspects of bridges.
- design the short span bridges and slab culverts.
- design the long span girder bridges and box girder bridges.
- design the pre stressed concrete bridges.
- design the various components of bridges.

REFERENCES

1. Raina V.K. "Concrete Bridge Practice", Tata McGraw Hill Publishing Company, New Delhi, 2010.
2. Jagadeesh T.R and Jayaram M.A, "Design of Bridge Structures", PHI Learning Private Limited, 2009.
3. Krishnaraju, N., "Design of Bridges "Oxford and IBH Publishing Co., Bombay, Calcutta, New Delhi, 2010.
4. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, 2008

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
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CO2	3	2	3	2	1	2	2	2	1	1	2	2	1	2
CO3	3	2	3	2	1	2	2	2	1	1	2	2	1	2
CO4	3	2	3	2	1	2	2	2	1	1	2	2	1	2
CO5	3	2	3	2	1	2	2	2	1	1	2	2	1	2

PSE23156 STRUCTURAL HEALTH MONITORING 3 0 0 3

COURSE OBJECTIVE

To enable the students to

- understand about proper health monitoring technique.
- impart knowledge on various health monitoring system and its applications.
- gain knowledge about non-destructive technique for existing structure.
- understand about the vibration control systems.
- know about the various retrofitting techniques.

Prerequisite: Nil

UNIT I INTRODUCTION TO STRUCTURAL HEALTH MONITORING 9

An overview of structural health monitoring - Structural health monitoring and smart materials, Structural health monitoring versus non-destructive evaluation; Emerging SHM technologies - Sensors; Piezoelectric material - magnetostrictive material, Optical fiber, LDV; Overview of application potential of SHM.

UNIT II APPLICATION OF SHM IN CIVIL ENGINEERING 9

An overview of notable applications of SHM - Civil engineering field applications; Case studies - Bridges, Pretension and pre-fabricated structures, External post tension cables, Historical buildings; Capacitive methods - Application on cover concrete.

UNIT III NON DESTRUCTIVE TESTING OF CONCRETE STRUCTURES 9

Introduction to NDT - Situations and contexts, Where NDT is needed, Classification of NDT procedures, Visual Inspection, Half-Cell electrical potential methods, Schmidt rebound hammer test, Resistivity measurement, Electromagnetic methods, Radiographic testing, Ultrasonic testing, Infra-red thermography, Ground penetrating radar, Other methods.

UNIT IV VIBRATION CONTROL FOR SHM 9

Introduction to FE formulation - Constitutive relationship, Element stiffness matrix and element mass matrix for high precision finite element, Developing actuator and sensor influence matrix, Estimating sensor voltage; Damping - Case study on performance estimation for different patches

UNIT V REHABILITATION AND RETROFITTING OF CONCRETE STRUCTURE 9

Introduction - Repair, rehabilitation & retrofitting of structures, Damage assessment of concrete structures, Materials and methods for repairs and rehabilitation, Modelling of repaired composite structure, Structural analysis and design; Importance of re-analysis - Execution of rehabilitation strategy; Electromechanical impedance technique (EMI) - Case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- adopt a proper health monitoring technique.
- analyze the various health monitoring system and apply to the real problems.
- identify the accurate non-destructive technique for existing structure.
- explain the vibration control systems in the construction.
- suggest solution for the problems identified in the structures.

REFERENCES

1. Daniel Balageas, Claus - Peter Fritzen, Alfredo Guemes, "Structural Health Monitoring", 1st Edition, ISTE Publishing Ltd., U.K. 2006.
2. Douglas E Adams, "Health Monitoring of Structural Materials and Components -Methods with Applications", John Wiley and Sons, 2007.
3. J.P. Ou, H.Li and Z.D. Duan, "Structural Health Monitoring and Intelligent Infrastructure", Vol-1, Taylor and Francis Group, London, U.K, 2006.
4. Hand book on "Repair and Rehabilitation of RCC Buildings", Director General, CPWD, Govt. of India, 2002.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	1	3	3	2	1	1	1	3	3	2
CO2	3	2	2	3	1	3	3	2	1	1	1	3	3	2
CO3	3	2	2	3	1	3	3	2	1	1	1	3	3	2
CO4	3	2	2	3	1	3	3	2	1	1	1	3	3	2
CO5	3	2	2	3	1	3	3	2	1	1	1	3	3	2

PSE23157	PERFORMANCE OF STRUCTURES WITH SOIL-STRUCTURE INTERACTION	3	0	0	3

COURSE OBJECTIVE

To enable the students to

- understand the concept of soil structure interaction.
- know the static analysis of infinite and finite beams.
- familiarize with finite thin and thick plates.
- study the static and dynamic analysis of soil structure.
- understand about the ground foundation and structure interaction problems.

Prerequisite: Nil

UNIT I SOIL-FOUNDATION INTERACTION **9**

Introduction to soil-foundation interaction problems - Soil behaviour, Foundation behaviour interface behaviour, Scope of soil foundation interaction analysis; Winkler's hypothesis - Soil response models, Elastic continuum, Two parameter elastic models, Elastic-plastic behaviour, Time dependent behaviour.

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

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

UNIT III PLATES ON ELASTIC CONTINUUM **9**

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

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

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

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

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

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- explain the concept of soil structure interaction.
- do a static analysis of infinite and finite beams resting on elastic foundation.
- analyse finite thin and thick plates.
- do a static and dynamic analysis of soil structure interaction problems.
- analyze ground foundation and structure interaction problems.

REFERENCES

1. Rolando P. Orense, Nawawi Chouw& Michael J. Pender – Soil-Foundation-Structure Interaction, CRC Press, Taylor & Francis Group, London, UK, 2010.
2. Bowels, J.E., "Analytical and Computer methods in Foundation" McGraw Hill Book Co., New York., 1974.
3. Steven L. Kramer., "Geotechnical Earthquake Engineering" Pearson Education, 1996.
4. Desai C.S. and Christian J.T., "Numerical Methods in Geotechnical Engineering" McGraw Hill Book Co. New York, 1977.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	1	1	1	1	2	1	1	1	1	1
CO2	3	2	3	1	2	1	1	1	1	1	1	1	1	1
CO3	3	2	3	1	2	1	1	1	1	1	1	1	1	1
CO4	2	2	2	1	2	1	1	1	1	1	1	1	1	2
CO5	2	2	2	1	2	1	1	1	1	1	1	1	1	2

PSE23158 REHABILITATION AND RETROFITTING OF STRUCTURES 3 0 0 3

COURSE OBJECTIVE

To enable the students to

- study the performance of construction materials and components.
- understand the diagnosis of construction failures.
- understand the methods of corrosion protection techniques.
- apply the various retrofitting techniques of earthquake affected buildings and bridges.
- study the protection and maintenance schedule against all environmental distress.

Prerequisite: Nil

UNIT I GENERAL ASPECTS 9

Performance of construction materials and components in actual structure for strength - Permeability, Thermal properties and cracking effects due to climate, Temperature, Chemicals, Wear and erosion; Design and construction errors; Effects of cover thickness.

UNIT II MAINTENANCE AND DIAGNOSIS OF FAILURE 9

Maintenance - Repair and rehabilitation, Facets of maintenance, Importance of maintenance; Various aspects of inspection; Assessment procedure for evaluating a damaged structure; Diagnosis of construction failures.

UNIT III MATERIALS AND TECHNIQUES FOR REPAIR 9

Special concretes and Mortar - Concrete chemicals, Expansive cement, Polymer concrete, Sulphur infiltrated concrete, Ferrocement, Fiber reinforced concrete, Mortar and Dry pack, Vacuum concrete, Gunite and Shotcrete; Epoxy injection - Mortar repair for cracks, Rust eliminators and Polymer coating for rebars; Methods of corrosion protection - Corrosion inhibitors, Corrosion resistant coatings.

UNIT IV MODERN TECHNIQUES OF RETROFITTING 9

Structural first aid after a disaster - Jacketing, Use of chemicals in repair, Application of polymers, Ferrocement and fiber concrete as rehabilitation materials; Strengthening by Prestressing - Shoring and Underpinning; Retrofitting of earthquake affected buildings - Retrofitting of bridges.

UNIT V POST REPAIR MAINTENANCE OF STRUCTURES 9

Protection and Maintenance schedule against environmental distress to all those structures - Special care in rehabilitation of heritage structures, High rise buildings, Bridges and other special Structures.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- know the causes of deterioration of structures and structural damage.
- predict the construction failures in damaged structures.
- interpret the methods of corrosion protection techniques.

- assessing the various retrofitting techniques of buildings.
- compute the protection and maintenance schedule against all environmental distress.

REFERENCES

1. Bhattacharjee. J., "Concrete Structures Repair Rehabilitation and Retrofitting", CBS Publishers and Distributors. Pvt. Ltd., 2017.
2. Shetty .M.S., "Concrete, Technology", Theory and Practice, S. Chand and Company, New Delhi 2010.
3. G.Nandini Devi., "Maintenance, Repair, Rehabilitation and Retrofitting of structures", I.K. International Publishing House Pvt. Ltd., 2021.
4. B.Vidivelli., "Rehabilitation of Concrete Structures", Standard Publishers Distributors Pvt.Ltd., 2009.

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
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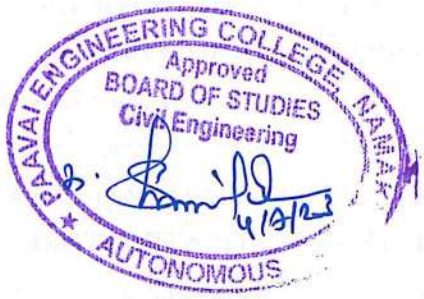
CO1	3	2	3	2	2	2	2	1	1	1	1	1	2	2
CO2	3	2	3	2	2	2	2	1	1	1	1	1	2	2
CO3	3	2	3	2	2	2	2	1	1	1	1	1	2	2
CO4	3	2	3	2	2	2	2	1	1	1	1	1	2	2
CO5	3	2	3	2	2	2	2	1	1	1	1	1	2	2



PSE23159 **DESIGN OF SUB STRUCTURES** **3 0 0 3**

COURSE OBJECTIVE

To enable the students to

- assess the soil condition at a given location in order to suggest suitable foundation based upon bearing capacity.
- know about the design of different type of shallow foundations.
- familiarize with the design of pile foundation and pile caps.
- outline the design of well and caisson foundations.
- know about the earth pressure behind retaining walls and to carry out stability analysis.

Prerequisite: Nil

UNIT I SITE INVESTIGATION, SELECTION OF FOUNDATION AND BEARING CAPACITY **9**

Objectives - Methods of exploration, Depth of exploration, Sample disturbance, Factors governing location and depth of foundation; In situ testing of Soils - Plate load test; Geophysical methods - Selection of foundation, Bearing capacity of shallow foundations by Terzaghi's theory, Meyerhof's theory and codal provisions, Bearing capacity of footing subjected to inclined and eccentric loading, Problems; Types of shear failure - General principles of foundation design, Foundations on expansive soil.

UNIT II DESIGN OF SHALLOW FOUNDATIONS **9**

Types of shallow foundations - General principles of design of reinforced concrete shallow foundations, Structural design of isolated, Combined footing and strap footings, Mat foundation - Structural design of rafts by conventional method, Principles of design of buoyancy raft and basement (no design problems).

UNIT III PILE FOUNDATION **9**

Pile foundations - Types, General principles of design, Estimation of load capacity of piles by static and dynamic formulae; Detailing of reinforcement as per IS 2911 - Configuration of piles, Different shapes of piles cap, Design of Piles and Pile caps, Settlement analysis of pile groups, Negative skin friction, Pile load tests.

UNIT IV WELL AND CAISSON FOUNDATIONS **9**

Well and caisson foundations - Structural elements of Caisson and Well foundations, Elements of well foundation, Forces acting on Caisson and well foundations, Design of individual components of Caisson and well foundation (only forces acting and design principles), Sinking of well, Shifts and tilts in well foundations, Failures and Preventive measures.

UNIT V RETAINING WALLS 9

Plastic equilibrium in soils - Active and passive states, Rankine's theory, Cohesion less and cohesive soil, Condition for critical failure plane, Earth pressure on retaining walls of simple configurations - Culmann's Graphical method, Pressure on the wall due to line load; Stability analysis of retaining walls - Use of geosynthetics for different applications.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- understand the suitability of soil exploration methods for different projects.
- design shallow foundation & calculate settlement for different soil strata.
- analyze and design pile foundation.
- understand about the construction procedure and design of well and caisson foundation.
- estimate the earth pressure behind retaining walls.

REFERENCES

1. S.Saran, "Analysis and Design of Substructures: Limit State Design", 2nd Edition, Kindle Edition,2015.
2. Arora. K.R, "Soil Mechanics & Foundation Engineering", Standard Publishers & Distributors, 2005.
3. Tomlinson. M.J. and Boorman, R., "Foundation Design and Construction", VI edition, ELBS Longman, 2001.
4. Winterkorn. H. F., and Fang, H. Y., "Foundation Engineering Hand Book - Van Nostrard Reinhold - 2010.

CO PO MAPPING:

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CO4	2	2	3	2	2	2	1	2	1	1	1	1	1	2
CO5	2	2	3	2	2	2	1	2	1	1	1	1	1	2

PSE23160 MECHANICS OF COMPOSITE MATERIALS 3 0 0 3

COURSE OBJECTIVE

To enable the students to

- understand the various types of composites and their constituents.
- study the relationship between stresses and strain in a composite material.
- familiarize with a laminated plate.
- understand the various failure criteria and fracture mechanics of composites.
- know the concept of simple composite elements.

Prerequisite: Nil

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 plate, Inter laminar stresses.

UNIT IV FAILURE AND FRACTURE OF COMPOSITES 9

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

UNIT V APPLICATIONS AND DESIGN 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- explain the various types of composites and their constituents.
- derive the constitutive relationship and determine the stresses and strains in a composite material.
- analyze a laminated plate.
- explain the various failure criteria and fracture mechanics of composites.
- design simple composite elements.

REFERENCES

1. Hyer M.W., and White S.R., "Stress Analysis of Fiber-Reinforced Composite Materials", D.Estech Publications Inc., 2009.
2. Agarwal. B.D. Broutman. L.J. and Chandrashekara. K. "Analysis and Performance of Fiber Composites", Fourth Edition, John-Wiley and Sons, 2017.
3. Daniel. I.M, and Ishai. O, "Engineering Mechanics of Composite Materials", Second Edition, Oxford University Press, 2005.
4. Mukhopadhyay.M, "Mechanics of Composite Materials and Structures", Universities Press, India, 2005.

CO PO MAPPING:

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CO3	3	2	3	1	2	1	1	1	2	1	1	1	3	3
CO4	2	2	2	1	2	1	1	1	2	1	1	1	3	3
CO5	2	2	2	1	2	1	1	1	2	1	1	1	3	3

PSE23161 DESIGN OF SHELL AND SPATIAL STRUCTURES 3 0 0 3

COURSE OBJECTIVE

To enable the students to

- know about the different forms of shells and domes
- identify the structural behaviour and design of folded plate structures
- learn about various functional configurations of space frames
- apply the knowledge of CAD for the analysis of space structures
- work on FORMIAN software to analyze the configurations of space structures

Prerequisite: Nil

UNIT I CLASSIFICATION OF SHELLS 9

Shells - Classification, Types, 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 and 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 PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- explain the different forms of shells and design the domes.
- evaluate the structural behaviour and design of folded plate.
- explain the various configurations of space frame.
- analyze and design space frames and apply the knowledge of CAD for the analysis of space structures
- analyze the configurations of space structures using FORMIAN software

REFERENCES

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

CO PO MAPPING:

Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	2	1	2	2	1	1	1	1	2	1	2
CO2	3	2	2	2	1	2	2	1	1	1	1	2	1	2
CO3	3	2	2	2	1	2	2	1	1	1	1	2	1	2
CO4	2	2	2	2	1	2	2	1	1	1	1	2	1	2
CO5	2	2	2	2	1	2	2	1	1	1	1	2	1	2

PSE23162 DESIGN OF OFFSHORE STRUCTURES 3 0 0 3

COURSE OBJECTIVE

To enable the students to

- learn the types and functions of offshore structure.
- study the behavior of structures subjected to hydrodynamic loads.
- know about different analysis procedures for different offshore structures.
- identify the wave structure interaction.
- learn about the design of framed structure in offshore.

Prerequisite: Nil

UNIT I INTRODUCTION 9

Types of off shore structures - Types of offshore platforms, Functions of offshore structures, Components of a typical offshore structure.

UNIT II LOADS ON OFFSHORE STRUCTURES 9

Loads - Gravity load, Wind load, Offshore load, Fatigue load, Seismic load.

UNIT III CONCEPTS OF FIXED PLATFORM JACKET AND DECK 9

Jacket concepts - Redundant framing arrangement, Launch and Lift jackets, Simple deck configurations for lift and float, Over installations, In-service and pre-service loads and analysis.

UNIT IV WAVE THEORIES AND WAVE FORCE ON OFFSHORE STRUCTURES 9

Wave generation and Propagation - Small and finite amplitude wave theories, Wave energy and pressure distribution, Slender vertical cylindrical members, Linearization of nonlinear wave drag force, Wave forces on arbitrarily oriented cylindrical members, Wave forces on large diameter structures.

UNIT V FUNDAMENTAL CONSIDERATIONS FOR FRAMED OFFSHORE STRUCTURAL ANALYSIS 9

Site characteristics and modelling procedures for analysis, Hydrostatic pressure and buoyancy finite element applications for framed offshore structural analysis.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- understand the types and functions of offshore structure.
- evaluate the loads experienced by offshore structure.
- deliver the concept of fixed offshore structures.
- understand the wave hydrodynamics and Evaluate the wave forces on offshore structures.
- design the framed structure in offshore.

REFERENCES

1. D.V. Reddy, A. S. J. Swamidas , "Essentials of Offshore Structures, CRC Press, Taylor & Francis Group"2014.
2. Mohamed A. El-Reedy, "Offshore Structure, Design, Construction and Maintenance", Gulf Professional Publishing 2012.
3. Chandrasekaran, S, "Dynamic analysis and design of ocean structures" 2017.
4. B. Gou, S.Song, J Chacko and A. Ghalambar, "Offshore pipelines", GPP publishers, 2006.

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Mapping of course objectives with Programme Outcomes: (1/2/3 indicates strength of correlation) 3- strong,2-Medium, 1-Weak														
Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	1	1	1	1	2	1	1	1	1	1
CO2	3	2	3	1	2	1	1	1	1	1	1	1	1	1
CO3	3	2	3	1	2	1	1	1	1	1	1	1	1	1
CO4	2	2	3	1	2	1	1	1	1	1	1	1	1	1
CO5	2	2	3	1	2	1	1	1	1	1	1	1	1	2