PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

M.E. STRUCTURAL ENGINEERING (FULL TIME)

REGULATION 2016

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

SEMESTER III

Course Code	Course Title	L	T	P	C
PSE1655*	Elective V	3	0	0	3
PSE1665*	Elective VI	3	0	0	3
PSE1675*	Elective VII	3	0	0	3
PSE16301	Project Work (Phase I)	0	0	12	6
PSE16302	Practical Training (4 weeks)	0	0	0	1
PSE16303	Technical Seminar	0	0	2	1
	Total	**9**	**0**	**14**	**17**

SEMESTER IV

Course Code	Course Title	L	T	P	C
PSE16401	Project Work (Phase II)	0	0	24	12
	Total	0	0	24	12

LIST OF ELECTIVES

ELECTIVE V

Course Code	Course Title	L	T	P	C
PSE16551	Design of Prefabricated Structures	3	0	0	3
PSE16552	Theory of Plates	3	0	0	3
PSE16553	Design of Shell Structures	3	0	0	3

ELECTIVE VI

Course Code	Course Title	L	T	P	C
PSE16651	Design of Industrial Structures	3	0	0	3
PSE16652	Stability of Structures	3	0	0	3
PSE16653	Cracks and Crack Control in Concrete Structures	3	0	0	3

ELECTIVE VII

Course Code	Course Title	L	T	P	C
PSE16751	Design of Steel Concrete Composite Structures	3	0	0	3
PSE16752	Mechanics of Composite Materials	3	0	0	3
PSE16753	Design of Power Plant Structures	3	0	0	3

SEMESTER III

PSE16301 **PROJECT WORK (PHASE I)** **0 0 12 6**

COURSE OBJECTIVES

- To identify a specific problem for the current need of the society
- To collect information related to the literatures.
- To develop the methodology to solve the identified problems.
- 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 PERIODS 180

COURSE OUTCOMES

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

- have a clear idea of his/her current need of the society.
- gain knowledge from various literature reviews related to their project.
- develop methodology for identified problems.
- prepare project reports and to face reviews and viva-voce examination.

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	3	-	2	-	2	3	2	1	3	2	3
CO2	3	2	1	3	-	-	-	-	3	-	1	3	2	3
CO3	2	2	1	-	-	2	-	2	2	2	1	3	2	3
CO4	2	2	1	-	-	2	-	2	2	2	1	3	2	3

PSE16302 **PRACTICAL TRAINING (4 Weeks)** **0 0 0 1**

COURSE OBJECTIVES

- 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.
- To develop skills in facing and solving the field problems.

SYLLABUS

The students individually undertake training in reputed Structural Engineering Companies during the summer vacation for a specified period 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.

COURSE OUTCOMES

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

- trained in tackling a practical field/industry orientated problem related to Structural Engineering.
- solve field related problems related to their project.

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	2	1	3	-	-	-	-	-	-	3	2	2
CO2	3	1	2	1	3	-	-	-	-	-	-	3	2	2

PSE16303 **TECHNICAL SEMINAR** **0 0 2 1**

COURSE OBJECTIVES

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

SYLLABUS

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

TOTAL PERIODS 30

COURSE OUTCOMES

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

- face an audience and to tackle any problem during group discussion in the Interviews.
- gain knowledge on writing abilities for seminars and conferences.

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	3	-	2	-	2	3	2	1	3	2	3
CO2	3	2	1	3	-	-	-	-	3	-	1	3	2	3

LIST ELECTIVES

ELECTIVE V

PSE16551 DESIGN OF PREFABRICATED STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To get introduced to the concepts of prefabrication, types and its systems.
- To have a knowledge about the structural behaviour of prefabricated structures.
- To obtain knowledge in design of cross section and the joints in structures.
- To have a detailed knowledge in designing and detailing of various prefabricated units.
- To possess a comprehensive knowledge in design of structures subjected to earthquake.

UNIT I INTRODUCTION 9

Types of prefabrication, prefabrication systems and structural schemes - Need for prefabrication - Principles - Materials; Disuniting of structures- Handling and erection - Elimination of erection stresses

UNIT II PREFABRICATED COMPONENTS 9

Production, Transportation & erection- Shuttering and mould design - Dimensional tolerances - Erection of R.C. Structures, Total prefabricated buildings; Structural behaviour of precast structures - Large panel constructions - Construction of roof and floor slabs - Wall panels - Columns - Shear walls.

UNIT III DESIGN PRINCIPLES 9

Design of cross section based on efficiency of material used - Problems in design - joint flexibility - Allowance for joint deformation; Design of construction and expansion joints.

UNIT IV STRUCTURAL MEMBERS 9

Designing and detailing of prefabricated units - industrial structures - Multi-storey buildings; Water tanks - Dimensioning and detailing of joints for different structural connections.

UNIT V DESIGN FOR ABNORMAL LOADS 9

Progressive collapse - Codal provisions - Equivalent design loads for considering abnormal effects such as earthquakes, cyclones - Importance of avoidance of progressive collapse.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- understand the basic concepts of prefabrication and their needs in construction industry.
- know the behaviour of prefabricated structures.
- design the cross section and joints of prefabricated units
- exhibit their knowledge in designing and detailing of prefabrication units.
- design the structures for abnormal loads using the codal provisions.

REFERENCES

1. Gerostiza C.Z., Hendrikson C. and Rehat D.R., “Knowledge based process planning for construction and manufacturing”, Academic Press Inc., 1994.
2. “Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete”, Netherland BetorVerlag, 1978.

3. Hass, A.M. “Precast Concrete Design and Applications”, Applied Science Publishers, 1983.
4. Promislow, V “Design and Erection of Reinforced Concrete Structures”, MIR Publishers, Moscow 1980
5. Koncz T., “Manual of precast concrete construction”, Vols. I, II and III, Bauverlag,GMBH,1971.
6. IS 15916:2011 - Building Design And Erection Using prefabricated Concrete.
7. IS 11447: 1985 - Code of practice for construction with large panel prefabricates.
8. IS 1893: 2002 (Part - I)- Criteria for Earthquake Resistant Design of Structures - General.
9. IS 13920: 1993 - Ductile detailing of Reinforced Concrete 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	2	2	-	-	-	-	2	-	2
CO2	3	-	-	-	2	2	2	-	-	-	-	2	-	2
CO3	3	-	-	-	-	2	2	-	-	-	-	2	-	2
CO4	3	-	-	-	-	2	2	-	-	-	-	2	-	2
CO5	3	-	-	-	-	2	2	-	-	-	-	2	-	2

PSE16552 **THEORY OF PLATES** **3 0 0 3**

COURSE OBJECTIVES

- To get introduced to various plate theories, governing equations for bending of plates and various boundary conditions.
- To conceptualise the Navier's solution and Levy's solution and to analyse rectangular plates.
- To study the behaviour of bending of circular plates.
- To familiarise with the concepts of finite difference method.
- To use energy methods to analyse the solution of rectangular plates for the given boundary conditions.

UNIT I INTRODUCTION TO PLATE THEORY **9**

Thin and thick plates - Small and large - Deflection theory of thin plate - assumptions - Moment curvature relations - stress resultants, governing - Differential equation for bending of plates - various boundary conditions.

UNIT II RECTANGULAR PLATES **9**

Navier's Solution - Simply supported rectangular plates subjected to UDL and varying loads on entire area - Parabolic loads, sinusoidal loads - partly loaded plates - concentrated loads and couples - Distributed Couples - Symmetric and Antisymmetric Loadings; Levy's Solution - Plates subjected to UDL and varying loads, sinusoidal parabolic loads between the supported edges - Conditions for other two edges - Simply supported, fixed, free and Elastically restrained.

UNIT III CIRCULAR PLATES **9**

Bending of circular plates with clamped and simply supported edges - plate with central hole - uniformly distributed and varying loads - conical loads, Distributed couples - Ring loads - Semi circular plates - Asymmetrically loaded plates.

UNIT IV STRUCTURAL MEMBERS **9**

Solution of plate problems - Deviation of Delta / Pattern / Stencil for biharmonic form for a rectangular mesh - Two stage solutions - Solutions for various loadings and boundary conditions; Use of Symmetry and Anti - symmetry - extrapolation formula; Introduction to improved finite difference technique.

UNIT V DESIGN FOR ABNORMAL LOADS **9**

Use of potential energy principle - solution of rectangular plates with various boundary conditions and loadings.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- explain about various plate theories
- gain the knowledge of Navier's solution, Levy's solution and solve for the rectangular plates.
- analyse circular plates for any boundary conditions.
- use finite difference method for solving plate problems.
- realise the potential energy principle and find the solution of rectangular plates for various loadings.

REFERENCES

1. Timoshenko S. and Krieger S.W. “Theory of Plates and Shells”, McGraw Hill Book Company, New York, 2003.
2. Bairagi, “Plate Analysis”, Khanna Publishers, 1996.
3. Reddy J N, “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Company, 2006.
4. Szilard R., “Theory and Analysis of Plates”, Prentice Hall Inc., 2004.
5. Chandrashekahara, K., “Theory of Plates”, University Press (India) Ltd., Hyderabad, 2001.

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	-	2
CO2	3	2	-	-	-	-	2	-	-	-	-	1	-	2
CO3	3	2	-	-	-	-	2	-	-	-	-	1	-	2
CO4	3	2	-	-	-	-	2	-	-	-	-	1	-	2
CO5	3	2	-	-	-	-	2	-	-	-	-	1	-	2

PSE16553 DESIGN OF SHELL STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To classify and analyse the different type of shell structures.
- To design circular domes, conical roofs and circular cylindrical shells.
- To study the behaviour of pyramidal roof.
- To be familiar with design philosophy of space frames.
- To study the finite element analysis shell structures.

UNIT I SHELL CLASSIFICATION AND ANALYSIS 9

Classification of shells - Structural actions - Membrane theory; Analysis of spherical dome - Cylindrical shells - Folded plates

UNIT II DESIGN OF SHELLS 9

Design of circular domes - Conical roofs - Circular cylindrical shells.

UNIT III FOLDED PLATES 9

Folded plate structures - Structural behaviour - Types - Design - Pyramidal roof.

UNIT IV INTRODUCTION TO SPACE FRAME 9

Space frames - Configuration - Types of nodes - General principles of design Philosophy - Behaviour.

UNIT V FINITE ELEMENT ANALYSIS 9

Finite element application on cylindrical shells - Introduction to shell elements- Flat elements - Axisymmetric elements- Degenerated elements - General shell element.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- analyse and design various shell and spatial structures
- design all types of domes.
- understand the behaviour of folded plates.
- know the structural behaviour and philosophy of space frames.
- proficient with finite element analysis of shell structures.

REFERENCES

1. Billington.D.P, “Thin Shell Concrete Structures”, McGraw Hill Book Co., New York,2008.
2. Santhakumar.A.R and Senthil.R, “Proceedings of International Conference on Space Structures”, Anna University, Chennai, 1997.
3. Subramanian.N /’Principles of Space Structures”, Wheeler Publishing Co. 1999.

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**	**PO 3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	1	2	1	-	-	-	-	-	-	1	1	2
CO2	2	3	1	2	1	-	-	-	-	-	-	1	1	2
CO3	2	3	1	2	1	-	-	-	-	-	-	1	1	2
CO4	2	3	1	2	1	-	-	-	-	-	-	1	1	2
CO5	2	2	1	2	1	-	-	-	-	-	-	1	1	2

ELECTIVE VI

PSE16651 DESIGN OF INDUSTRIAL STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To impart a broad knowledge in the area of Planning and functional requirements for industrial structures
- To understand the basic idea about the materials and design of industry structural elements.
- To know the design concepts of power plant structures,
- To realise the design concepts of power transmission structures
- To understand the basic design concepts of chimneys, bunkers and silos and the construction techniques.

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

Roofs for industrial buildings - Steel and RCC - Gantry girders; Design of corbels and nibs - Machine foundations.

UNIT III POWER PLANT STRUCTURES 9

Types of power plants - Design of turbo generator foundation - Containment structures.

UNIT IV POWER TRANSMISSION STRUCTURES 9

Principles of analysis and design of lattice towers - Transmission towers - Tower foundations - Testing Towers.

UNIT V AUXILIARY STRUCTURES 9

Design of steel and RCC Chimneys - Bunkers and silos.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- know the planning and functional requirements of various industries.
- get an idea about the materials used and design of industry structural elements.
- realize the basic concepts and design of power plant structures.
- design power transmission structures.
- possess the ability to understand the design concepts of chimneys, bunkers and silos.

REFERENCES

1. Manohar S.N, “Tall Chimneys - Design and Construction”, Tata McGraw Hill, 1985.
2. Santhakumar A.R. and Murthy S.S., “Transmission Line Structures”, Tata McGrawHill, 1992.
3. Srinivasulu P and Vaidyanathan.C, “Handbook of Machine Foundations”, Tata McGraw Hill, 1976.
4. Jurgen Axel Adam, KatharriaHausmann, Frank Juttner, Klauss Daniel, “Industrial Buildings: A Design Manual”, Birkhauser Publishers, 2004.
5. Procs. of Advanced course on “Industrial Structures”, Structural Engineering Research Centre, Chennai, 1982.

6. IS 4995 (Part I) -1974 - Criteria for design of reinforced concrete bins for the storage of granular and powder materials.
7. IS 4995 (Part II) -1974 - General Requirements and assessment of bin Loads.
8. IS 6060 -1971 - Code of practice for Day lighting of factory buildings.
9. IS 3103 -1975- Code of practice for industrial ventilation.
10. IS 3483 -1965 - Code of practice for Noise reduction in industrial buildings.
11. IS:456-2000 - Code of Practice for Plain and Reinforced Concrete.
12. IS 6533 (Part 2) -1989 - Code of practice for design and construction of steel chimneys.
13. IS:875 (Part 1 to 5) - Code of Practice for Design loads.
14. IS:802-1977(Part 2) - Code of practice for use of structural steel in Over Head transmission line towers.
15. IS:3370-1967 - Part 2 to 4 - Code of Practice for Concrete Structures for the storage of liquids - Reinforced Concrete Structures.
16. IS:4091-1979 - Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles.
17. IS:9178-1980 - Criteria for Design of Steel Bins for Storage of Bulk Materials.

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	-	-	-	-	2	-	2
CO2	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	2	-	2

PSE16652 STABILITY OF STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To study the stability of columns using theoretical and numerical methods.
- To understand the approximate methods and numerical methods of inelastic buckling.
- To get accustomed to beam column behaviour and that of frames.
- To enumerate the lateral buckling, lateral torsional buckling and flexural torsional buckling of beams.
- To study various numerical techniques and energy methods for buckling of thin plates.

UNIT I STABILITY OF COLUMNS 9

Fundamental concepts - Elastic structural stability - Structural instability; Analytical methods for the stability analysis, equilibrium, imperfections and energy methods - Non-prismatic columns- Built up columns- Buckling modes - Effect of shear on buckling load - Large deflection theory.

UNIT II METHODS OF ANALYSIS AND INELASTIC BUCKLING 9

Approximate methods - Rayleigh and Galerkin methods - Numerical methods - Finite difference and finite Element; Analysis of columns - Experimental study of column behaviour - South well plot - Column curves - Derivation of column design formula - Effective length of Columns - Inelastic behaviour- Tangent modulus and Double modulus theory

UNIT III BEAM COLUMNS AND FRAMES 9

Beam column behaviour- standard cases- Continuous columns and beam columns - Columns on elastic foundation; Buckling of frames - Single storey portal frames with and without side sway - Classical and stiffness methods - Use of Wood's charts.

UNIT IV BUCKLING OF BEAMS 9

Lateral buckling of beams - Energy method- Application to symmetric and single symmetric I beams - Simply supported and cantilever beams - Narrow rectangular cross sections - Numerical solutions; Torsional buckling - Uniform and non-uniform torsion on open cross section - Flexural torsional buckling - Equilibrium and energy approach.

UNIT V BUCKLING OF THIN PLATES 9

Isotropic rectangular plates - Governing Differential equations - Simply supported on all edges - Use of energy methods -Numerical techniques.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- analyze both static and dynamic instabilities, by both theoretical and numerical methods.
- execute and work out the inelastic buckling using various methodologies.
- examine the behaviour of beam columns and frames with and without side sway using classical and stiffness methods.
- be well versed in the lateral buckling, torsional buckling, flexural torsional buckling of various beams and non-circular sections.
- evaluate buckling of thin plates using energy methods and various numerical techniques.

REFERENCES

1. Timoshenko, S., and Gere., "Theory of Elastic Stability", McGraw Hill Book Company, 2012.
2. Chajes, A. "Principles of Structural Stability Theory", Prentice Hall, 1974.
3. Ashwini Kumar, "Stability of Structures", Allied Publishers LTD, New Delhi, 2003.
4. Iyenger.N.G.R., "Structural Stability of Columns and Plates", Affiliated East West Press,1988.
5. Gambhir, "Stability Analysis and Design of Structures", springer, New York , 2004.

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	-	-	-	-	-	-	2
CO2	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO3	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	-	-	2
CO5	3	2	-	-	-	2	2	-	-	-	-	-	-	2

PSE16653 CRACKS AND CRACK CONTROL IN CONCRETE STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To equip the students with a knowledge of properties and microstructure of concrete.
- To impose a knowledge of various durability and corrosion behavior of concrete.
- To classify the different types of cracks due to any type of force including earthquake force and other factors.
- To have a knowledge of long term effects of cracking.
- To impinge a knowledge of crack detection and crack measuring techniques

UNIT I PROPERTIES OF CONCRETE 9

Historical note on Portland Cement Concrete - Basic properties of plain concrete - Microstructure - Shrinkage, creep and strength of concrete - Temperature effect on concrete; Transport properties of concrete - Tensile, shear, bend and torsional strength of plain and reinforced concrete.

UNIT II DURABILITY OF CONCRETE 9

Durability of concrete causes for inadequate durability of concrete chloride diffusion - Carbonation of concrete - Sulphate attack - Acid attack on concrete - Alkali - Silica reaction - Abrasion resistance - Fire resistance - Erosion resistance - Cavitations - Flame resistance - corrosion resistance - Chemical resistance of concrete and other durability tests methods on concrete.

UNIT III THEORY OF CONCRETE 9

Classifications of cracks in plain and reinforced concrete - Theories of cracking and fundamental mechanics of cracking - Shear cracking, Moment cracking, Torsional cracking - Settlement cracks - Cracks due to force transfer - Cracking due to earthquake forces and cracking due to other factors.

UNIT IV PROPERTIES OF CRACKS 9

Long term effects of cracking - Material and loading effects- Creep effect Bond - Slip theory - Straight line theory - Flexural stiffness - Effective moment of inertia; Computation of deflection due to short term and long term - Computation of crack width and crack spacings.

UNIT V CRACK DETECTION AND CONTROL 9

Crack detection - Crack measuring techniques - Control of cracking in plain and reinforced concrete beams and columns - Crack control by material selection - Crack reduction designs and construction practices - Advanced crack control and repair techniques.

TOTAL PERIODS 45

COURSE OUTCOMES

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

- gain the knowledge of properties and microstructure of concrete.
- get exposed to durability of concrete and corrosion behavior.
- familiarize with advanced knowledge of causes and propagation of cracks.
- understand the long term effects of cracking
- detect various cracks and measuring techniques for the same.

REFERENCES

1. SandorPopovics, " Concrete Materials: Properties, Specifications, and Testing", Noyes Publications, 1992.
2. Prashanthkumar, "Elements of Fracture Mechanics", by Wheeler Publishing Company, New Delhi, 2009
3. Srinath L.S., "Advanced mechanics of Solids", TataMcgraw-hill Publishing Company Ltd, New Delhi, 2009.
4. Parton V.N, Movozov E.M., "Elastic-plastic Fracture Mechanics", Mir publishers Moscow, 1984.
5. Kong F.K. and Evans R.H, "Reinforced and Prestressed Concrete", 3rd Ed- ELBS- Van no strand Reinhold (International), 1998.
6. IS 456 - 2000 Plain and Reinforced Concrete - Code of Practice.
7. SP:16 -1980 Design Aids for Reinforced Concrete to IS:456-1978.

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	2	-	-	-	1	-	-	-	-	-	-	2	1	2
CO2	2	-	-	-	1	-	-	-	-	-	-	2	1	2
CO3	2	-	-	-	1	-	-	-	-	-	-	2	1	2
CO4	2	-	-	-	1	-	-	-	-	-	-	2	2	2
CO5	2	-	-	-	1	-	-	-	-	-	-	1	2	2

ELECTIVE VII

PSE16751 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To get introduced to composite construction and composite behaviour of steel concrete composite structures.
- To obtain the knowledge to conceptualize and design the composite beams, columns, floors, slabs and concrete filled steel tubes.
- To get introduced to various connections and connection design of composite structures
- To have a knowledge in the behaviour of composite box girder bridges.
- To possess practical knowledge on the skills of composite construction and seismic behaviour of composite structures through case studies.

UNIT I INTRODUCTION 9

Introduction to steel – Concrete composite construction – Behaviour of composite structures – Composite construction

UNIT II DESIGN OF COMPOSITE MEMBERS 9

Design of composite beams - slabs and composite floors - composite columns – Design of composite trusses

UNIT III DESIGN OF CONNECTIONS 9

Types of connections - Design of connections in the composite structures – Shear connections – Degree of shear connection – Partial shear interaction

UNIT IV COMPOSITE BOX GIRDER BRIDGES 9

Introduction – Behaviour of box girder bridges – Design concepts

UNIT V CASE STUDIES 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

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

- possess knowledge of the composite behaviour of structures.
- design various composite structural elements such as beams,columns, floors, slabs and concrete filled steel tubes.
- analyse the connection behaviour and design.
- enumerate the behaviour of box girder bridges and the design concepts of the same.
- have practical knowledge of construction and design of various structural elements and design concepts through case studies.

REFERENCES

1. Johnson R.P., "Composite Structures of Steel and Concrete", Blackwell Scientific Publications , UK 2008.
2. Oehers D.J. and Bradford M.A., "Composite Steel and Concrete Structural Members, Fundamental Behaviour", Permagon Press, Oxford, 1999.
3. Proceedings of Workshop on "Steel Concrete Composite Structures", Anna University, 2007.
4. INSDAG Materials , Volume I and II. 2000.
5. BS 5950-1 : 2000 Structural use of steel work in building. Code of practice for design - Rolled and welded sections.
6. EN 1994 Euro code 4 : Design of composite steel and concrete structures, composite slabs.
7. IS11384 - 1985 code of practice for composite construction in structural steel and concrete.

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	-	-	-	-	2	1	2
CO2	3	2	-	-	-	2	2	-	-	-	-	2	1	2
CO3	3	2	-	-	-	2	2	-	-	-	-	2	1	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2	1	2
CO5	3	2	-	-	-	2	2	-	-	-	-	2	1	2

PSE16752 MECHANICS OF COMPOSITE MATERIALS 3 0 0 3

COURSE OBJECTIVES

- To describe the composite materials and properties of composite fiber and matrix constituents.
- To state stress strain relation of orthotropic and anisotropic materials.
- To recall the static, dynamic and stability analysis for simpler cases of composite plates.
- To elucidate the failure criterion and fracture mechanism of composites.
- To identify the metal and ceramic composite & design with composites

UNIT I INTRODUCTION 9

Introduction to Composites - Classifying composite materials and their properties - Commonly used fiber and matrix constituents; Composite Construction - Properties of Unidirectional Long Fiber Composites - Short Fiber Composites.

UNIT II STRESS STRAIN RELATIONS 9

Concepts in solid mechanics - Hooke's law for orthotropic and anisotropic materials - Linear Elasticity for Anisotropic materials - rotations of stresses, strains, residual stresses.

UNIT III ANALYSIS OF LAMINATED COMPOSITES 9

Governing equations for anisotropic and orthotropic plates - Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates; Inter laminar stresses.

UNIT IV FAILURE AND FRACTURE OF COMPOSITES 9

Netting analysis - Failure criterion - maximum stress - maximum strain, fracture mechanics of composites; Sandwich construction.

UNIT V APPLICATIONS AND DESIGN 9

Metal and ceramic matrix composites - Applications of composites, composite joints; Design with composites- Review, Environmental issues

TOTAL PERIODS 45

COURSE OUTCOMES

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

- categorize the fibre types and classify the composite material.
- tell the stress –strain properties, longitudinal and transverseproperties of composites lamina.
- analyse the laminated composites and compute the lamina strength.
- locate the failure criterion and fracture mechanics of composites.
- relate the load deformation relation, residual stresses for the design of composites.

REFERENCES

1. Daniel and Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2006.
2. Jones R.M., "Mechanics of composite materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1998.
3. Agarwal.B.D. and Broutman.L.J., "Analysis and Performance of fiber composites", John-Wiley and Sons, 2006.
4. Michael W.Hyer, "Stress Analysis of Fiber-Reinforced Composite Materials", McGraw Hill, 2009.

WEB LINKS

1. http://users.fs.cvut.cz/tomas.mares/mkm/mkm.pdf
2. http://www.nptel.ac.in/courses/101104010
3. http://naca.central.cranfield.ac.uk/reports/arc/rm/3677.pdf

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	-	-	-	-	2	2	2
CO2	3	2	-	-	-	2	2	-	-	-	-	2	2	2
CO3	3	2	-	-	-	2	2	-	-	-	-	2	2	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2	2	2
CO5	3	2	-	-	-	2	2	-	-	-	-	2	2	2

PSE16753 DESIGN OF POWER PLANT STRUCTURES 3 0 0 3

COURSE OBJECTIVES

- To familiar with various planning and lay out of power plants.
- To introduce the design of analysis and design of steel and concrete chimneys.
- To be familiar with cooling towers.
- To understand the design of machine foundations and turbo generator foundations.
- To familiarize with different material handling system

UNIT I POWER PLANTS 9

Planning and Layout of different types of Power plants.

UNIT II CHIMNEYS 9

Analysis and Design of Chimneys - IS codal provisions.

UNIT III COOLING TOWERS 9

Induced draught and natural draught cooling towers.

UNIT IV FOUNDATIONS 9

Machine foundations and Turbo generator foundations. Silos and Bunkers

UNIT V MATERIAL HANDLING STRUCTURES 9

Silos and Bunkers

TOTAL PERIODS 45

COURSE OUTCOMES

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

- formulate the planning and layout of different power plants
- analyse and design chimneys as per codal provisions.
- be efficient in design of cooling towers.
- be familiar with all types of machine foundations.
- design all types of material handling systems.

REFERENCES

1. Krishna Raju N. "Advanced Reinforced Concrete Design", CBS Publishers and Distributors, 2nd Edition, 2008.
2. Srinivasulu, P and Vaidyanathan, G.V., "Handbook of Machine Foundations", Tata McGraw Hill, 2nd Edition, 1999.
3. Vijay K. Puri and ShamsherPrakash, "Foundations for Machines: Analysis and Design (Series in Geotechnical Engineering)", John Wiley & Sons, 2nd Edition, 2000.
4. Eldey Mc. K., Naxey Brooke K.K. "The Industrial Cooling Tower with special reference to design, construction, operation and maintenance of water cooling tower", Elsevier Publishing company, 1st Ed., 1990.
5. IS:9178-1980 - Criteria for Design of Steel Bins for Storage of Bulk Materials.
6. IS:2974 (Part I to V) - Code of practice for design and construction of machine foundations.
7. IS 4995 (Part II) -1974 - General Requirements and assessment of bin Loads.

8. IS 6060 -1971 - Code of practice for Day lighting of factory buildings.
9. IS:456-2000 - Code of Practice for Plain and Reinforced Concrete.
10. IS 6533 (Part 2) -1989 - Code of practice for design and construction of steel chimneys.
11. IS:875 (Part 1 to 5) - Code of Practice for Design loads.

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	2	-	1	-	1	1	1	-	-	-	1	2	1	1
CO2	2	-	1	-	1	1	1	-	-	-	1	1	1	1
CO3	2	-	1	-	1	1	1	-	-	-	1	2	1	1
CO4	2	-	1	-	1	1	1	-	-	-	1	2	1	1
CO5	2	-	1	-	1	1	1	-	-	-	1	1	1	1

SEMESTER IV

PSE16401 PROJECT WORK (PHASE II) 0 0 24 12

COURSE OBJECTIVES

- To solve the identified problem based on the formulated methodology.
- To gain knowledge on experimental works.
- To develop skills to analyze field related problems.
- To 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. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL PERIODS 360

COURSE OUTCOMES

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

- solve challenging practical problem in their project
- practice various experimental work related to their project.
- develop skills to analyze field problems.
- get the test results and make possible conclusions.

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	2	2	2	-	-	-	-	-	2	1	-	2	-	2
CO2	2	2	2	-	-	-	-	-	2	1	-	2	-	2
CO3	2	2	2	-	-	-	-	-	2	1	-	2	-	2
CO4	2	2	2	-	-	-	-	-	2	1	-	2	-	2