# SETHU INSTITUTE OF TECHNOLOGY

Pulloor, Kariapatti – 626 115.

(*An Autonomous Institution*)

## DEPARTMENT OF CIVIL ENGINEERING

# M.E. STRUCTURAL ENGINEERING

REGULATIONS 2019 – CHOICE BASED CREDIT SYSTEM

# CURRICULUM & SYLLABUS

Approved in the

Academic Council Meeting on 21.09.2019

Chairperson/BOS

Chairman

Academic Council

# SETHU INSTITUTE OF TECHNOLOGY

Pulloor, Kariapatti – 626 115

(***An Autonomous Institution***)

**M.E. Degree Programme**

**CURRICULUM**

## Regulations 2019

**Master of Engineering in Structural Engineering**

### OVERALL COURSE STRUCTURE

| Category | Total No. of Courses | Credits | Percentage |
|---|---|---|---|
| Programme Core | **8** | **20** | **29** |
| Programme Elective | **5** | **15** | **21** |
| Open Elective | **1** | **3** | **4** |
| Mandatory Credit Course | **1** | **3** | **4** |
| Audit Course | **2** | **-** | **-** |
| Project work | **3** | **29** | **42** |
| **TOTAL** | **20** | **70** | **100** |

### COURSE CREDITS – SEMESTER WISE

| Branch | I | II | III | IV | TOTAL |
|---|---|---|---|---|---|
| **Structural Engineering** | **16** | **16** | **22** | **16** | **70** |

## LIST OF WINTER COURSES

| S.No | Subject Code | Subject Name | L | T | P | C | Category |
|---|---|---|---|---|---|---|---|
| 1. | 19PSE101 | Design of Advanced Concrete Structures | 3 | 0 | 0 | 3 | **PC** |
| 2. | 19PSE102 | Theory of Elasticity and Plasticity | 3 | 0 | 0 | 3 | **PC** |
| 3. | 19PGM701 | Research Methodology and IPR | 3 | 0 | 0 | 3 | **BS** |
| 4. | 19PGM801 | Pedagogy Studies | 2 | 0 | 0 | 0 | **BS** |
| 5. | 19PSE103 | Computing in Structures | 0 | 0 | 4 | 2 | **PC** |
| 6. | 19PSE104 | Advanced Concrete Laboratory | 0 | 0 | 4 | 2 | **PC** |
| 7. | 19PSE301 | Dissertation Phase I | 0 | 0 | 20 | 10 | **PW** |

## LIST OF SUMMER COURSES

| S.No | Subject Code | Subject Name | L | T | P | C | Category |
|---|---|---|---|---|---|---|---|
| 1. | 19PSE201 | Finite Element Analysis for Structural Engineering | 3 | 0 | 0 | 3 | **PC** |
| 2. | 19PSE202 | Structural Dynamics | 3 | 0 | 0 | 3 | **PC** |
| 3. | 19PGM802 | English for Research Paper Writing | 2 | 0 | 0 | 0 | **BS** |
| 4. | 19PSE203 | Structural Design Laboratory | 0 | 0 | 4 | 2 | **PC** |
| 5. | 19PSE204 | Structural Testing Laboratory | 0 | 0 | 4 | 2 | **PC** |
| 6. | 19PSE205 | Mini Project with Seminar | 0 | 0 | 4 | 3 | **PW** |
| 7. | 19PSE401 | Dissertation Phase II | 0 | 0 | 32 | 16 | **PW** |

## LIST OF PROGRAMME ELECTIVES

| S.No | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | 19PSE501 | Analysis and Design of Tall Buildings | 3 | 0 | 0 | 3 |
| 2. | 19PSE502 | Offshore Structures | 3 | 0 | 0 | 3 |
| 3. | 19PSE503 | Optimization of Structures | 3 | 0 | 0 | 3 |
| 4. | 19PSE504 | Design of Bridges | 3 | 0 | 0 | 3 |
| 5. | 19PSE505 | Mechanics of Composite Materials | 3 | 0 | 0 | 3 |
| 6. | 19PSE506 | Advanced Concrete Technology | 3 | 0 | 0 | 3 |
| 7. | 19PSE507 | Design of Sub Structures | 3 | 0 | 0 | 3 |
| 8. | 19PSE508 | Design of Industrial Structures | 3 | 0 | 0 | 3 |
| 9. | 19PSE509 | Nonlinear Analysis of Structures | 3 | 0 | 0 | 3 |
| 10. | 19PSE510 | Precast and Prefabricated Structures | 3 | 0 | 0 | 3 |
| 11. | 19PSE511 | Theory of Plates and Shells | 3 | 0 | 0 | 3 |
| 12. | 19PSE512 | Earthquake Analysis and Design of structures | 3 | 0 | 0 | 3 |
| 13. | 19PSE513 | Matrix Methods for Structural Analysis | 3 | 0 | 0 | 3 |
| 14. | 19PSE514 | Design of Storage Structures | 3 | 0 | 0 | 3 |
| 15. | 19PSE515 | Engineering Fracture Mechanics | 3 | 0 | 0 | 3 |
| 16. | 19PSE516 | Constitutive Models and modes of failure | 3 | 0 | 0 | 3 |
| 17. | 19PSE517 | Smart Materials and Smart Structures | 3 | 0 | 0 | 3 |
| 18. | 19PSE518 | Design of Steel Concrete Composite Structures | 3 | 0 | 0 | 3 |
| 19. | 19PSE519 | Stability of Structures | 3 | 0 | 0 | 3 |
| 20. | 19PSE520 | Advanced Steel Design | 3 | 0 | 0 | 3 |
| 21. | 19PSE521 | Design of Prestressed Concrete Structures | 3 | 0 | 0 | 3 |
| 22. | 19PSE522 | Experimental Techniques and Instrumentation | 3 | 0 | 0 | 3 |
| 23. | 19PSE523 | Theory and Applications of Cement Composites | 3 | 0 | 0 | 3 |
| 24. | 19PSE524 | Structural Health Monitoring | 3 | 0 | 0 | 3 |
| 25. | 19PSE525 | Design of Formwork | 3 | 0 | 0 | 3 |

## LIST OF OPEN ELECTIVES

| S.No | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | 19PCD601 | Industrial Safety | 3 | 0 | 0 | 3 |
| 2. | 19PCS602 | Business Analytics | 3 | 0 | 0 | 3 |
| 3. | 19PCM603 | IOT for Smart Applications | 3 | 0 | 0 | 3 |
| 4. | 19PPE604 | Bio Energy from Waste | 3 | 0 | 0 | 3 |
| 5. | 19PSE605 | Smart City Technologies | 3 | 0 | 0 | 3 |

## LIST OF MANDATORY CREDIT COURSE

| S.No | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | 19PGM701 | Research Methodology and IPR | 3 | 0 | 0 | 3 |

## LIST OF AUDIT COURSE

| S.No | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | 19PGM801 | Pedagogy Studies | 2 | 0 | 0 | 0 |
| 2. | 19PGM802 | English for Research Paper Writing | 2 | 0 | 0 | 0 |

**SEMESTER I**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 19PSE101 | Design of Advanced Concrete Structures | 3 | 0 | 0 | 3 |
| 19PSE102 | Theory of Elasticity and Plasticity | 3 | 0 | 0 | 3 |
| | Professional Elective I | 3 | 0 | 0 | 3 |
| 19PGM701 | Research Methodology and IPR (Mandatory Credit Course) | 3 | 0 | 0 | 3 |
| 19PGM801 | Pedagogy Studies (Audit Course – I) | 2 | 0 | 0 | 0 |
| **PRACTICAL** | | | | | |
| 19PSE103 | Computing in Structures | 0 | 0 | 4 | 2 |
| 19PSE104 | Advanced Concrete Laboratory | 0 | 0 | 4 | 2 |
| | **TOTAL** | **14** | **0** | **8** | **16** |
| **Total No. of Credits – 16** | | | | | |

**SEMESTER II**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| 19PSE201 | Finite Element Analysis for Structural Engineering | 3 | 0 | 0 | 3 |
| 19PSE202 | Structural Dynamics | 3 | 0 | 0 | 3 |
| | Professional Elective II | 3 | 0 | 0 | 3 |
| 19PGM802 | English for Research Paper Writing (Audit Course – II) | 2 | 0 | 0 | 0 |
| **PRACTICAL** | | | | | |
| 19PSE203 | Structural Design Laboratory | 0 | 0 | 4 | 2 |
| 19PSE204 | Structural Testing Laboratory | 0 | 0 | 4 | 2 |
| 19PSE205 | Mini Project with Seminar | 0 | 0 | 4 | 3 |
| | **TOTAL** | **11** | **0** | **12** | **16** |
| **Total No. of Credits – 16** | | | | | |

**SEMESTER III**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **THEORY** | | | | | |
| | Professional Elective III | 3 | 0 | 0 | 3 |
| | Professional Elective IV | 3 | 0 | 0 | 3 |
| | Professional Elective V | 3 | 0 | 0 | 3 |
| | Open Elective | 3 | 0 | 0 | 3 |
| **PRACTICAL** | | | | | |
| 19PSE301 | Dissertation Phase I | 0 | 0 | 20 | 10 |
| | **TOTAL** | **12** | **0** | **20** | **22** |
| **Total No. of Credits – 22** | | | | | |

**SEMESTER IV**

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| **PRACTICAL** | | | | | |
| 19PSE401 | Dissertation Phase II | 0 | 0 | 32 | 16 |
| | **TOTAL** | **0** | **0** | **32** | **16** |
| **Total No. of Credits – 16** | | | | | |

# SEMESTER I

| 19PSE101 | DESIGN OF ADVANCED CONCRETE STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To give an exposure on the behavior, analysis and design of R.C structures and to calculate deflection and crack width.
- To teach the design aspects of shear walls, flat slabs, deep beams and grid floors.
- To impart knowledge on detailing for earthquake resistant design.

**UNIT I DESIGN PHILOSOPHY** **9**

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

**UNIT II DESIGN OF SPECIAL RC ELEMENTS** **9**

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

**UNIT III FLAT SLABS AND YIELD LINE BASED DESIGN** **9**

Design of flat slabs and flat plates according to IS Method - Check for shear - Design of spandrel beams - Yield line theory and Hillerborgs strip method of design of slabs.

**UNIT IV INELASTIC BEHAVIOUR OF CONCRETE STRUCTURES** **9**

Inelastic behaviour of concrete beams and frames, moment - rotation curves

**UNIT V DUCTILE DETAILING** **9**

Concept of Ductility – Detailing for ductility – Design of beams, columns for ductility - Design of cast- in-situ joints in frames – Expansion and construction joints in buildings. Fire resistance of Reinforced concrete members –

**TOTAL: 45 PERIODS**

**(Note: Use of IS 13920:2016, IS 456:2000 and SP16 are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to,**

- Design beams, slabs and columns by limit state method estimates deflection and crack width. **(Apply)**
- Design special R.C. elements such as shear walls, Corbels and deep beams and grid floors. **(Apply)**
- Apply Yield line theory for design of slabs. **(Apply)**
- Analyse inelastic behavior of beams and frames. **(Analyse)**
- Detail R.C. members for ductility as per IS codes. **(Apply)**

**REFERENCES:**


1. Unnikrishna Pillai and Devdas Menon “Reinforced concrete Design‟, Tata McGraw Hill Publishers Company Ltd., New Delhi, 3rd Edition 2017.
2. Varghese, P.C., “Limit State Design of Reinforced Concrete”, Prentice Hall of India,2010.
3. Varghese, P.C, “Advanced Reinforced Concrete Design”, Prentice Hall of India,2009.
4. Purushothaman, P, “Reinforced Concrete Structural Elements : Behaviour Analysis and Design”, Tata McGraw Hill,1986.
5. Gambhir.M.L., “Design of Reinforced Concrete Structures”, Prentice Hall of India,2012.
6. Krishna Raju. N Advanced Reinforced Concrete Design (IS : 456-2000)] Publisher: CBS; 3rd edition (2017).


**STANDARDS:**


1. IS: 13920-2016 - Ductile detailing of reinforced concrete structures subjected to seismic forces – Code of Practice.
2. IS: 456-2000 - Indian Standard Code of Practice for Plain and Reinforced Concrete.
3. SP16-Design Aid for RC to IS456-1978.

| 19PSE102 | THEORY OF ELASTICITY AND PLASTICITY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on the elastic and plastic properties of various elements.
- To train the students to solve problems of thin walled open and closed sections subjected to torsion.
- To introduce energy principles and their application to elasticity problems.

**UNIT I ELASTICITY** **9**

Analysis of stress and strain, Equilibrium equations - Compatibility equations – stress strain relationship - Generalized Hooke‟s law.

**UNIT II ELASTICITY SOLUTION** **9**

Methods of formulation of elasticity problems - methods of solution of elasticity problems - Plane stress and plane strain - Simple two dimensional problems in Cartesian and polar co-ordinates.

**UNIT III ENERGY METHODS** **9**

Numerical and Energy methods - Castiglianos theorem - Principle of Virtual work - Principle of stationary potential energy - Principle of least work - Rayleigh‟s method - Rayleigh-Ritz method- Finite difference method - Simple applications.

**UNIT IV TORSION** **9**

Introduction - general solution of torsion problems - boundary conditions- stress function method- Torsion of non-circular sections – Saint venant’s Method- Prandtl's membrane analogy - torsions of thin walled open and closed sections and thin walled multiple cell closed sections.

**UNIT V PLASTICITY** **9**

Strain hardening, Idealized stress strain curve - criterion of yielding, Von Mises yield criterion, Tresca yield criterion - Physical Assumptions – yield criterion plastic stress strain relationship - Elastic plastic problems in bending – torsion and thick cylinder.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Distinguish plane stress and plane strain problems. **(Understand)**
- Obtain elasticity solutions for Simple two dimensional problems in Cartesian and polar coordinates. **(Understand)**
- Apply energy methods to solve elasticity problems. **(Apply)**
- Solve thin walled open and closed sections for torsion. **(Apply)**
- Solve Plasticity problems. **(Apply)**

**REFERENCES:**


1. Ansel.C.Ugural and Saul.K.Fenster, ”Advanced Strength and Applied Elasticity,” Fourth Edition, Prentice Hall Professional technical Reference, New Jersy,2003.
2. Chakrabarty.J, “Theory of Plasticity”, Third Edition, Elsevier Butterworth - Heinmann – UK, 2007.
3. Jane Helena H, “Theory of Elasticity and Plasticity”, PHI Learning Pvt. Ltd., 2016 .
4. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 2005.
5. Slater R.A.C, “Engineering Plasticity”, John Wiley and Son, NewYork,1977.
6. Timoshenko, S. and Goodier J.N."Theory of Elasticity", McGraw Hill Book Co., New York, 2010.

| 19PSE103 | COMPUTING IN STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

- To train the students to develop the design charts for structural components using spread sheets.
- To give exposure in modeling and analysis of structural components using use the software packages for Structural analysis and Design.
- To develop programs using numerical techniques.

## LIST OF EXPERIMENTS

1. Develop design charts for the following structural elements using Spread sheets
   a. RCC beams
   b. Slabs
   c. Columns
   d. Foundations
   e. Retaining walls
2. Stress analysis of a beams with different loading conditions using software packages
3. Model analysis of a simply supported beam using software packages
4. Development of programs to solve problems using numerical techniques
   a. Roots of an equation using Newton – Raphson method
   b. Solution of linear simultaneous equations using Gauss elimination.
   c. Curve fitting using Polynomial Regression.

**LABORATORTY EQUIPMENTS REQUIREMENTS**

- Spread sheet tool, ANSYS, MATLAB

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Develop design charts for structural components using spread sheets. **(Apply)**
- Do modeling and analysis of structural components. **(Apply)**
- To develop programs using numerical techniques. **(Apply)**
- Determine solutions of linear simultaneous equations. **(Apply)**
- Do curve fitting using Polynomial Regression. **(Apply)**

| 19PSE104 | ADVANCED CONCRETE LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

- To make them to do concrete mix design as per ACI and IS code.
- To give exposure to special concrete mix design.
- To study the fresh and hardened properties.

**LIST OF EXPERIMENTS**

1. Mix design for normal strength concrete using admixture/plasticizer by IS code method.
2. Mix design for high strength concrete using admixture/plasticizer IS code method.
3. Develop design charts for concrete mix design using spread sheets.
4. Concrete Mix Design- ACI codeMethod.
5. Concrete Mix Design of Special Concrete.
   a. Fibre Reinforced concrete - FRC.
   b. Selfcompacting concrete - SCC.
   c. Geopolymer Concrete.
6. Study the workability properties.
7. Determination of compressive, split tensile and flexural strengths of concrete.
8. Determination of Modulus of Elasticity of Concrete using Compressometer.

**LABORATORTY EQUIPMENTS REQUIREMENTS**

- Concrete mixer,
- Compression testing machine
- Flexural testing machine
- Compressometer
- Table and needle vibrators
- Cube , Cylinder and Beam Moulds

**TOTAL – 30 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to,**

1. Arrive at concrete mix design for various types of concretes as per IS code and ACI code. **(Apply)**
2. Find dosage of admixture/plasticizer. **(Understand)**
3. Develop design charts for concrete mix design using spread sheets. **(Apply)**
4. Determine the mix proportions for special concretes. **(Understand)**
5. Check the strength of concrete. **(Understand)**

**REFERENCES:**


1. Gambhir.M.L., Concrete Technology, McGraw Hill Education,2017.
2. Gupta.B.L.,Amit Gupta, “Concrete Technology, Jain Book Agency,2014.
3. Neville, A.M., Properties of Concrete, Prentice Hall, 2014,London.
4. Santhakumar.A.R. ;”Concrete Technology”,Oxford UniversityPress,2018.
5. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi,2018
6. Concrete mix proportioning guide lines Second revision IS 10262: 2019

# SEMESTER-II

| 19PSE201 | FINITE ELEMENT ANALYSIS FOR STRUCTURAL ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart the finite element concepts.
- To train the students to solve for displacements and stresses using finite element analysis.
- To provide an overview of nonlinear analysis of structures.

**UNIT I INTRODUCTION TO FINITE ELEMENT METHOD 9**

Historical Background - Basic Concept of FEM - Engineering problems and governing differential equations - Finite element modeling - Discretisation - Node, Element - different types of element - Approximate Solutions - Principal of minimum potential energy- Rayleigh-Ritz method and Galerkins methods.

**UNIT II FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS 9**

One dimensional problems - Coordinate systems – global, local and natural coordinate systems- shape functions – Bar, beam and truss element - Generation of Stiffness Matrix and Load Vector- Applications

**UNIT III FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS 9**

Two Dimensional problems – Plane Stress, Plane Strain Problems - Triangular and Quadrilateral Elements - Isoparametric Formulation - Natural Coordinates - Shape function - stiffness matrix- Axisymmetric Problems - Higher Order Elements - Numerical Integration.

**UNIT IV MESHING AND SOLUTION PROBLEMS 9**

Higher Order Elements - p and h Methods of Mesh Refinement - ill conditioned Elements – Discretisation Errors – Auto and Adaptive Mesh Generation Techniques - Error Evaluation.

**UNIT V NONLINEAR, VIBRATION AND THERMAL PROBLEMS 9**

Material and Geometric Nonlinearity – Methods of Treatment – Consistent System Matrices - Dynamic Condensation - Eigen Value Extraction - thermal analysis.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explain basic concepts of finite element analysis. **(Understand)**
- Solve one dimensional problems like bars, beams and truss. **(Apply)**
- Find out the solutions for two dimensional and axi symmetric problems using finite element method. **(Apply)**
- Describe the concepts of different mesh generation techniques. **(Understand)**
- Apply finite element method to solve nonlinear, vibration and thermal problems. **(Apply)**

**REFERENCE:**


1. Bhavikatti.S.S, “Finite Element Analysis”, New Age International Publishers, Third Edition 2015.
2. Chandrupatla, R.T. and Belegundu, A.D., “Introduction to Finite Elements in Engineering”, Prentice Hall of India,2014.

3. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill Publishing Company Limited, New Delhi, First Edition 2017.
4. Moaveni, S., “Finite Element Analysis Theory and Application with ANSYS”, Prentice Hall Inc.,2017.
5. Rao.S.S, “Finite Element Method in Engg.”, Butterworth – Heinemann, UK, Sixth Edition 2017.
6. Logan D. L., A First Course in the Finite Element Method, Thomson Learning, 2007.

| 19PSE202 | STRUCTURAL DYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To expose the students the principles and methods of dynamic analysis of structures.
- To make the students to solve single, two and MDOF systems
- To outline the practical applications of dynamic analysis.

**UNIT I INTRODUCTION AND SINGLE DEGREE OF FREEDOM SYSTEM** **9**

Objectives, Importance of Vibration Analysis, Nature of Exciting Forces, Mathematical Modeling of Dynamic Systems. Free and Forced Vibration with and without Damping, Response to Harmonic Loading, Response to General Dynamic Loading using Duhamel's Integral Methods

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

Two Degree of Freedom System, Multiple Degree of Freedom System, Inverse Iteration Method for Determination of Natural Frequencies and Mode Shapes, Dynamic Response by Modal Superposition Method, Direct Integration of Equation of Motion.

**UNIT III CONTINUOUS SYSTEMS** **9**

Free and forced vibration of continuous systems, Rayleigh – Ritz method – Formulation using Conservation of Energy – Formulation using Virtual Work, Applications.

**UNIT IV NUMERICAL SOLUTION** **9**

. Response using Newmark Method and Wilson Method, Numerical Solution for State Space Response using Direct Integration

**UNIT V SPECIAL TOPICS IN STRUCTURAL DYNAMICS (CONCEPTS ONLY):** **9**

Dynamic Effects of Wind Loading, Moving Loads, Vibrations caused by Traffic, Blasting and Pile Driving, Foundations for Industrial Machinery, Base Isolation.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Analyse and study dynamics response of single degree freedom system using fundamental theory and equation of motion. **(Apply)**
- Analyse and study dynamics response of Multi degree freedom system using fundamental theory and equation of motion. **(Apply)**
- Solve free and forced vibration of continuous systems. **(Apply)**
- Evaluate the response of systems due to dynamic loads using direct integration methods. **(Evaluate)**
- Explains the dynamic effects of various loadings. **(Understand)**

**REFERENCE:**


1. Anil K.Chopra, Dynamics of Structures, Pearson Education, Fifth Edition 2015.
2. Leonard Meirovitch, Elements of Vibration Analysis, McGraw Hill, 1986, IOS Press,2006.
3. Mario Paz, Structural Dynamics -Theory and Computation, Kluwer Academic Publishers, 2004.
4. Roy R.Craig, Jr, Andrew J. Kurdila, Fundamentals of Structural Dynamics, John Wiley & Sons,2011.
5. Madhujit Mukhopadhyay - Structural Dynamics Vibrations and Systems, Ane Books India Publishers, 2010.
6. Anil K.Chopra, Dynamics of Structures, Pearson Education, 2007.

| 19PSE203 | STRUCTURAL DESIGN LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

- To make the students develop knowledge by using software packages on analysis of structures.
- To enable the students familiar in designing all the structural components of frame buildings and multi storey frame buildings by using software packages
- To train the students to use IS codes for detailing the reinforcements of structural components and complete multi-storey frame buildings

**LIST OF EXPERIMENTS**

1. Design and detailed drawing of multi storey framed buildings by individual student using latest relevant IS codes and software packages

**LABORATORTY EQUIPMENTS REQUIREMENTS**

- Staad Pro. Software, Auto CAD

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to,**

- Proficiently use the software packages for Structural analysis and Design. **(Apply)**
- Design and Detail all the Structural Components of Frame Buildings. **(Apply)**
- Design and Detailing of a complete Multi-Storey Frame Buildings. **(Apply)**

**REFERENCES:**


1. Krishnamoorthy C.S., and Rajeev.S., “Computer Aided Design and Analytical tools”, Narosa., 2000.
2. Krishna Raju, N., “Design of Reinforced Concrete Structures”, CBS Publishers & Distributors, New Delhi, 2017.
3. Ductile Design and Detailing ofReinforced Concrete StructuresSubjected to Seismic forces code of Practice IS13920: 2016.
4. IS 456:2000: Code of practice for plain and reinforced concrete (fourth revision)
5. IS 800:2007 : Code of practice for general construction in steel (third revision)
6. IS 875(Part 1 to 5):1987
7. SP 34 : 1987 : Hand book on concrete reinforcement and detailing
8. SP16-Design Aid for RC to IS456-1978

| 19PSE204 | STRUCTURAL TESTING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**OBJECTIVES:**

1. To train the students to carry out experimental testing of RC and steelbeams.
2. To make them understand the strength and deflection behavior of flexural members.
3. To prepare them to conduct non-destructive tests onconcrete.

## LIST OF EXPERIMENTS

1. Study the different structural testing methods, loading conditions, Related instrumentation such as deflection gauges, load cells, proving rings, strain gauges, accelerometers, impact hammers, data acquisition systems
2. Fabrication, casting and testing of simply supported R.C beam for Strength and deflection behaviour.
3. Testing of simply supported Steel beam for strength and deflectionbehaviour.
4. Fabrication, casting and testing of RC column subjected to Concentric and eccentricloading.
5. Determination of in-situ strength and quality of concrete using
   i) Reboundhammer
   ii) Ultrasonic Pulse VelocityTester
6. Determination of Impact Resistance of concrete
7. Determination of Permeability of concrete
8. Measurement of Cracks
9. Durability Tests on Concrete
   - Water absorption
   - Sorptivity
   - Acid resistance
   - Sulphate resistance
10. Study of Strain Measuring devices
    - Mechanical StrainGauge
    - Electrical StrainGauges.

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Understand the various testing methods and equipment used for testing. **(Understand)**
- Evaluate the structural behavior of RCC flexural members. **(Apply)**
- Evaluate the structural behavior of Steel flexural members. **(Apply)**
- Assess the quality of concrete using Non-Destructive Testing Methods. **(Apply)**
- Determine the Durability properties of Concrete. **(Apply)**

**REFERENCES:**


1. Dally J W, and Riley W F, “Experimental Stress Analysis”, McGraw-Hill Inc. New York, 1991.
2. Gambhir.M.L., Concrete Technology, McGraw Hill Education,2009.
3. Gupta.B.L.,Amit Gupta, “Concrete Technology, Jain Book Agency,2010.
4. Neville, A.M., Properties of Concrete, Prentice Hall, 1995,London.
5. Santhakumar.A.R. ;”Concrete Technology”,Oxford UniversityPress,2007.
6. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi,2006
7. M.S. Shetty, “Concrete Technology”, S. Chand and Co., 2006

| 19PSE205 | Mini Project with Seminar | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

**Mini Project Description**

The introduction of mini projects ensures preparedness of students to undertake major projects / dissertation.Every candidate shall be permitted to undertake a mini project of his choice related to his / her discipline in consultation with the Head of the Department. The project shall be supervised by a faculty member of the Department in which the candidate registered a course.

In case of a project work at Industrial / Research organization, the project work shall be jointly supervised by the faculty supervisor and an expert from the organization.

He / She shall be required to undergo three reviews in a semester to assess the progress of the project work. The project work shall be evaluated based on the project report submitted by the candidate and Viva-voce examination conducted by a committee consisting of an external examiner, internal examiner, and the supervisor of the candidate. The evaluation is done for 100 marks.

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Analyse structural engineering problems reviewing available literature. **(Analyse)**
- Study different techniques used to analyse complex structural systems. **(Understand)**
- Work on the solutions given and present solution by using his/her technique applying engineering principles. **(Create)**

# SEMESTER-III

| 19PSE301 | DISSERTATION PHASE I | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 20 | 10 |

**OBJECTIVES:**

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

**PROJECT DESCRIPTION**

Every candidate shall be permitted to undertake a research based project work of his choice related to his / her discipline in consultation with the Head of the Department. The project shall be supervised by a faculty member of the Department in which the candidate registered acourse.

In case of a project work at Industrial / Research organization, the project work shall be jointly supervised by the faculty supervisor and an expert from the organization. The planning of laboratory work/ modelling/ computational work with execution schedule is suggested at the being of the programme to ensure expected outcome. This will lead to creation of patents from the result of the programme

He / She shall be required to undergo three reviews in a semester to assess the progress of the project work. The project work shall be evaluated based on the project report submitted by the candidate and Viva-voce examination conducted by a committee consisting of an external examiner, internal examiner, and the supervisor of the candidate. The evaluation is done for 100 marks.

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Analyse structural engineering problems reviewing available literature. **(Analyse)**
- Study different techniques used to analyse complex structural systems. **(Understand)**
- Work on the solutions given and present solution by using his/her technique applying engineering principles. **(Create)**

# SEMESTER-IV

| 19PSE401 | DISSERTATION PHASE II | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 32 | 16 |

**OBJECTIVES:**

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review ofliterature.
- To develop the methodology to solve the identifiedproblem.
- To train the students in preparing project reports and to face reviews and viva-voce examination

**DISSERTATION PHASE II DESCRIPTION**

Every candidate shall be permitted to undertake a research based project work of his choice related to his / her discipline in consultation with the Head of the Department. The project shall be supervised by a faculty member of the Department in which the candidate registered acourse.

In case of a project work at Industrial / Research organization, the project work shall be jointly supervised by the faculty supervisor and an expert from the organization.

Dissertation – II will be extension of the work on the topic identified in Dissertation – I. Continuous assessment should be done

He / She shall be required to undergo three reviews in a semester to assess the progress of the dissertation work. The work shall be evaluated based on the project report submitted by the candidate and Viva-voce examination conducted by a committee consisting of an external examiner, internal examiner, and the supervisor of the candidate. The evaluation is done for 100 marks.

**COURSE OUTCOMES:**

After successful completion of this course, the students will be able to

- Solve complex structural problems by applying appropriate techniques. **(Apply)**
- Exhibit good communication skill to the engineering community and society. **(Understand)**
- Demonstrate professional ethics and work cure. **(Understand)**

# PROGRAMME ELECTIVES

| 19PSE501 | ANALYSIS AND DESIGN OF TALL BUILDINGS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart the design philosophy of tall structures.
- To make the students to understand the behavior of various structural systems.
- To give an exposure on the stability analysis of different structural systems.

**UNIT I LOADING AND DESIGN PRINCIPLES 9**

Loading - sequential loading- Gravity loading - Wind loading - Earthquake loading - Equivalent lateral force - modal analysis - combination of loading – Static and Dynamic approach - Analytical and wind tunnel experimental methods - Design philosophy - working stress method, limit state method and plastic design.

**UNIT II BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS 9**

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

**UNIT III ANALYSIS AND DESIGN 9**

Modeling for approximate analysis- Accurate analysis and reduction techniques- Analysis of buildings as total structural system considering overall integrity and major subsystem interaction- Analysis for member forces, drift and twist - Computerized three dimensional analysis – Assumptions in 3D analysis – Simplified 2Danalysis.

**UNIT IV STRUCTURAL ELEMENTS 9**

Sectional shapes - properties and resisting capacity - design- deflection - cracking - prestressing - shear flow - Design for differential movement - creep and shrinkage effects - temperature effects and fire resistance.

**UNIT V STABILITY OF TALL BUILDINGS 9**

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

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Illustrate the design principles involved in the design of tall buildings. **(Apply)**
- Discuss the structural behavior of various structural systems in tall buildings. **(Understand)**
- Apply reduction techniques to simplify the analysis of multistory frames. **(Apply)**
- Detrmine the structural response for different loading. **(Apply)**
- Explain the second order effects of gravity loads. **(Understand)**

**REFERENCES:**


1. Bryan Stafford Smith and Alexcoull, “Tall Building Structures - Analysis and Design”, John Wiley and Sons, Inc.,2005.
2. Taranath B.S., “Structural Analysis and Design of Tall Buildings”, McGraw Hill,2016.
3. Gupta.Y.P.,(Editor), Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi,1995.
4. Lin T.Y and Stotes Burry D, “Structural Concepts and systems for Architects and Engineers”, John Wiley,1988.
5. Beedle.L.S., “Advances in Tall Buildings”, CBS Publishers and Distributors, Delhi,1986.
6. Structural Analysis and Design of Tall Buildings, Taranath B. S., Mc Graw Hill, 1988.
7. Shah V. L. &Karve S. R., Illustrated Design of Reinforced ConcreteBuildings(GF+3storeyed), Structures Publications, Pune, 2013

| 19PSE502 | OFFSHORE STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To introduce the concepts of wave theories.
- To make the students aware of the various forces acting on offshore structures.
- To make the students to analyse and design offshore structures.

**UNIT I WAVE THEORIES** **8**

Wave generation process - small and finite amplitude wave theories.

**UNIT II FORCES OF OFFSHORE STRUCTURES** **8**

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

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

Different types of offshore structures - foundation modeling and structural modeling- fixed jacket platform structural modeling

**UNIT IV ANALYSIS OF OFFSHORE STRUCTURES** **10**

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

**UNIT V DESIGN OF OFFSHORE STRUCTURES** **10**

Design of platforms - helipads - Jacket tower - analysis and design of mooring cables and pipe lines.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Describe the basic concepts in coastal engineering such as the linear wave theory, energy propagation in waves, shoaling, refraction, diffraction, and breaking. **(Understand)**
- Determine the forces acting on offshore structures. **(Apply)**
- Simulate offshore foundation and structural elements. **(Apply)**
- Analyse offshore structures for static and dynamic conditions. **(Apply)**
- Design platforms, helipads and pipelines. **(Apply)**

**REFERENCES:**


1. Chakrabarti, S.K. “Hydrodynamics of Offshore Structures”, Computational Mechanics Publications, 2001.
2. Chakrabarti, S.K., Handbook of Offshore Engineering by, Elsevier, 2005.
3. Dawson.T.H., “Offshore Structural Engineering”, Prentice Hall Inc Englewood Cliffs, N.J. 1983
4. Brebia,C.AandWalker,S.,“DynamicAnalysisofOffshoreStructures”,NewButterworths, U.K. 1979.
5. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex,2005.
6. James F. Wilson, Dynamics of Offshore Structures, John Wiley & Sons, Inc, 2003.

7. Reddy.D.V and Swamidas A.S.J.,Essential of offshore structures.CRC Press.2013
8. 8. Turgut Sarpkaya, Wave Forces on Offshore Structures, Cambridge University Press, 2010.

| 19PSE503 | OPTIMIZATION OF STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on the optimization methodologies applied to structural engineering.
- To train the students to use LP and NLP methods for structural optimization.
- To introduce the concepts of geometric and dynamic programming.

**UNIT I BASIC PRINCIPLES AND CLASSICAL OPTIMIZATIONTECHNIQUES 9**

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

**UNIT II LINEAR AND NON-LINEAR PROGRAMMING 10**

LINEAR PROGRAMMING: Formulation of problems - Graphical solution - Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - simplex method - Two phase method - Penalty method - Duality theory - Primal - Dual algorithm. NON LINEAR PROGRAMMING: One Dimensional minimization methods: Unid imensional – Uni modal function - Exhaustive and unrestricted search -Dichotomous search - Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques.

**UNIT III GEOMETRIC PROGRAMMING 8**

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

**UNIT IV DYNAMIC PROGRAMMING 9**

Bellman's principle of optimality - Representation of a 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 multistorey buildings, water tanks and bridges.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explain the basic concepts of optimization. **(Understand)**
- Solve optimisation problems using linear and non-linear programming techniques. **(Apply)**
- Solve constrained and unconstrained problems with zero difficulty. **(Apply)**
- Explain the concepts of sub-optimization problems using classical and tabular methods. **(Understand)**
- Optimise structural elements such as continuous beams, sine story frames and truss. **(Apply)**

**REFERENCES:**


1. Rao,S.S. “Optimization theory and applications”, Wiley Eastern (P) Ltd.,1984.
2. Uri Krish, “Optimum Structural Design”, McGraw Hill Book Co.2008.
3. Spunt, “Optimization in Structural Design”, Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey1971.
4. Iyengar.N.G.R and Gupta.S.K, “Structural Design Optimization”, Affiliated East West Press Ltd, New Delhi,1997

| 19PSE504 | DESIGN OF BRIDGES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To outline the loads and forces on bridges as per IRC guidelines
- To make the students to design several types of bridges.
- To give an overview of bridge foundations.

**UNIT I SHORT SPAN RC BRIDGES 8**

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

**UNIT II LONG SPAN RC BRIDGES 9**

Design principles of continuous girder bridges - box girder bridges - balanced cantilever bridges – Arch bridges – Box culverts

**UNIT III PRESTRESSED CONCRETE BRIDGES 10**

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 IV STEEL BRIDGES 9**

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

**UNIT V BEARINGS AND SUBSTRUCTURES 9**

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

**TOTAL: 45PERIODS**

**(Note: Use of IRC: 6-2010, IRC: 18-2000, IRC:21-2000, IRC: 22-2008, IRC: 24-2010, IRC: 83-1999 (Part-I to III), IS 800:2007,IS 456:2000, SP 6-1:1964 and Pigeaud's curves are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Identify the possibility of construction of bridge in a particular location **(Understand)**
- Discuss the live loads acting on bridges as per IRC specifications. **(Understand)**
- Design Culvert, T beam and prestressed concrete bridges. **(Apply)**
- Design plate girder and box girder bridges. **(Apply)**
- Describe types and design of bearings. **(Understand)**

**REFERENCES:**


1. Ponnuswamy, S., “Bridge Engineering”, Tata McGraw Hill,2008.
2. Johnson Victor, D. “Essentials of Bridge Engineering”, Oxford and IBH Publishing Co. New Delhi,6th Edition 2007.
3. Jagadeesh.T.R. and Jayaram.M.A, “Design of Bridge Structures”, Prentice Hall of India Pvt. Ltd. 2004.
4. Raina V.K.” Concrete Bridge Practice” Tata McGraw Hill Publishing Company, New Delhi, Second Edition, 2019.


**STANDARDS:**

1. IS 800:2007 Indian Standard General Construction in Steel – code of practice, Third Revision.
2. SP 6-1:1964(Reaffirmed 2003) Handbook for Structural Engineers
3. IS:456-2000, Plain and Reinforced Concrete – code of practice (4thEdition).
4. IRC: 6-2010 Standard Specifications and Code of Practice for Road Bridges, Section II – Loads and Stresses (Fifth Revision).
5. IRC: 18-2000 Design Criteria for Prestressed Concrete Road Bridges (Post-Tensioned Concrete) (Third Revision).
6. IRC:21-2000 Standard Specifications and Code of Practice for Road Bridges, Section III – Cement Concrete (Plain and Reinforced) (Third Revision).
7. IRC: 22-2008 Standard Specifications and Code of Practice for Road Bridges, Section VI – Composite Construction (Limit States Design) (Second Revision).
8. IRC: 24-2010 Standard Specifications and Code of Practice for Road Bridges, Steel Road Bridges (Limit State Method)Third Revision).
9. IRC: 83-1999 (Part-I) Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part I : Metallic Bearings (First Revision).
10. IRC: 83-1987 (Part II) Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part II: Elastomeric Bearings.
11. IRC: 83-2002 (Part III) Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part III: POT, POT-CUMPTFE,PIN and Metallic Guide Bearings.
12. Pigeaud’s curves

| 19PSE505 | MECHANICS OF COMPOSITE MATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To explain the behaviour of composite materials
- To impart the failure and fracture characteristics.
- To discuss the applications of various types of composite materials.

**UNIT I INTRODUCTION** **9**

Introduction to Composites, Classifying composite materials, Commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites, Short Fiber Composites- Surface Preparation and Bonding Techniques.

**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: 45PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Classify composite materials. **(Understand)**
- Discuss the stress –strain relationships for orthotrophic and anisotrophic materials. **(Understand)**
- Derive the Governing equations for anisotropic and orthotropic plates. **(Apply)**
- Explains the failure and fracture mechanism of composites. **(Understand)**
- Describe the various applications of composite materials. **(Understand)**

**REFERENCES:**


1. Agarwal.B.D.,Broutman.L.J., and Chandrashekara.K. “Analysis and Performance of Fiber Composites”, John-Wiley and Sons,4th Edition, 2017.
2. Daniel.I.M., and Ishai.O, “Engineering Mechanics of Composite Materials”, Oxford University Press,2005.
3. Hyer M.W., and White S.R., “Stress Analysis of Fiber-Reinforced Composite Materials”, D.Estech Publications Inc.,2009
4. Jones R.M., “Mechanics of Composite Materials”, Taylor and Francis Group1999.
5. Mukhopadhyay.M, “Mechanics of Composite Materials and Structures”, Universities Press, India, 2005.

| 19PSE506 | ADVANCED CONCRETE TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To outline the properties of concrete making materials, tests and mix design for concrete.
- To introduce the mix design of special concretes
- To give an idea about various nondestructive testing methods.

**UNIT I CONCRETE MAKING MATERIALS 9**

Aggregates classification, Artificial and recycled aggregates - IS Specifications - Grading, Methods of combining aggregates - specified grading - Cement - Hydration of cement - Structure of hydrated cement - special cements - Chemical admixtures - Mineral admixtures, Nano materials - Sustainable Materials and Test, Detailed Quality Control.

**UNIT II MICROSTRUCTURE OF MORTAR AND CONCRETE 9**

Microstructure of Mortar and concrete - Interfacial transition zone in concrete and its influence on strength, behavior and properties of concrete, Significance of properties of fresh and hardened concrete,. Durability of concrete - permeability, chemical attack, sulphate attack, alkali aggregate reaction, corrosion and carbonation of concrete.

**UNIT III MIX DESIGN 9**

Principles of concrete mix design - Methods of concrete mix design - IS Method, ACI Method, Detailed Quality Control - sampling and acceptance criteria. Mix Design for Special Concretes like Fiber Reinforced Concrete (FRC), Self Compacting Concrete (SCC) &Geo Polymer Concrete.

**UNIT IV NONDESTRUCTIVE TESTING OF CONCRETE 9**

Nondestructive testing of concrete- Surface Hardness Test, Penetration resistance tests- Rebound hammer test, Pullout tests, ultrasonic pulse velocity methods, Half-cell potential meter, ground penetrating radar, Infrared thermography, infrared and radioactive methods.

**UNIT V NEO CONCRETE 9**

Ready mixed concrete - Sprayed and pumped concrete, High density concrete - Lightweight concrete- Fly ash Concrete - Self consolidating concrete, Polymer impregnated concrete, High performance concrete –Roller compacted concrete, Porous concrete, Bacterial concrete, translucent concrete, Engineered cementations composites and smart concrete, Robo sand concrete, Self-healing concrete, Waste Material Based Concrete.

**(Note: Use of IS 10262:2019, IS:456-2000, Charts from ACI 211.1-91 – 1991 and DOE 1988 are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Describe the properties cement, aggregates and admixtures. **(Understand)**
- Explains Interfacial transition zone in concrete and its influence on strength and durability. **(Understand)**
- Design concrete mixes using IS, ACI Codes. **(Apply)**
- Explains the principles and procedures of NDT methods. **(Understand)**
- Select suitable neo concrete according to field requirement. **(Apply)**

**REFERENCES:**


- Gambhir.M.L., Concrete Technology, McGraw Hill Education,2017.
- Gupta.B.L.,Amit Gupta, “Concrete Technology, Jain Book Agency,2014.
- Neville, A.M., Properties of Concrete, Prentice Hall, 2014,London.
- Santhakumar.A.R. ;”Concrete Technology”,Oxford UniversityPress,2018.
- Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi,2018
- Concrete mix proportioning guide lines Second revision IS 10262: 2019

| 19PSE507 | DESIGN OF SUB STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To teach the design aspects of piles pile cap and sheet piles structures.
- To enhance knowledge on the design of foundations for reciprocating machines, impact machines and design of anchors.
- To give an exposure on the methods of foundation in expansive soils.

**UNIT I SHALLOW FOUNDATIONS** **9**

Soil investigation – Basic requirements of foundation – Types and selection of foundations. Bearing capacity of soil - plate load test – Design of reinforced concrete isolated, strip, combined and strap footings – mat foundation.

**UNIT II PILE FOUNDATIONS** **9**

Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles – different shapes of piles cap – structural design of pile cap.

**UNIT III WELL FOUNDATIONS** **9**

. Types of well foundation – Grip length – load carrying capacity – construction of wells – Failures and Remedies – Design of well foundation – Lateral stability.

**UNIT IV MACHINE FOUNDATIONS** **9**

Introduction - Types of machine foundation – Basic principles of design of machine foundation- Dynamic properties of soil - Vibration analysis of machine foundation - Natural frequency - Design of foundation for Reciprocating machines and Impact machines - Reinforcement and construction details – Vibration isolation.

**UNIT V SPECIAL FOUNDATION** **9**

Foundation on expansive soils – choice of foundation – under-reamed pile foundation. Foundation for concrete Towers, chimneys – Design of anchors- Reinforced earth retailing walls.

**TOTAL: 45 PERIODS**

**(Note: Use of IS Codes 2911 (Part 1 to 4) and IS: 2974 (Part I to V) are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Select appropriate foundation for various soil conditions. **(Understand)**
- Design piles and pile cap. **(Apply)**
- Design well foundations. **(Apply)**
- Design foundations for Reciprocating machines and Impact machines. **(Apply)**
- Discuss different methods of foundation for expansive soils. **(Understand)**

**REFERENCES:**


1. Swamy Saran, Analysis and Design of Substructures, Oxford and IBH Publishing Co. Pvt. Ltd.,2006.
2. P. C. Varghese, Design of Reinforced Concrete Foundations, Prentice-Hall of India Private Ltd, New Delhi,2009.
3. M. J. Thomlinson and R. Boorman, Foundation Design and Construction, ELBS Longman, 1995.
4. V. N. S. Murthy, Advanced Foundation Engineering, CBS publisher,2017.


**STANDARDS:**


1. IS Code 2911 (Part 1):2010 “Concrete Piles” Bureau of Indian Standards, New Delhi, Second revision.
2. IS Code 2911 (Part 2):1980 (Reaffirmed 2010) “Timber Piles”, Bureau of Indian Standards, New Delhi, First Revision.
3. IS Code 2911 (Part 3):1980 (Reaffirmed 2006) “Under Reamed Piles”, Bureau of Indian Standards, New Delhi, First Revision.
4. IS Code 2911 (Part 4):1985 (Reaffirmed 2010) “Load Test on Piles”, Bureau of Indian Standards, New Delhi, First Revision.
5. IS: 2974 (Part I to V) - Code of practice for design and construction of machine foundations.

| 19PSE508 | DESIGN OF INDUSTRIAL STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To give an overview of the requirements, planning and design of Industrial structures.
- To train the students to design components of industrial buildings.
- To impart the design concepts of power plant and power transmission structures.

**PLANNING AND FUNCTIONAL REQUIREMENTS** **9**

**UNIT I**

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 – Analysis and Design of Steel Space Frames.

**UNIT III POWER PLANT STRUCTURES** **9**

Types of power plants – Design of Turbo generator foundation – containment structures.

**UNIT IV TRANSMISSION LINE STRUCTURES AND CHIMNEYS** **9**

Analysis and design of transmission line towers - Sag and Tension calculations- Testing of towers – Design of self supporting chimney- Design of Chimney bases.

**UNIT V FOUNDATION** **9**

Design of foundation for Towers- Chimneys and Cooling Towers - Machine Foundation – Design of Wind Turbine Foundation.

**TOTAL: 45PERIODS**

**(Note: Use of IS 6060:1971,IS 3103:1975, IS 800:2007,IS 6533:1989, Part-I, IS 6533:1989,Part-II, IS 4995:1974,Part-II, IS: 3483 -1965, IS: 875 (Part 1 to 5), IS: 3370-1967, IS: 802-1977(Part 2), IS:4091-1979,IS:9178-1980,IS:2974 (Part I to V) and IS 456:2000 are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Prepare the layout of Industrial buildings as per requirements. **(Understand)**
- Design R.C corbels, bunkers and Silos. **(Apply)**
- Design Turbo Generator Foundation. **(Apply)**
- Design of transmission line towers and Chimneys. **(Apply)**
- Design of foundation for Towers, Machine foundation, Wind Turbine Foundation. **(Apply)**

**REFERENCES:**


1. Manohar S.N, “Tall Chimneys - Design and Construction”, Tata McGraw Hill,1985.
2. Santhakumar A.R.an d Murthy S.S., “Transmission Line Structures”, Tata McGraw Hill, 1992.
3. Srinivasulu P and Vaidyanathan.C, “Handbook of Machine Foundations”, Tata McGraw Hill,2017.
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.


**STANDARDS:**

1. IS 4995 (Part I) -1974 - Criteria for design of reinforced concrete bins for the storage of granular and powder materials.
2. IS 4995 (Part II) -1974 - General Requirements and assessment of bin Loads.
3. IS 6060 -1971 - Code of practice for Day lighting of factory buildings.
4. IS 3103 -1975- Code of practice for industrial ventilation.
5. IS: 3483 -1965 - Code of practice for Noise reduction in industrial buildings.
6. IS: 456-2000 - Code of Practice for Plain and Reinforced Concrete.
7. IS: 6533 (Part 2) -1989 - Code of practice for design and construction of steel chimneys.
8. IS: 875 (Part 1 to 5) - Code of Practice for Design loads.
9. IS: 802-1977(Part 2) - Code of practice for use of structural steel in Over Head transmission line towers.
10. IS: 3370-1967 – Part 2 to 4 - Code of Practice for Concrete Structures for the storage of liquids – Reinforced Concrete Structures.
11. IS:4091-1979 - Code of Practice for Design and Construction of Foundations for Transmission Line Towers andPoles.94
12. IS: 9178-1980 - Criteria for Design of Steel Bins for Storage of Bulk Materials.
13. IS: 2974 (Part I to V) - Code of practice for design and construction of machine foundations.
14. IS 800:2007 Indian Standard General Construction in Steel – code of practice, Third Revision

| 19PSE509 | NONLINEAR ANALYSIS OF STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To emphasize the knowledge on the concepts of nonlinear behaviour and analysis of simple structures.
- To introduce the concepts of elastic and inelastic analysis of plates.
- To give an overview of nonlinear vibration of elastically supported beams.

**UNIT I INTRODUCTION TO NONLINEAR ANALYSIS 9**

Material nonlinearity- geometric nonlinearity - statically determinate and statically indeterminate flexible bars of uniform and variable thickness.

**UNIT II INELASTIC ANALYSIS OF FLEXURAL MEMBERS 9**

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

**UNIT III VIBRATION THEORY AND ANALYSIS OF FLEXURAL MEMBERS 9**

Vibration theory and analysis of flexible members- hysteretic models and analysis of uniform and variable stiffness members under cyclic loading

**UNIT IV ELASTIC AND INELASTIC ANALYSIS OF PLATES 9**

Elastic and inelastic analysis of uniform and variable thickness plates

**UNIT V NONLINEAR VIBRATION AND INSTABILITY 9**

Nonlinear vibration and Instabilities of elastically supported beams.

**TOTAL: 45. PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explains the Material nonlinearity and geometric nonlinearity. **(Understand)**
- Perform elastic and inelastic analysis of flexural members. **(Apply)**
- Discuss the theory of vibration. **(Understand)**
- Perform elastic and inelastic analysis of plates of uniform and variable thickness. **(Apply)**
- Describe the concepts of nonlinear vibration and instability of elastically supported beams. **(Understand)**

**REFERENCES:**


1. Sathyamoorthy, M.,"Nonlinear Analysis of Structures", CRC Press, Boca Raton, Florida,2010.
2. Fertis, D. G.,"Nonlinear Mechanics", CRC Press, Boca Raton, Florida,1999.
3. Reddy.J.N, "Non linear Finite Element Analysis", Oxford University Press,2008.
4. Varghese.P.C., Design of Reinforced Concrete Shells and Folded Plates, PHI Learning Pvt. Ltd., 2010.

| 19PSE510 | PRECAST AND PREFABRICATED STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To enhance knowledge on the design principles, analysis and design of prefabricated elements.
- To provide an overview of connections involved in prefabricated structures.
- To outline the design concepts of precast walls, floors, stairs and roofs.

**UNIT I DESIGN PRINCIPLES 9**

General Civil Engineering requirements - specific requirements for planning and layout of prefabrication plant. IS Code specifications. Modular co-ordination- standardization - Disuniting of Prefabricates - production- transportation- erection - stages of loading and code provisions - safety factors - material properties - Deflection control- Lateral load resistance - Location and types of shear walls.

**UNIT II REINFORCED CONCRETE 9**

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

**UNIT III FLOORS,STAIRS AND ROOFS 9**

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

**UNIT IV WALLS 9**

Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls - load transfer from floor to wall panels, vertical loads - Eccentricity and stability of wall panels - Design Curves, types of wall joints - their behaviour and design, Leak prevention - joint sealants - sandwich wall panels, approximate design of shear walls.

**UNIT V INDUSTRIAL BUILDINGS AND SHELL ROOFS 9**

Components of single-storey industrial sheds with crane gantry systems - R.C. Roof Trusses - Roof Panel - corbels and columns - wind bracing design. Cylindrical, Folded plate and hypar-prefabricated shells - Erection and jointing, joint design, hand book based design

**TOTAL: 45 PERIODS**

**(Note: Use of IS 15916:2011, IS 11447: 1985, IS 1893: 2002 (Part - I) and IS 13920: 1993 are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explain the requirements for planning and preparing layout of prefabricate plant. **(Understand)**
- Discuss the types and systems of prefabrication. **(Understand)**
- Illustrate the design procedure of roof panels, corbels, and columns. **(Understand)**
- Describe the joint details of prefabricated units. **(Understand)**
- Discuss the various precast components of Industrial buildings. **(Understand)**

**REFERENCES:**


1. B.Lewicki, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam/ London/New York,1966
2. Koncz.T, Manual of Precast Concrete Construction, Vol.I II and III, Bauverlag, GMBH, 1971.
3. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precast Concrete, Netherland BetorVerlag,2009.
4. Laszlo Mokk, Prefabricated Concrete for Industrial and Public Sectors, AkademiaiKiado, Budapest, 2007.
5. Murashev.V, Sigalov.E, and Bailov.V, Design of Reinforced Concrete Structures, Mir Publishers,1968.
6. Gerostiza. C.Z., Hendrikson, C. and Rehat D.R., Knowledge Based Process Planning for Construction and Manufacturing, Academic Press, Inc.,1989.
7. Warszawski, A., Industrialization and Robotics in Building - A managerial approach, Harper and Row,1990.


**STANDARDS:**

1. IS 15916:2011 – Building Design And Erection Using prefabricated Concrete.
2. IS 11447: 1985 – Code of practice for construction with large panel prefabricates.
3. IS 1893: 2002 (Part - I)- Criteria for Earthquake Resistant Design of Structures –General.
4. IS 13920: 1993 - Ductile detailing of Reinforced Concrete Structures.

| 19PSE511 | THEORY OF PLATES AND SHELLS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on the behaviour of thin plates
- To train the students to apply special and approximate methods for analyzing plates.
- To provide an overview of the analysis of anisotropic and thick plates

**UNIT I INTRODUCTION TO PLATES THEORY 10**

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

**UNIT II RECTANGULAR PLATES 10**

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge conditions, plates on elastic foundation.

**UNIT III CIRCULAR PLATES 9**

Symmetrical bending of circular plates.

**UNIT IV CLASSIFICATION OF SHELLS 9**

Classification of shells, types of shells, structural action - Design of circular domes, conical roofs, and circular cylindrical shells by ASCE Manual No.31.

**UNIT V FOLDED PLATES 7**

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

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Formulate governing differential equation for bending of thin plates. **(Apply)**
- Determine the deflection and bending moments of rectangular plates using Navier's solution and Levy's method. **(Apply)**
- Estimate deflection and bending moments of circular plates. **(Apply)**
- Design circular domes. **(Apply)**
- Design Folded Plate structures. **(Apply)**

**REFERENCES:**


1. Timoshenko, S. and Krieger S.W. "Theory of Plates and Shells", McGraw Hill Book Company, New York, 2010.
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.

| 19PSE512 | EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To brief the effects and characteristics of earthquakes.
- To impart the design principles of earthquake resistant masonry structures.
- To make the students to design earthquake resistant R.C. Buildings.

**EARTHQUAKES AND GROUND MOTION** **9**

**UNIT I**

Engineering Seismology (Definitions- Introduction to Seismic hazard - Earthquake Phenomenon) – Seismo tectonics and Seismic Zoning of India - Earthquake Monitoring and Seismic Instrumentation - Characteristics of Strong Earthquake Motion- Estimation of Earthquake Parameters- Micro zonation.

**UNIT II EFFECTS OF EARTHQUAKE ON STRUCTURES** **9**

Dynamics of Structures (SDOFS/ MDOFS)- Response Spectra - Evaluation of Earthquake Forces as per codal provisions - Effect of Earthquake on Different Types of Structures - Lessons Learnt From Past Earthquakes

**UNIT III EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES** **9**

Structural Systems - Types of Buildings, Causes of damage, Planning Considerations, Philosophy and Principle of Earthquake Resistant Design - Guidelines for Earthquake Resistant Design - Earthquake Resistant Masonry Buildings - Design consideration – Guidelines.

**UNIT IV EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES** **9**

Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis – Capacity based Design and detailing – Rigid Frames – Shear wall

**UNIT V VIBRATION CONTROL TECHNIQUES** **9**

Vibration Control - Tuned Mass Dampers – Principles and application - Basic Concept of Seismic Base Isolation – various Systems- Case Studies - Important structures.

**TOTAL: 45PERIODS**

**(Note: Use of IS: 13920-1993, IS: 1893 (Part I) – 2002, IS: 4326 – 1993, IS: 13827-1993 and IS: 13828 – 1993 are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Understand the working principle of various earthquake monitoring Instruments. **(Understand)**
- Evaluate Earthquake Forces as per codal provisions. **(Apply)**
- Discuss the principles and philosophy of .earthquake resistant design of masonry and R.C. Structures. **(Understand)**
- Calculate earthquake induced lateral force on the structure. **(Apply)**
- Explain the basic concepts of seismic base isolation techniques. **(Understand)**

**REFERENCES:**


1. Bruce A Bolt, “Earthquakes” W H Freeman and Company, New York,2004.
2. C. A. Brebbia,”Earthquake Resistant Engineering Structures VIII”,WIT Press,2011
3. Mohiuddin Ali Khan “Earthquake-Resistant Structures: Design, Build and Retrofit”, Elsevier Science & Technology,2012
4. Pankaj Agarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures”, Prentice Hall of India,2009.
5. Paulay,T and Priestley, M.J.N., “Seismic Design of Reinforced Concrete and Masonry buildings”, John Wiley and Sons,1992.
6. S K Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press,2007.


**STANDARDS:**

1. IS: 13920-1993 - Ductile detailing of reinforced concrete structures subjected to seismic forces – Code of Practice.
2. IS: 1893 (Part I) – 2002 - Indian Standard Criteria for Earthquake Design of Structures – General Provisions and Buildings.
3. IS: 4326 – 1993 - Earthquake Resistant Design and Construction of Buildings - Code of Practice.
4. IS: 13827-1993 - Improving Earthquake Resistance of Earthen Buildings – Guidelines.
5. IS: 13828 – 1993 - Improving Earthquake Resistance of Low Strength Masonry Buildings – Guidelines.

| 19PSE513 | MATRIX METHODS FOR STRUCTURAL ANALYSIS | L | T | P | C |
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**OBJECTIVES:**

- To give an overview on the Energy Concepts in Structures, Characteristics and Transformation of Structures.
- To teach the concepts of flexibility and stiffness method.
- To train the students to analyse beams, frames and trusses using matrix methods.

**UNIT I ENERGY CONCEPTS IN STRUCTURES 9**

Introduction – Strain Energy – Symmetry of The Stiffness And Flexibility Matrices – Strain Energy in Terms of Stiffness And Flexibility Matrices – Stiffness And Flexibility Coefficients in Terms of Strain Energy – Additional properties of [a] and [k] – another Interpretation of coefficients aij and kij – Betti's law – Applications of Betti's law: Forces not at the coordinates – Strain energy in systems and in Elements.

**UNIT II CHARACTERSTICS OF STRUCTURES – STIFFNESS AND FLEXIBILITY 9**

Introduction – Structure with Single Coordinate- Two Coordinates-Flexibility and Stiffness Matrices in Coordinates- Examples-Symmetric Nature of Matrices- Stiffness and Flexibility Matrices in Constrained Measurements- Stiffness and Flexibility of Systems and Elements-Computing Displacements and Forces form Virtual Work-Computing Stiffness and Flexibility Coefficients

**UNIT III TRANSFORMATION OF INFORMATION IN STRUTURES 9**

Determinate- Indeterminate Structures-Transformation of System Forces to Element Forces-Element Flexibility to System Flexibility - System Displacement to Element Displacement-Element Stiffness to System Stiffness-Transformation of Forces and Displacements in General –Stiffness and Flexibility in General –Normal Coordinates and Orthogonal Transformation-Principle of Contregradience

**UNIT IV THE FLEXIBILITY METHOD 9**

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

**UNIT V THE STIFFNESS METHOD 9**

Introduction-Development of Stiffness Method- Stiffness Matrix for Structures with zero Force at some Coordinates-Analogy between Flexibility and Stiffness-Lack of Fit-Stiffness Matrix with Rigid Motions-Application of Stiffness Approach to Pin Jointed Plane Trusses-Continuous Beams-Frames-Grids-Space Trusses and Frames-Introduction Only-Static Condensation Technique-Choice of Method-Stiffness or Flexibility.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explain the concepts of strain energy in systems and elements. **(Understand)**
- Compute Stiffness and Flexibility Coefficients. **(Apply)**
- Transmits system force and displacements to elemental force and displacement. **(Apply)**
- Analyse pin jointed frames and continuous beams using flexibility method. **(Apply)**
- Analyse pin jointed frames and continuous beams using stiffness method. **(Apply)**

**REFERENCES:**


1. Rubinstein.F.M., " Matrix Computer Methods of Structural Analysis", Prentice Hall, Inc. N.J.,2014
2. Dr. DevadasMenon., "Advanced Structural Analysis", Narosa Publishing House, New Delhi,2018
3. Pandit G.S. and Gupta S.P., "Structural Analysis-A Matrix Approach", Tata McGraw-Hill PublishingCompany Limited, New Delhi,2018
4. Reddy C.S., "Basic Structural Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi,2011.

| 19PSE514 | DESIGN OF STORAGE STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart the principles involved in designing storage structures.
- To train the students to design concrete and steel material retaining structures.
- To provide an overview on the principles of circular prestressing.

**UNITI STEEL WATER TANKS 9**

Design of rectangular riveted steel water tank – Tee covers – Plates – Stays –Longitudinal and transverse beams – Design of staging – Base plates – Foundation and anchor bolts – Design of pressed steel water tank – Design of stays – Joints – Design of hemispherical bottom water tank – side plates – Bottom plates – joints – Ring girder – Design of staging and foundation.

**UNITII CONCRETE WATER TANKS 9**

Design of Circular tanks – Hinged and fixed at the base – IS method of calculating shear forces and moments – Hoop tension – Design of intze tank – Dome – Ring girders – Conical dome – Staging – Bracings – Raft foundation – Design of rectangular tanks – Approximate methods and IS methods – Design of underground tanks – Design of base slab and side wall – Check for uplift.

**UNITIII STEEL BUNKERSANDSILOS 9**

Design of square bunker –Jansen's and Airy's theories – IS Codal provisions – Design of side plates – Stiffeners – Hooper – Longitudinal beams – Design of cylindrical silo – Side plates – Ring girder – stiffeners.

**UNIT IV CONCRETE BUNKERS AND SILOS 9**

Design of square bunker – Side Walls – Hopper bottom – Top and bottom edge beams – Design of cylindrical silo – Wall portion – Design of conical hopper – Ring beam at junction

**UNIT V PRESTRESSED CONCRETE WATER TANKS 9**

Principles of circular prestressing – Design of prestressed concrete circular water tanks

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explain the principles involved in designing storage structures. **(Understand)**
- Design rectangular steel water tanks. **(Apply)**
- Design rectangular and circular concrete water tanks. **(Apply)**
- Design steel and concrete bunkers and silos. **(Apply)**
- Discuss the principles of circular prestressing. **(Understand)**

**REFERENCES:**


1. Rajagopalan K., Storage Structures, Tata McGraw-Hill, New Delhi,1998.
2. Krishna Raju N., Advanced Reinforced Concrete Design, CBS Publishers and Distributors, New Delhi,1998.

| 19PSE515 | ENGINEERING FRACTURE MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To introduce the students to the basic concepts and principles of different modes of fracture failure.
- To impart the concepts of elastic and plastic fracture mechanics.
- To explain the concept of crack propagation and crack arrest methods.

**UNIT I INTRODUCTION** **9**

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

**UNIT II LINEAR ELASTIC FRACTURE MECHANICS** **9**

Elastic crack tip stress field Stress and displacement fields in isotropic elastic materials - Westergaard‟s approach (opening mode) - Plane Strain Fracture toughness (KIC) testing- Feddersen approach - Determination of R curve ,Energy released rate for DCB specimen – An elastic deformation at crack tip - K1c Test techniques, Various test specimens - Critical energy release rate

**UNIT III ELASTIC PLASTIC FRACTURE MECHANICS** **9**

LimitationofKapproach-Approximateshapeandsizeoftheplasticzone-Effectivecracklength - Effect of plate thickness - Elastic plastic fracture concept - Crack tip opening displacement - Dugdaleapproach-Pathindependence,CriticalJintegral–EvaluationofCTOD-Relationship between CTOD, K1 and G1 for small scale yielding

**UNIT IV FATIGUE CRACK GROWTH** **9**

Fatigue crack growth to sharpen the tip - methods to determine J1cMechanism of Fatigue, Fatigue crack propagation - Paris law - Crack closure mechanism - Residual stresses at crack tip - Retardation effect fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor - Variable amplitude service loading, Interaction effects

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

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

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explain the concept of different modes of fracture failure. **(Understand)**
- Analyse the linear elastic fracture mechanics problems. **(Apply)**
- Explain the concept of elastic plastic fracture mechanics. **(Understand)**
- Estimate the residual life of fatigue Crack Growth in structure. **(Apply)**
- Suggest suitable crack arrest parameters using various techniques. **(Understand)**

**REFERENCES:**


1. Barson M. &Stanely T. Rolfe, “Fracture and Fatigue Control in Structure,” Prentice Hall Inc, USA,1999.
2. Bhushan L. Karihaloo, “Fracture Mechanics and Structural Concrete,” Longman Scientific Publishers, USA, 1995.
3. David Broek, “Elementary Engineering Fracture Mechanics, “ MartinusNijhoff Publishers, The Hague,2012.
4. Gdoutos E. E., “ Fracture Mechanics – An introduction,” Kluwer Academic publishers, Dordrecht,2016.
5. Jean Lemative& Jean Louis Chboche, “Mechanics of Solid Materials,” Cambridge University Press,Cambridge,1987.
6. Knott J. F., “Fundamentals of Fracture Mechanics,” John Wiley & Sons, New York1973.
7. Simha K. R. Y ., “Fracture Mechanics for Modern Engineering Design,” University Press (India) Ltd, Hyderabad,2001.
8. Suresh S., “Fatigue of Materials,” Cambridge University Press, Cambridge1991.

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| 19PSE516 | CONSTITUTIVE MODELS AND MODES OF FAILURE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on elastic and plastic theories.
- To provide concepts of various mechanical and material models
- To impart knowledge on energy relations..

**UNIT I ELASTICITY 9**

Stress strain analysis – 2D problems – Cartesian and polar coordinates – generalized Hooke‟s law – 3D problems – energy relations

**UNIT II PLASTICITY 9**

Yielding and yield surface – strain rates and failure theories – flow rule – elastic plastic and strain hardening models – beam and soil applications.

**UNIT III MECHANICAL MODELS 9**

Kelvin and Maxwell models – Visco-elasticity – Friction and Coloumb models – Series, parallel and hybrid models – Applications

**UNIT IV ENERGY RELATIONS 9**

Work and energy types – energy theorems and material models – formulations, Applications in beams and simple structures.

**UNIT V APPLICATIONS 9**

Engineering material models – steel and concrete – reinforced concrete- composites -one, two and three dimensional models – practical examples.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Apply elastic theories for various engineering problems. **(Apply)**
- Apply plastic theories for various engineering problems. **(Apply)**
- Apply various mechanical models to real life events. **(Apply)**
- Apply energy theorems for beams and simple structures. **(Apply)**
- Prepare engineering models for materials and structural elements. **(Apply)**

**REFERENCE BOOKS:**


1. Dowling, N.E., „Mechanical Behaviour of Materials: Engineering Methods of Deformation, Fracture and Fatigue", 2nd Edition, Prentice – Hall, 2007.
2. Bedford, A.M. and Liechti, K.M., „Mechanics of Materials", Prentice Hall, 2001.
3. Popov, E "Mechanics of Materials", Prentice Hall Reprinted Pearson Education, 2003.

| 19PSE517 | SMART MATERIALS AND SMART STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on strain measuring techniques, smart materials and signal processing and control systems.

**UNIT I INTRODUCTION** **9**

Introduction to Smart Materials and Structures - Instrumented structures functions and response - Sensing systems – Self -diagnosis - Signal processing consideration -Actuation systems and effectors.

**UNIT II MEASURING TECHNIQUES** **9**

Strain Measuring Techniques using Electrical strain gauges, Types - Resistance - Capacitance - Inductance – Wheatstone bridges - Pressure transducers - Load cells - Temperature Compensation - Strain Rosettes.

**UNIT III SENSORS** **9**

Sensing Technology - Types of Sensors - Physical Measurement using Piezo Electric Strain measurement – Inductively Read Transducers - The LVDT - Fiber optic Techniques. Chemical and Bio-Chemical sensing in structural Assessment- Absorptive chemical sensors - Spectroscopes - Fibre Optic Chemical Sensing Systems and Distributed measurement.

**UNIT IV ACTUATORS** **9**

Actuator Techniques - Actuator and actuator materials - Piezoelectric and Electrostrictive Material Magneto structure Material - Shape Memory Alloys-Electro-rheological Fluids- Electromagnetic actuation - Role of actuators and Actuator Materials.

**UNIT V SIGNAL PROCESSING AND CONTROL SYSTEMS** **9**

Data Acquisition and Processing - Signal Processing and Control for Smart Structures - Sensors as Geometrical Processors- Signal Processing - Control System - Linear and Non-Linear.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explain the functions and response of instrumented structures. **(Understand)**
- Explain the various strain measuring techniques. **(Understand)**
- Describe the working principles of smart materials such as sensors. **(Understand)**
- Describe the various types of actuator techniques and materials. **(Understand)**
- Expalin about the signal processing and control systems for smart structures. **(Understand)**

**REFERENCE BOOKS:**


1. Brain Culshaw,"Smart Structure and Materials", Artech House - Borton. London, 2017.
2. Srinivasan, A.V. and Michael McFarland, D., "Smart Structures: Analysis and Design", Cambridge University Press, 2010.
3. L. S. Srinath, "Experimental Stress Analysis", Tata McGraw Hill, 2012.
4. J. W. Dally & W. F. Riley, "Experimental Stress Analysis", Tata McGraw Hill Company

| 19PSE518 | DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To develop an understanding of the behaviour and design study of steel concrete composite elements and structures.
- To prepare the students to design composite beams and columns
- To give an overview of design concepts of box girder bridges.

**UNIT I INTRODUCTION** **9**

Introduction to steel - concrete composite construction - theory of composite ructures - construction.

**UNIT II DESIGN OF COMPOSITE MEMBERS** **9**

Design of composite beams, slabs, columns - design of principal 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 - behavior of box girder bridges - design concepts

**UNIT V GENERAL** **9**

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

**TOTAL: 45 PERIODS**

**(Note: Use of BS 5950-1 : 2000, EN 1994 Euro code 4 and IS 11384 – 2019 are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explain the theory and principles of Steel – Concrete Composite construction. **(Understand)**
- Design composite beams and columns. **(Apply)**
- Design shear connectors for composite beams. **(Apply)**
- Describe the behavior and design concepts of box girder bridges. **(Understand)**
- Elaborate case studies on steel - concrete composite construction in buildings. **(Apply)**

**REFERENCES:**


1. Johnson R.P., “Composite Structures of Steel and Concrete”, Blackwell Scientific Publications, UK, 2008.
2. Oehlers D.J. and Bradford M.A., “Composite Steel and Concrete Structural Members, Fundamental behaviour”, Pergamon press, Oxford, 1995.
3. Proceedings of Workshop on “Steel Concrete Composite Structures”, Anna University, 2007.
4. Owens.G.W and Knowles.P, ”Steel Designers Manual”, Steel Concrete Institute(UK), Oxford Blackwell Scientific Publications, 1994.

**STANDARDS:**

1. BS 5950-1 : 2000 Structural use of steel work in building. Code of practice for design – Rolled and welded sections.
2. EN 1994 Euro code 4 : Design of composite steel and concrete structures, composite slabs.
3. IS11384 – 2019 code of practice for composite construction in structural steel and concrete.

| 19PSE519 | STABILITY OF STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES:**

- To teach the buckling concepts of slender members.
- To impart knowledge on buckling of beam column, frame and plates.
- To make the students to estimate critical loads of structural elements using finite difference method.

**UNIT I BUCKLING OF COLUMNS 9**

Concepts of stability – Classification of buckling problems - Governing equation for columns - Analysis for various boundary conditions– Equilibrium approach, energy approach, imperfection approach - Eccentrically loaded column - Higher order governing equations

**UNITII APPROXIMATE METHODS 9**

Approximate methods - Rayleigh Ritz method, Galerkins Method - Numerical Techniques - Finite difference method - Derivation of Column design formula - Effective length of Columns.

**UNIT III BUCKLING OF BEAM-COLUMNS 9**

Theory of beam column - Stability analysis of beam column with central concentrated load, uniformly distributed load and end couples - Columns on Elastic Foundation.

**UNIT IV BUCKLING OF FRAMES 9**

Analysis of single storey portal frames with and without sway using Equilibrium approach – Analysis of frames using Slope deflection and stiffness method– Use of Wood's charts

**UNIT V BUCKLING OF THIN PLATES 9**

Governing differential equation - Buckling of thin plates, various edge conditions - Analysis by equilibrium and energy approach – Finite Difference Method.

**TOTAL: 45 PERIODS**

**(Note: Use of Woods Charts is permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Derive the governing differential equation for buckling of columns. **(Apply)**
- Calculate the load carrying capacity of columns by approximate methods. **(Apply)**
- Solve problems on buckling of beam columns. **(Apply)**
- Determine the buckling load of frames by stiffness method. **(Understand)**
- Analyse buckling of thin plates using numerical methods. **(Apply)**

**REFERENCES:**


1. Timoshenko, S., and Gere., “Theory of Elastic Stability”, McGraw Hill Book Company, 1985.
2. Chajes, A. “Principles of Structures Stability Theory”, Prentice Hall,1974.
3. Ashwini Kumar, “Stability Theory of Structures”, Tata McGraw Hill Publishing Company 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.
6. Simitser.G.J and Hodges D.H, ”Fundamentals of Structural Stability”, Elsevier Ltd., 2006.

| 19PSE520 | ADVANCED STEEL DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To teach the behaviour of steel members and connections.
- To prepare the students to design industrial buildings.
- To give an exposure on the design of cold formed steel and plastic analysis of structures.

**UNIT I GENERAL** **9**

Design of members subjected to combined forces – Design of Purlins, Louver rails, Gable column and Gable wind girder – Design of simple bases, Gusseted bases and Moment Resisting Base Plates.

**UNIT II DESIGN OF CONNECTIONS** **9**

Types of connections – Welded and Bolted – Throat and Root Stresses in Fillet Welds – Seated Connections – Unstiffened and Stiffened seated Connections – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections.

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

Analysis and design of different types of Live pan, Pratt and north light trusses roofs – Analysis and design of industrial buildings – Sway and non sway frames – Aseismic design of steel buildings

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

Introduction - Shape factor - Moment redistribution- 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**

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

**TOTAL: 45 PERIODS**

**(Note: Use of IS 800:2007, IS: 875 (Part I to V), IS: 801-1975, IS: 811-1987, IS: 6533-1989 (Part I & II), IS: 802-1977 and SP: 6 are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Design members subjected to combined forces. **(Apply)**
- Design various types of steel connections and joints. **(Apply)**
- Analyse and design different types of roof trusses. **(Apply)**
- Perform plastic analysis of structures. **(Apply)**
- Design light gauge steel flexural and compression members. **(Apply)**

**REFERENCES:**

1. Lynn S. Beedle, Plastic Design of Steel Frames, John Wiley and Sons, 1990.
2. Narayanan.R.et.al., Teaching Resource on Structural steel Design, INSDAG, Ministry of Steel Publishing, 2000.
3. Subramanian.N, Design of Steel Structures, Oxford University Press, 2014.
4. Subramanian.N, Steel Structures: Design and Practice ,2011.
5. Wie Wen Yu, Design of Cold Formed Steel Structures, Wiley; 4 edition (October 5, 2010).

**STANDARDS:**

1. IS: 800-2007 - Indian Standard Code of Practice for general construction in steel (Limit State).
2. IS: 875 (Part I to V) - Code of Practice for Design loads.
3. IS: 801-1975 - Code of practice for use of cold formed light gauge steel structural members in general building construction.
4. IS: 811-1987 - Cold formed light gauge structural steel sections.
5. IS: 6533-1989 (Part I & II) - Code of Practice for Design and Construction of Steel Chimney.
6. IS: 802-1977 - Code of Practice for use of structural steel in Overhead Transmission Line Towers.
7. SP: 6 - Handbook on Structural Steel Section.

| 19PSE521 | DESIGN OF PRESTRESSED CONCRETE STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES:**

- To introduce the Principles of prestressing.
- To train the students to design prestressed concrete elements.
- To impart the concepts of circular and partial prestressing.

**UNIT I PRINCIPLES OF PRESTRESSING** **9**

Principles of Prestressing - types and systems of prestressing, need for High Strength materials - Analysis methods losses, deflection (short-long term) - camber - cable layouts.

**UNIT II DESIGN OF FLEXURAL MEMBERS** **9**

Behaviour of flexural members - determination of ultimate flexural strength – Codal provisions - Design of flexural members, Design for shear, bond and torsion. Design of end blocks.

**UNIT III DESIGN OF CONTINUOUS BEAMS** **9**

Analysis and design of continuous beams - Methods of achieving continuity - concept of linear transformations, concordant cable profile and gap cables

**UNIT IV DESIGN OF TENSION AND COMPRESSION MEMBERS** **9**

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

**UNIT V DESIGN OF COMPOSITE MEMBERS** **9**

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

**TOTAL: 45 PERIODS**

**(Note: Use of IS1343:2012 and IS 3370 Part III & IV are permitted in the End Semester Examinations)**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Determine the losses and deflection in prestressed elements. **(Apply)**
- Design prestressed concrete beams for shear, bond and torsion. **(Apply)**
- Design tension and compression members. **(Apply)**
- Perform analysis and design of continuous and composite beams. **(Apply)**
- Discuss the principles of partial prestressing. **(Understand)**

**REFERENCES:**


1. Krishna Raju, “Prestressed Concrete”, Tata McGraw Hill PublishingCo,2008.
2. Sinha.N.C.and.Roy.S.K, “Fundamentals of Prestressed Concrete”, S.Chand and Co.,1998.
3. Lin.T.Y.,and Burns.H “Design of Prestressed Concrete Structures”, John Wiley and Sons Inc, New York, 2009.
4. Evans, R.H. and Bennett, E.W., “Prestressed Concrete”, Champman and Hall, London, 1958.
5. Rajagopalan.N, Prestressed Concrete, Narosa Publications, New Delhi,2010.


**STANDARDS:**


1. IS1343:2012, Code of Practice for Prestressed Concrete, Bureau of Indian Standards, New Delhi, Second revision.
2. IS 3370 Code of practice for concrete structures for the storage of liquids Part III Prestressed concrete structures.
3. IS 3370 Code of practice for concrete structures for the storage of liquids Part IV Design Tables.

| 19PSE522 | EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES :**

- To impart knowledge on the principles of measurements of static and dynamic response of structures.
- To discuss the principles of pressure and flow measurements.
- To give an exposure on the principles of non destructive testing methods.

**UNIT I FORCES AND STRAIN MEASUREMENT 9**

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

**UNIT II MEASUREMENT OF VIBRATION AND WIND FLOW 9**

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – wind tunnels – Flow meters – Venturimeter – Digital data Acquisition systems.

**UNIT III ACOUSTICS AND WIND FLOW MEASURES 9**

Principles of Pressure and flow measurements – pressure transducers – sound level meter – venturimeter and flow meters – wind tunnel and its use in structural analysis structural modeling – Direct Model Study and Indirect Model study.

**UNIT IV DISTRESS MEASUREMENTS AND CONTROL 9**

Diagnosis of distress in structures – Crack observation and measurements – corrosion of reinforcement in concrete – Half cell- construction and use – damage assessment – controlled blasting for demolition – Techniques for residual stress measurements – Structural Health Monitoring.

**UNIT V NON DESTRUCTIVE TESTING METHODS 9**

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

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Describe the working principle of force and strain measuring devices. **(Understand)**
- Explain the working principles of various vibration measuring instruments. **(Understand)**
- Discuss the principles of sound and wind measurements. **(Understand)**
- Diagnose distress in structures. **(Understand)**
- Assess the strength of structures by NDT methods. **(Understand)**

**REFERENCES:**


1. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi,2006
2. Dalley.J.WandRiley.W.F,“ExperimentalStressAnalysis”,McGrawHillBookCompany, N.Y.1991
3. Srinath.L.S, Raghavan.M.R, ingaiah.K, Gargesha.G, Pant.B and Ramachandra.K, “Experimental Stress Analysis”, Tata McGraw Hill Company, New Delhi,1996.
4. Sirohi.R.S., Radhakrishna.H.C, “Mechanical Measurements”, New Age International (P) Ltd. 1997
5. Ravisankar.K. and Chellappan.A., “Advanced course on Non-Destructive Testing and Evaluation of Concrete Structures”, SERC, Chennai,2007.

| 19PSE523 | THEORY AND APPLICATIONS OF CEMENT COMPOSITES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To impart knowledge on basics of cement composite materials
- To give an exposure to the types, behavior, properties and applications of cement composite material
- To teach the design aspects of cement composite structural elements.

**UNIT I Introduction** **9**

Classification and Characteristics of Composite Materials- Basic Terminology, Advantages. Stress-Strain Relations- Orthotropic and Anisotropic Materials, Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Plane Stress Problem, Biaxial Strength, Theories for an Orthotropic Lamina.

**UNIT II Mechanical Behavior of Cement Composites** **9**

Mechanics of Materials Approach to Stiffness- Determination of Relations between Elastic Constants, Elasticity Approach to Stiffness- Bounding Techniques of Elasticity, Exact Solutions - Elasticity Solutions with Continuity, Hal pin, Tsai Equations, Comparison of approaches to Stiffness.

**UNIT III Types of Cement Composites** **9**

Types of Cement Composites, Terminology, Constituent Materials and their Properties, Construction Techniques for Fibre Reinforced Concrete - Ferro cement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing. Behavior of Ferro cement, Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion.

**UNIT IV Mechanical Properties of Cement Composites &Applications** **9**

FRC and Ferro cement- Housing, Water Storage, Boats and Miscellaneous Structures. Composite Materials- Orthotropic and Anisotropic behavior, Constitutive relationship, Elastic Constants.

**UNIT V Analysis and Design of Cement Composite Structural Elements** **9**

Ferrocement, SIFCON and Fibre Reinforced Concrete.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Classify the materials as per orthotropic and anisotropic behavior. **(Understand)**
- Estimate strain constants using theories applicable to composite materials. **(Apply)**
- Analyse and design structural elements made of cement composites. **(Apply)**
- Explains mechanical properties of cement composites &applications. **(Understand)**
- Analysis and Design of Cement Composite Structural Elements. **(Apply)**

**REFERENCE BOOKS:**


- Mechanics of Composite Materials, Jones R. M,, 2nd Ed., Taylor and Francis,BSP Books, 1998.
- Ferrocement – Theory and Applications, Pama R. P., IFIC, 1980.
- New Concrete Materials, Swamy R.N., 1stEd., Blackie, Academic and Professional, Chapman & Hall, 1983.

| 19PSE524 | STRUCTURAL HEALTH MONITORING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To teach the causes and factors of distress and health assessment of structures.
- To impart the knowledge on static and dynamic field testing.
- To prepare them to suggest repairs and rehabilitation measures of the structure.

**UNIT I Introduction** **9**

Concepts, Various Measures, Structural Safety in Alteration. Factors affecting Health of Structures, Causes of Distress, Regular Maintenance.

**UNIT II Structural Audit** **9**

Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures.

**UNIT III Static Field Testing** **9**

Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.

**UNIT IV Dynamic Field Testing** **9**

Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring, Basic Principles of Structural Health Monitoring Techniques

**UNIT V Introduction to Repairs and Rehabilitations of Structures** **9**

Case Studies (Site Visits), piezo– electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Diagnosis the distress in the structure understanding the causes and factors. **(Understand)**
- Investigate the collapse. **(Understand)**
- Assess the health of structure using static field methods. **(Understand)**
- Assess the health of structure using dynamic field tests. **(Understand)**
- Suggest repairs and rehabilitation measures of the structure. **(Understand)**

**REFERENCE BOOKS:**


- Structural Health Monitoring, Daniel Balageas, Claus_Peter Fritzen, Alfredo Güemes, John Wiley and Sons, 2006.
- Health Monitoring of Structural Materials and Components_Methods with Applications, Douglas E Adams, John Wiley and Sons, 2007
- Structural Health Monitoring and Intelligent Infrastructure, Vol1, J. P. Ou, H. Li and Z. D. Duan, Taylor and Francis Group, London, UK, 2006.
- Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, Academic Press Inc, 2007

| 19PSE525 | DESIGN OF FORMWORK | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To teach form work materials
- To impart the knowledge on From work design for special structures
- To prepare them to study flying formwork and form work failures

**UNIT I Introduction and Formwork Materials** **9**

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

**UNIT II Formwork Design** **9**

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

**UNIT III Formwork Design for Special Structures** **9**

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

**UNIT IV Flying Formwork** **9**

Table Form, Tunnel Form, Slip Form, Formwork for Precast Concrete, Formwork Management Issues – Pre- and Post-Award.

**UNIT V Formwork Failures** **9**

Causes and Case studies in Formwork Failure, Formwork Issues in Multistory Building Construction.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Select proper formwork, accessories and material. **(Understand)**
- Design the form work for Beams, Slabs, columns, Walls and Foundations. **(Apply)**
- Design the form work for Special Structures. **(Apply)**
- Understand the working of flying formwork. **(Understand)**
- Judge the formwork failures through case studies. **(Evaluate)**

**REFERENCE BOOKS:**


1. Formwork for Concrete Structures, Peurify, Mc Graw Hill India, 2015.
2. Formwork for Concrete Structures, Kumar NeerajJha, Tata McGraw Hill Education, 2012.
3. IS 14687: 1999, False workfor Concrete Structures - Guidelines, BIS

# OPEN ELECTIVES

| 19PCD601 | INDUSTRIAL SAFETY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To understand the operational safety
- To understand the safety management

**UNIT I ACCIDENT INVESTIGATION AND ANALYSIS 9**

Concept of an Accident, reportable and non reportable accidents, reporting to statutory authorities. Principles of accident prevention-accident investigation and analysis-Unsafe act and unsafe condition- Domino sequence-cost of accidents-permanent total disabilities, Permanent partial disabilities, Temporary total disabilities-Calculation of frequency rate and severity rate of accidents.

**UNIT II ERGONOMICS AND HUMAN BEHAVIOUR 9**

Introduction to ergonomics and its area of application in the work system. Anatomy, Posture and body mechanics-low back pain, risk factors for musculoskeletal disorders in the work place-behavioral aspects of posture - effectiveness. Individual differences, Factors contributing to personality, fitting the man to the job. Motivation -job satisfaction - Frustration and conflicts, reaction to frustration, emotion and frustration. Attitudes - determination of attitudes- changing attitudes.

**UNIT III HAZARDS AND THEIR CONTROL 9**

Physical hazards-Noise, heat, vibration, ionizing and non-ionizing radiations, and effects. Chemical hazards-dusts, fumes, mist, vapor, fog, gases, types, concentration, exposure Vs dose, TLV. Mechanical hazards. Engineering control methods- use of personal protective equipments.

**UNIT IV FIRE PREVENTION AND PROTECTION 9**

Fire triangle-principles of fire extinguishing- various classes of fires- A, B, C, D types of fire extinguishers- Industrial fire protection systems. Sprinklers- Fire hydrants- Alarm and detection systems- other suppression systems- CO2 system, foam system and DCP system.

**UNIT V SAFETY MANAGEMENT TECHNIQUES, EDUCATION AND TRAINING 9**

Incident Recall Technique (IRT), disaster control, Job safety Analysis, Safety survey, safety inspection. Safety training programs, seminars, conferences, competitions- method of promoting safe practice-motivation- creating awareness, awards, celebrations, safety posters, safety displays, safety incentive scheme- domestic safety and training.

**Total: 45 Periods**

**COURSE OUTCOMES:**

**After successful completion of this course, the Students will be able to**

- Evaluate the concept of accident prevention& accident investigation. **(Understand)**
- Identify the human behavior. **(Understand)**
- Demonstrate hazards and their control. **(Understand)**
- Prepare the fire prevention and protection. **(Understand)**
- Summarize the safety management techniques. **(Understand)**

**TEXT BOOKS:**


1. Heinrich.H.W. “Industrial Accident Prevention”, McGraw Hill Company, New York, 1980.
2. John V. Grimaldi and Rollin H. Simonds, “Safety Management” , All India Travellers Book Seller, New Delhi, 1989.
3. E.J.McCormick and M.S. Sanders “Human Factors in Engineering and Design”, TMH, New Delhi, 1982.
4. Hand Book of “Occupational Safety and Health”, National Safety Council, Chicago, 1982.
5. Derek, James, “Fire Prevention Hand Book”, Butter Worths and Company, London, 1986.


**REFERENCES:**


1. Krishnan.N.V. “Safety Management in Industry”, Jaico Publishing House, Bombay, 1997.
2. Lees, F. P. “Loss Prevention in Process Industries”, Butter Worth publications, London, 2nd Edition, 1990.
3. Dan Peterson, “Techniques of Safety Management”, McGraw Hill Company, Tokyo, 1981.
4. “Accident Prevention Manual for Industrial Operations”, N.S.C. Chicago, 1982.
5. Hunter, Gomos, “Engineering Design for Safety”, McGraw Hill Inc., 1992.
6. Encyclopedia of “Occupational Health and Safety” Vol I and II, Published by International Labour Office, Geneva, 1985.
7. Gupta. R.S., “Hand Book of Fire Technology”, Orient Longman, Bombay, 1977.

| 19PCS602 | BUSINESS ANALYTICS | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES :**

- Understand the role of business analytics within an organization.
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- Use decision-making tools/Operations research techniques.
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

**UNIT I BUSINESS ANALYTICS 9**

**Business analytics**: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

**UNIT II TRENDINESS AND REGRESSION ANALYSIS 9**

**Trendiness and Regression Analysis**: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

**UNIT III ANALYTICS MODELLING AND MINING 9**

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.

Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

**UNIT IV FORECASTING TECHNIQUES 10**

**Forecasting Techniques**: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

**UNIT V DECISION ANALYSIS 8**

**Decision Analysis**: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

**TOTAL: 45 Periods**

**COURSE OUTCOMES:**

**After the successful completion of this course, the student will be able to**

- Demonstrate the knowledge of data analytics. **(Understand)**
- Demonstrate the ability of think critically in making decisions based on data and deep analytics. **(Understand)**
- Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making. **(Understand)**
- Demonstrate the ability to translate data into clear, actionable insight. **(Understand)**

**REFERENCES:**

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.

| 19PCM603 | IOT FOR SMART APPLICATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Objectives:**

- Brief about the interconnection and integration of smart devices with controller/SoC
- Learn the architecture of IoT and its standards
- Give an basic idea about M2M-IoT

.

**UNIT I M2M and IoT- Introduction 9**

The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics.

**UNIT II M2M AND ioT TECHNOLOGY FUNDAMENTALS 9**

Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management.

**UNIT III IOT REFERENCE ARCHITECTURE 9**

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model-Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views..

**UNIT IV SENSORS AND SMART SENSORS 9**

Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP), Characterization. Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Strain Gauge, Resistance Strain Gauge, Semiconductor Strain Gauges, Inductive Sensors- Sensitivity and Linearity of the Sensor, Types- Capacitive Sensors, Electrostatic Transducer, Force/Stress Sensors using Quartz Resonators, Ultrasonic Sensors, Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring.

**UNIT V INTERNET OF THINGS –PRIVACY, SECURITY AND GOVERNANCE 9**

Introduction, Overview of Governance, Privacy and Security Issues, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course the students will be able to:**

- Understand the concept of web technology for IoT. **(Understand)**
- Understand the concept of IOT and M2M. **(Understand)**
- Differentiate between IOT architecture and Embedded Architecture. **(Understand)**
- Apply IoT technology for smart applications. **(Apply)**
- Study the security and privacy issues in IOT. **(Understand)**

**REFERENCES:**


1. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
2. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1stEdition, Apress Publications, 2013.
3. CunoPfister, “Getting Started with the Internet of Things”, OReilly Media, 2011.
4. McEwen, H. Cassimally, “Designing the Internet of Things”, Wiley, 2013.
5. Samuel Greenguard, “Internet of things”, MIT Press, 2015.
6. http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of-things1.html
7. https://developer.mbed.org/handbook/AnalogIn
8. http://www.libelium.com/50_sensor_applications

| 19PPE604 | BIOENERGY FROM WASTE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To provide the details of types of wastes.
- To illustrate the concept of waste treatment and disposal.
- To outline concepts behind eco-technological alternatives for waste to energy.

**UNIT-I INTRODUCTION TO WASTE & WASTE PROCESSING 9**

Definitions, sources, types and composition of various types of wastes; Characterization of Municipal Solid Waste (MSW) , Industrial waste and Biomedical Waste (BMW), waste collection and transportation; waste processing-size reduction, separation; waste management hierarchy, waste minimization and recycling of MSW; Life Cycle Analysis (LCA), Material Recovery Facilities (MRF), recycling processes of solid waste.

**UNIT-II WASTE TREATMENT AND DISPOSAL 9**

Aerobic composting, incineration, different type of incineration;medical and pharmaceutical waste incinerations- land fill classification, types, methods and sittingconsideration, layout and preliminary design of landfills: composition, characteristics, generation,movement and control of landfill leachate and gases, environmental monitoring system for land fill gases.

**UNIT-III ENERGY FROM WASTE-THERMO CHEMICAL CONVERSION 9**

Sources of energy generation, incineration, pyrolysis,gasification of waste using gasifiers, briquetting, utilization and advantages of briquetting,-environmental and health impacts of incineration; strategies for reducing environmental impacts.

**UNIT-IV ENERGY FROM WASTE- BIO-CHEMICAL CONVERSION 9**

Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestionbiogas production, land fill gas generation and utilization, present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages.

**UNIT-V ENVIRONMENTAL AND HEALTH IMPACTS-CASE STUDIES 9**

Environmental and health impacts of waste to energy conversion, case studies of commercial waste to energy plants, waste to energy- potential sand constraints in India, eco-technological alternatives for waste to energy conversions – Rules related to the handling, treatment and disposal of MSW and BMW in India.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course the students will be able to:**

- Classify different types of waste. **(Understand)**
- Implement the waste disposal & energy conversion techniques. **(Understand)**
- Apply the strategies for reducing environmental impacts. **(Apply)**
- Design the waste to energy plants. **(Apply)**

**REFERENCES:**


1. Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, by Gary C. Young, ISBN:9780470539675, Publisher: John Wiley & Sons, Publication Date: June 2010.
2. Recovering Energy from Waste Various Aspects Editors: Velma I. Grover and Vaneeta Grover, ISBN 978-1-57808-200-1; 2002
3. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.
4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987.
5. Waste-to-Energy by Marc J. Rogoff, DEC-1987, Elsiever, ISBN-13: 978-0-8155-1132-8, ISBN-10: 0-8155-1132-9.
6. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier AppliedScience, London, 1985.
7. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.
8. Bhide A. D., Sundaresan B. B., Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983.
9. Robert Green, From Waste to Energy, Cherry Lake Pub. ISBN: 1602795096, 2009.
10. G. Evans, Biowaste and Biological Waste Treatment, 2005
11. Biogas from waste and renewable resources, by Dieter D. And Angelika S. Wiley-Vch Publication 2010

| 19PSE605 | SMART CITY TECHNOLOGIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To make the students understand the core challenges relating to the foundation of sustainable smart cities
- To impart knowledge on understanding, and critical thinking related to smart, sustainable urban development.
- To explore issues relating to the development and deployment of new and emerging technologies, that will create a thorough understanding of smart processes and systems of the present and future

**UNIT I INTRODUCTION TO SMART CITIES 9**

Introduction, Definition, Drivers, barriers and benefits of smart cities, characteristics and factors of Smart cities, understanding Livability, Affordability and Inequality, Development standards, Fundamentals of smart city rankings, emerging trends and technologies.

**UNIT II SMART CITIES FRAMEWORK 9**

Smart city responsibilities: Built environment, Energy, Telecommunications, Transportation, Health and human services, Water and wastewater, Smart city enablers: instrumentation and control, connectivity, security, privacy and data management.

**UNIT III SMART AND SUSTAINABLE URBAN DEVELOPMENT 9**

Principles of sustainable development and smart growth, low carbon and renewable energy technologies, pollution prevention, climate adaptation, environmental systems management, smart buildings infrastructure

**UNIT IV SMART TECHNOLOGIES 9**

Concepts of Big Data Analytics: big data platforms and cloud computing, urban informatics, GIS and spatial analysis, measuring impact and data visualization

Smart Technologies: Internet of things, remote sensing and communication technologies.

**UNIT V INDIAN INITIATIVES TOWARDS SMART CITIES 9**

ICT initiatives in Indian Cities, Institutional frame work, selection of cities for suitability to become a smart city, e- governance, identification parameters for smart city fnd allocation, Case studies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Explain the concepts of smart cities. **(Understand)**
- Describe the framework of smart cities. **(Understand)**
- Analyse the principles of sustainable development. **(Understand)**
- Apply Big data analytics and smart technologies in creating smart cities. **(Understand)**
- Evaluate the smart city projects implemented in India. **(Understand)**

**REFERENCE BOOKS:**


1. Jesse Berst, Liz Enbysk and Christopher Williams Smart Cities Readiness Guide – The planning manual for building tomorrow‟s cities today, Smart Cities Council, 2014.
2. Joy Sen, Sustainable Urban Planning, The Energy and Resources Institute, New Delhi, 2013. (ISBN 978-81-7993-324-4).
3. Anthony M. Townsend, SMART CITIES Big Data, Civic Hackers, and the Quest for a New Utopia, W. W. Norton & Company, Inc., 2013.( ISBN-13: 978-0393082876)
4. Aniket Bhagwat, Suparna Bhalla, Sanjay Prakash Ashish Bhalla Destination 100 (The making of Smart Cities in India, Future Institute publishers, 2014.(ISBN 13: 9781 4392 57883).
5. Vinod kumar T. M., Geographic Information Systems for Smart Cities, Copal Publishing, New Delhi, 2014.(ISBN: 9788 1924 73352).

# MANDATORY CREDIT COURSE

| 19PGM701 | RESEARCH METHODOLOGY AND IPR | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- To provide an overview on selection of research problem based on the Literature review
- To enhance knowledge on the Data collection and Analysis for Research design
- To outline the importance of ethical principles to be followed in Research work and IPR

**UNIT I INTRODUCTION TO PROJECT FORMULATION 9**

Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis

**UNIT II DATA COLLECTION, ANALYSIS AND ETHICS 9**

Execution of the research - Observation and Collection of data - Methods of data collection Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation - Plagiarism, Application of results and ethics - Environmental impacts - Ethical issues - ethical committees

**UNIT III REPORT,THESIS, PAPER AND RESEARCH PROPOSAL WRITING 9**

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes, how to write report- Paper Developing a Research Proposal- Format of research proposal- a presentation and assessment by a review committee

**UNIT IV INTELLECTUAL PROPERTY 9**

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

**UNIT V PATENT RIGHTS AND NEW DEVELOPMENTS IN IPR 9**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications, New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc.Traditional knowledge Case Studies, IPR and IITs.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of this course, the students will be able to**

- Identify and Formulate the Research Problem. **(Understand)**
- Collect and Analyze data from various sources of Literature. **(Understand)**
- Write thesis effectively including technical reports and other contents. **(Understand)**
- Explain the ethical principles to be followed while patenting or obtaining copyright. **(Understand)**
- Apply for patent rights and demonstrate New developments in IPR. **(Understand)**

**REFERENCES**


1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.


**Additional reading**


1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Publications

# AUDIT COURSE

| 19PGM801 | PEDAGOGY STUDIES | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES:**

- To make the students understand a range of cognitive capacities in human learners
- To explain the outcome-based education system
- To describe the curriculum design process

**UNIT I: EDUCATIONAL PSYCHOLOGY AND ENGINEERING EDUCATION (8)**

Learning process, motivation and engagement, ICT in learning and teaching, Facilitating the learners, Engineering education and recent trends, Research in Engineering education, General maxims of teaching, Teacher-centered, learner-centered and learning-centered approaches, Becoming a reflective teacher, Disruptive Innovation in Education

**UNIT II: OUTCOME BASED EDUCATION (8)**

Outcome Based Education: A broad context for quality teaching and learning, planning for quality teaching and learning, Necessity for learning outcomes - Course Outcomes and Program Outcomes, Defining learning outcomes, learning outcomes in the cognitive domain, learning outcomes in the affective domain, learning outcomes in the psychomotor domain, Program Outcomes, Graduate Attributes, Program Educational Objectives, linking learning outcomes to teaching and assessment.

**UNIT III: CURRICULUM DESIGN (7)**

Curriculum design cycle, curriculum structure, credit and academic load, need assessment – feedback from stakeholders, concept of “Constructive alignment”, the two loop approach of ABET, tuning approach of curriculum design, CDIO concept of curriculum design and implementation, Industry relevant curriculum design and implementation, concept mapping, Instructional design and delivery.

**UNIT IV: TEACHING AND ASSESSMENT STRATEGIES (7)**

Direct instruction as teaching strategy, co-operative learning, problem-solving, industry relevant teaching, role-play, case study, technology enabled teaching, research orientation, measurement and evaluation of students’ achievement, assessment of learning outcomes - assessment tools: direct and indirect assessment tools, rubrics for assessment, attainment analysis, corrective action- curriculum updation, improvement in pedagogy, innovative assessment methods.

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

**After successful completion of the course students will be able to:**

- Develop pedagogical expertise through an introduction to theoretically-based teaching methods and strategies/ **(Understand)**
- Write learning outcomes and link learning outcomes to appropriate assessments. **(Understand)**
- Design syllabus and lesson plans that align with learning outcomes. **(Understand)**
- Use technology to enhance teaching and learning. **(Understand)**
- Choose teaching-learning strategies appropriate to the needs of the learners. **(Understand)**

**REFERENCES:**


1. Dr.Sue Duchesne, Anne McMaugh, Sandra Bochner, Kerri-Lee Krause, “Educational Psychology for Learning and Teaching”, Cengage Learning, 4th Edition, 2019.
2. *Lisa R. Lattuca, Patrick T. Terenzini, J. Fredericks Volkwein, and George D. Peterson, “*The Changing Face of Engineering Education*”* The Bridge, National Academy of Engineering, Summer 2006
3. Anderson, L. & Krathwohl , D. A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives . New York: Longman, 2001.
4. Blumberg, P. Developing learner-centred teaching: A practical guide for faculty. San Francisco: Jossey-Bass, 2017.
5. Teaching Support Services. Learning objectives. University of Guelph, Guelph, ntario. Retrieved from http://www.uoguelph.ca/tss/resources/idres/learningobjectives1.pdf
6. O.V. Boev, N.Gruenwald and G.Heitmann, “Engineering Curriculum Design aligned with Accrediation Standards”, Hochschule Wismar Publishers, 2013
7. Fink, D. L. Integrated course design. Manhattan, KS: The IDEA Center, 2005. Retrieved from http://www.theideacenter.org/sites/default/files/Idea_Paper_42.pdf

| 19PGM802 | ENGLISH FOR RESEARCH PAPER WRITING | L | T | P | C |
|---|---|---|---|---|---|
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**OBJECTIVES**

- To give and exposure on writing skills and readability
- To impart the knowledge of each section of the paper
- To enhance the student to write the good quality Research paper

**UNIT INTRODUCTION TO RESEARCH 9**

Introduction to Research Paper, Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs, Clarity and Removing Redundancy, Highlighting the Findings, Hedging and Criticising, Paraphrasing and Plagiarism - Useful idioms & phrases.

**UNIT STRUCTURE OF RESEARCH PAPER 6**

Types of the Research papers, Regular Research Paper - Review Research Paper – Case Study Research Paper – Research Letters - Sections of a Paper, Title, Author names and affiliations - Corresponding author - Abstracts, Keywords, Highlights, Graphical Abstract - Introduction, Methods, Results, Discussion, Conclusions, Acknowledgment - the First Draft.

**UNIT METHODOLOGY, RESULTS & DISCUSSION AND CONCLUSION 9**

Introduction – Writing preview of Research work – Review of literature – assimilating the points – Logical flow – Research gap - Writing the Methodology – Sequence - Specification – Explaining results – Interpretation and plotting – Discussion of the salient findings – Critical analysis – Writing the Conclusion

**UNIT SUBMISSION OF RESEARCH PAPER 6**

References – Citations and Checking the Citations – Various forms of Citation - Guildlines for authors – Manuscript submission – Conflict of Interest - Authors reply for Reviewer comments – Point by Point Explanation – Resubmission – Acceptance – Copyright - Proofreading and final submission.

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES**

**After successful completion of this course, the students will be able to**

- Write research paper effectively with improved standard of language. **(Understand)**
- Explain the different sections of the Research paper. **(Understand)**
- Formulate the Acceptable Research Manuscript. **(Understand)**

**REFERENCES**


1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
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'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011


**ADDITIONAL READING**


1. MLA Handbook for Writers of Research Papers, The Modern Language Association of America, New York 2009