SETHU INSTITUTE OF TECHNOLOGY

Pulloor, Kariapatti–626 115.

(*An Autonomous Institution*)

DEPARTMENT OF CIVIL ENGINEERING

M.E. STRUCTURAL ENGINEERING

REGULATION 2021 – CHOICE BASED CREDIT SYSTEM

CURRICULUM & SYLLABUS

Approved in the

Academic Council Meeting on 14.05.2022

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Chairperson/BOS

Chairman
Academic Council

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PULLOOR, KARIAPATTI – 626 115

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M.E. DEGREE PROGRAMME

CURRICULUM

REGULATION – 2021

MASTER OF ENGINEERING IN STRUCTURAL ENGINEERING

OVERALL COURSE STRUCTURE

Category	Total No. of Courses	Credits	Percentage
Professional Core	**9**	**26**	**37**
Professional Elective	**6**	**18**	**27**
Open Elective	**1**	**3**	**4**
Mandatory Course	**1**	**3**	**4**
Audit Course	**2**	**-**	**-**
Project Work	**3**	**20**	**28**
TOTAL	**22**	**70**	**100**

COURSE CREDITS – SEMESTER WISE

Branch	I	II	III	IV	Total
Structural Engineering	**21**	**22**	**15**	**12**	**70**

SEMESTER I

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
21PSE101	Design of Advanced Concrete Structures	4	0	0	4
21PSE102	Theory of Elasticity and Plasticity	4	0	0	4
	Professional Elective I	3	0	0	3
	Professional Elective II	3	0	0	3
21PGM701	Research Methodology and IPR **(Mandatory Course)**	3	0	0	3
21PGM801	Pedagogy Studies (**Audit Course–I)**	2	0	0	0
PRACTICAL					
21PSE103	Computing in Structures	0	0	4	2
21PSE104	Advanced Concrete Laboratory	0	0	4	2
	TOTAL	**19**	**0**	**8**	**21**
Total No. of Credits –21					

SEMESTER II

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
21PSE201	Finite Element Analysis for Structural Engineering ***[INTEGRATED COURSE]***	2	0	2	3
21PSE202	Structural Dynamics	3	0	0	3
21PSE203	Advanced Steel Design	3	0	0	3
21PSE204	Stability of Structures	3	0	0	3
	Professional Elective III	3	0	0	3
	Professional Elective IV	3	0	0	3
PRACTICAL					
21PSE205	Structural Design & Testing Laboratory	0	0	4	2
21PSE206	Term Paper with Seminar	0	0	4	2
	TOTAL	**17**	**0**	**10**	**22**
Total No. of Credits – 22					

SEMESTER III

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
	Professional Elective V	3	0	0	3
	Professional Elective VI	3	0	0	3
	Open Elective	3	0	0	3
21PGM802	English for Research Paper Writing (**Audit Course–II)**	2	0	0	0
PRACTICAL					
21PSE301	Dissertation Phase I	0	0	12	6
	TOTAL	**11**	**0**	**12**	**15**
Total No. of Credits – 15					

SEMESTER IV

COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL					
21PSE401	Dissertation Phase II	0	0	24	12
	TOTAL	**0**	**0**	**24**	**12**
Total No. of Credits – 12					

TOTAL CREDITS - 70

LIST OF PROFESSIONAL CORE

SL.NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	21PSE101	Design of Advanced Concrete Structures	4	0	0	4
2.	21PSE102	Theory of Elasticity and Plasticity	4	0	0	4
3.	21PSE103	Computing in Structures	0	0	4	2
4.	21PSE104	Advanced Concrete Laboratory	0	0	4	2
5.	21PSE201	Finite Element Analysis for Structural Engineering ***[INTEGRATED COURSE]***	2	0	2	3
6.	21PSE202	Structural Dynamics	3	0	0	3
7.	21PSE203	Advanced Steel Design	3	0	0	3
8.	21PSE204	Stability of Structures	3	0	0	3
9.	21PSE205	Structural Design & Testing Laboratory	0	0	4	2

LIST OF PROFESSIONAL ELECTIVES

SL.NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	21PSE501	Design of Industrial Structures	3	0	0	3
2.	21PSE502	Constitutive Models and Modes of Failure	3	0	0	3
3.	21PSE503	Design of Sub Structures	3	0	0	3
4.	21PSE504	Design of Bridges	3	0	0	3
5.	21PSE505	Design of Storage Structures	3	0	0	3
6.	21PSE506	Advanced Concrete Technology	3	0	0	3
7.	21PSE507	Design of Steel Concrete Composite Structures	3	0	0	3
8.	21PSE508	Design of Formwork	3	0	0	3
9.	21PSE509	Design of Pre stressed Concrete Structures	3	0	0	3
10.	21PSE510	Earthquake Analysis and Design of Structures	3	0	0	3
11.	21PSE511	Experimental Stress Analysis and Techniques	3	0	0	3
12.	21PSE512	Matrix Methods for Structural Analysis	3	0	0	3
13.	21PSE513	Green Building Management	3	0	0	3
14.	21PSE514	Innovation, Entrepreneurship & Venture Development	3	0	0	3
15.	21PSE515	Offshore Structures	3	0	0	3
16.	21PSE516	Precast and Prefabricated Structures	3	0	0	3
17.	21PSE517	Smart Materials and Smart Structures	3	0	0	3
18.	21PSE518	Structural Health Monitoring	3	0	0	3
19.	21PSE519	Vulnerability and Risk Analysis	3	0	0	3
20.	21PSE520	Engineering Fracture Mechanics	3	0	0	3
21.	21PSE521	Mechanics of Composite Materials	3	0	0	3
22.	21PSE522	Optimization of Structures	3	0	0	3
23.	21PSE523	Theory and Applications of Cement Composites	3	0	0	3
24.	21PSE524	Theory of Plates and Shells	3	0	0	3
25.	21PSE525	Maintenance and Rehabilitation of Structures	3	0	0	3

LIST OF OPEN ELECTIVE

SL.NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	21PSE605	Smart City Technologies	3	0	0	3

LIST OF MANDATORY COURSE

SL.NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	21PGM701	Research Methodology and IPR	3	0	0	3

LIST OF AUDIT COURSES

SL.NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	21PGM801	Pedagogy Studies	2	0	0	0
2.	21PGM802	English for Research Paper Writing	2	0	0	0

LIST OF PROJECT WORK

SL.NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	21PSE206	Term Paper with Seminar	0	0	4	2
2.	21PSE301	Dissertation Phase I	0	0	12	6
3.	21PSE401	Dissertation Phase II	0	0	24	12

SEMESTER I

21PSE101	DESIGN OF ADVANCED CONCRETE STRUCTURES	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES :

- To give exposure on the behavior, analysis and design of R.C structures.
- 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	12

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	12

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	12

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 BEHAVIOR OF CONCRETE STRUCTURES	12

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

UNIT V	DUCTILE DETAILING	12

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 : 60 Periods

[Note: Use of IS 13920:2016, IS 456:2000 and SP16 are permitted in the End Semester Examinations]

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Use the yield line hypothesis while designing then RC elements as per the requirements of the IS codes and inspect the same for ductility***.(Apply)***
- **CO2** - Show structural details for various RC structural members in accordance with IS Code requirements***.(Apply)***
- **CO3** - Check and ensure the serviceability criteria for reinforced concrete structural elements***.(Apply)***
- **CO4** – Design as per limit state method and estimates are made for Deflection, Shear Reinforcement, and Fracture Width. ***(Analyze)***
- **CO5** - Select unique R.C. components including grid floors, Corbels, deep beams, and shear walls. ***(Analyze)***
- **CO6** - Investigate the behavior of beams and frames in elastic and inelastic conditions***.(Create)***

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.

21PSE102	THEORY OF ELASTICITY AND PLASTICITY	L	T	P	C
		4	0	0	4

COURSE 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	12

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

UNIT II	ELASTICITY SOLUTION	12

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	12

Numerical and Energy methods - Castiglione's 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	12

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	12

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 : 60 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Apply the concepts of stress, strain, torsion, bending and deflection of bar and beam in Engineering Field. ***(Apply)***
- **CO2** - Relate theory of elasticity and plasticity to design tooling in manufacturing instead of using 'thumb rule'. ***(Apply)***
- **CO3** - Analyze various principles to solve problems in a practical situation and compare its solution ***(Analyze)***
- **CO4** - Assess the mechanical handling of the transition from elastic to plastic deformation.***(Evaluate)***
- **CO5** - Design the optimum dimension of the body in a variety of situations where specific properties are required***.(Create)***
- **CO6** – Relate theory of plasticity to design tooling in manufacturing instead of using 'thumb rule'. ***(Create)***

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.

Timoshenko, S. and GoodierJ.N."Theory of Elasticity", McGraw Hill Book Co., New York, 2010.

21PSE103	COMPUTING IN STRUCTURES	L	T	P	C
		0	0	4	2

COURSE 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 the software packages
- To train the students to write programs using numerical techniques.

LIST OF EXPERIMENTS

. Develop design charts for the following structural elements using Spread sheets

a. RCC beams
b. Slabs
c. Columns
d. Foundations
e. Retaining walls

. Stress analysis of a beams with different loading conditions using software packages

. Modal analysis of a simply supported beam using software packages

. 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.

TOTAL : 30 Periods

LABORATORTY EQUIPMENT REQUIREMENTS

Spread Sheet Tool, ANSYS, MATLAB

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1 -** Develop design charts for structural components using spread sheets. ***(Apply)***
- **CO2 -** Compute modal analysis of structural components. ***(Apply)***
- **CO3 -** Develop programs using numerical techniques and Perform curve fitting using Polynomial Regression. ***(Apply)***
- **CO4 -** Analyze the Stress variation in beams for various loads using software package ***(Analyze)***
- **CO5 -** Adapt them to work in a group as a member or a leader for efficiently executing the given task using various numerical techniques. ***(Receive/Respond–Affective Domain)***
- **CO6 -** Review the power of the range of variables in a virtual environment. Thereby helping engineers to design and do materials selection works quickly and efficiently. ***(Characterization – Affective Domain)***

21PSE104	ADVANCED CONCRETE LABORATORY	L	T	P	C
		0	0	4	2

COURSE 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 concrete 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 code Method.
5. Concrete Mix Design of Special Concrete.
   a. Fibre Reinforced concrete - FRC.
   b. Self compacting 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.

TOTAL : 30 Periods

LABORATORTY EQUIPMENT REQUIREMENTS

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

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

CO1 - Design the appropriate concrete mix for various types of concretes as per IS code and ACI code. ***(Apply)***

CO2 - Determine the properties of fresh concrete using various tests . ***(Apply)***

CO3 - Analyze the properties hardened concrete by Lab and in-situ test methods under different exposures. ***(Analyze)***

CO4 - Analyze the mix proportions for different type of concrete using spread sheet. ***(Analyze)***

CO5 - Make use of problem solving approaches to various contemporary issues regarding failure of structures due to unsuitable materials and make decisions in team. ***(Respond - Affective Domain)***

CO6 - Investigate the mechanical properties of the concrete materials, check the strength parameters as per codal provisions and present the report. ***(Value - Affective Domain)***

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

21PSE201	FINITE ELEMENT METHODS FOR STRUCTURAL ENGINEERING	L	T	P	C
	[INTEGRATED COURSE]	2	0	2	3

COURSE OBJECTIVES :

- To impart the concepts of finite element methods
- To impart knowledge in the analysis of frame structures.
- To train the students in the analysis of beams and 2D,3D Frame structures using Finite Element Software

UNIT I	INTRODUCTION TO FINITE ELEMENT METHOD	9 + 6

Introduction - Basic Concepts of Finite Element Analysis - Introduction to Elasticity - Steps in Finite Element Analysis - Virtual Work and Variational Principle -Rayleigh-Ritz method- Galerkin Method- simple application in structural analysis

UNIT II	ELEMENT PROPERTIES	9 + 6

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

UNIT III	ANALYSIS OF FRAZME STRUCTURES	9 + 6

Stiffness of Truss Members - Analysis of Truss - Stiffness of Beam Members - Finite Element Analysis of Continuous Beam - Plane Frame Analysis - Analysis of Grid and Space Frame-Finite Element Formulation for 3 Dimensional Elements – Solution for simple frames.- Introduction to Plate Bending Problems

Analyze and Design Exercises for practical component (Using Computer Software)

LIST OF EXPERIMENTS

1. Use of FEM packages for analysis of propped cantilever, fixed beams, continuous beam
2. Use of FEM packages for analysis of pin jointed frame,2D rigid frame
3. Use of FEM packages for analysis of 3D rigid and pin jointed frame and Multistory & multi bay Frame structures
4. Thermal stress analysis within the rectangular plate

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1 -** Describe the basic concepts of finite element analysis, element properties and Framed structures ***(Understand)***
- **CO2** - Solve problems on continuous beams and plane frames using finite element method. ***(Apply)***
- **CO3 -** Analyze problems on continuous beams and plane frames using finite element method. ***(Analyze)***
- **CO4 -** Use the modern tools to formulate the problem, and able to create geometry, discretize, apply boundary conditions to solve problems with different loading conditions. ***(Apply -Modern tool usage)***
- **CO5 -** Create models and use design to interpret the numerical results.. ***(Create)***
- **CO6 -** Organize a team or individual presentation that addresses the problems with multi-story structures.. ***(Organize - Affective Domain)***

TEXTBOOKS:

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. Seshu P. "Text Book of Finite Element Analysis", Prentice Hall, New Delhi, 2007.

REFERENCES:

1. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill Publishing Company Limited, New Delhi, First Edition 2017.
2. Moaveni, S., "Finite Element Analysis Theory and Application with ANSYS", Prentice Hall Inc.,2017.
3. Rao.S.S, "Finite Element Method in Engg.", Butterworth – Heinemann, UK, Sixth Edition 2017.

21PSE202	STRUCTURAL DYNAMICS	L	T	P	C
		3	0	0	3

COURSE 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	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 New mark Method and Wilson Method, Numerical Solution for State Space Response using Direct Integration

UNIT V	SPECIAL TOPICS IN STRUCTURAL DYNAMICS (CONCEPTS)	9

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

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1 -** Develop dynamic structure discretization. ***(Apply)***
- **CO2 -** Analyze and study dynamics response of single & Multiple degree freedom system using fundamental theory and equation of motion. ***(Analyze)***
- **CO3 -** Analyze the applications of direct integration methods, Rayleigh – Ritz methods ***(Analyze)***
- **CO4 -** Analyze the dynamic properties of a structure such as natural frequencies and mode shapes and to compared these to the properties of the load. ***(Analyze)***
- **CO5 -** Investigate the natural frequency of residential building using Software.***(Evaluate)***
- **CO6 -** Create necessary matrices for the equation of motion, stiffness, mass and damping matrix. ***(Create)***

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. MadhujitMukhopadhyay– Structural Dynamics Vibrations and Systems, Ane Books India Publishers, 2010.
6. Anil K.Chopra, Dynamics of Structures, Pearson Education, 2007.

21PSE203	ADVANCED STEEL DESIGN	L	T	P	C
		3	0	0	3

COURSE 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	INTRODUCTION	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	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 III), IS: 802-1977 and SP: 6 are permitted in the End Semester Examinations]

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Design connections and structural steel members using IS codes***(Apply)***
- **CO2** - Perform plastic analysis of structures. ***(Apply)***
- **CO3** - Design industrial steel structural components subjected to gravity and lateral loads by using modern tool as per IS codes. ***(Apply)***
- **CO4** - Analyze the special connections as per IS codes. ***(Analyze)***
- **CO5** - Analyze the behaviour of structural steel members considering strength and serviceability limit states. ***(Analyze)***
- **CO6** - Write a technical report on any steel structure. ***(Create)***

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, Design of Steel Structures, Oxford University Press, 2014.
4. Subramanian, 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.

21PSE204	STABILITY OF STRUCTURES	L	T	P	C
		3	0	0	3

COURSE 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

UNIT II	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 learning the contents of this course, the student would be able to,

- **CO1** - Examine the phenomenon of buckling of columns and plates by various approaches. ***(Apply)***
- **CO2** - Explore the concepts of torsional and lateral buckling of thin walled members . ***(Apply)***
- **CO3** - Analyze advanced numerical techniques to buckling of structures. ***(Analyze)***
- **CO4** - Analyze the inelastic buckling of columns and plates. ***(Analyze)***
- **CO5** - Estimate the buckling load of beam – columns and frames. ***(Evaluate)***
- **CO6** - Formulate your analysis in written and graphical form. ***(Create)***

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
4. Ltd., New Delhi, 2003.
5. Iyenger.N.G.R.,, "Structural stability of columns and plates", Affiliated East West Press,1988.
6. Gambhir, "Stability Analysis and Design of Structures", Springer, New York,2004.
7. Simitser.G.J and Hodges D.H, "Fundamentals of Structural Stability", Elsevier Ltd., 2006.

21PSE205	STRUCTURAL DESIGN & TESTING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES :

- To enable the students familiar in designing all the structural components of frame buildings and multistory frame buildings by using software packages and detailing the reinforcements using IS codes
- To make them understand the strength and deflection behavior of RC and Steel flexural members.
- To prepare them to conduct non-destructive tests on concrete.

LABORATORTY EQUIPMENT REQUIREMENTS

- STAAD Pro. Software, Auto CAD
- Loading frame with Load cell,
- Data acquisition systems,
- Rebound hammer,
- Ultrasonic Pulse Velocity Tester

LIST OF EXPERIMENTS

1. Design and detailed drawing of multistory framed buildings by individual student using latest relevant IS codes and software packages
2. 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
3. Fabrication, casting and testing of simply supported R.C beam for Strength and deflection behaviour.
4. Testing of simply supported Steel beam for strength and deflection behaviour.
5. Fabrication, casting and testing of RC column subjected to Concentric and eccentric loading.
6. Determination of in-situ strength and quality of concrete using
    i. Rebound hammer
    ii. Ultrasonic Pulse Velocity Tester
7. Determination of Impact Resistance of concrete
8. Determination of Permeability of concrete
9. Measurement of Cracks
10. Durability Tests on Concrete
    a. Water absorption
    b. Sorptivity
    c. Acid resistance
    d. Sulphate resistance
11. Study of Strain Measuring devices
    a. Mechanical Strain Gauge
    b. Electrical Strain Gauges.

TOTAL : 30 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

CO1 - Apply the knowledge of structural engineering in determining the strength and quality of concrete ***(Apply)***

CO2 - Assess the quality of concrete using Non-Destructive Testing Methods. ***(Apply)***

CO3 - Analyze the Durability properties of Concrete ***(Analyze)***

CO4 - Proficiently use the software packages for Structural analysis and Design ***(Analyze)***

CO5 - Evaluate the structural behavior and strain development of flexural and compression members ***(Evaluate)***

CO6 - Present the report for the advanced methods of structural testing. ***(Affective Domain Communicate).***

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 of Reinforced Concrete Structures Subjected 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
8. SP 34 : 1987 : Hand book on concrete reinforcement and detailing
9. SP16-Design Aid for RC to IS456-1978
10. Dally J W, and Riley W F, "Experimental Stress Analysis", McGraw-Hill Inc. New York, 1991.
11. Gambhir.M.L., Concrete Technology, McGraw Hill Education, 2009.
12. Gupta.B.L., Amit Gupta, "Concrete Technology, Jain Book Agency, 2010.
13. Neville, A.M., Properties of Concrete, Prentice Hall, 1995, London.
14. Santhakumar.A.R. ;"Concrete Technology", Oxford UniversityPress, 2007.
15. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi,2006
16. M.S. Shetty, "Concrete Technology", S. Chand and Co., 2006

21PSE206	TERM PAPER WITH SEMINAR	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES :

- To identify a specific social problem and collect detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports, to face reviews and viva-voce examination.

TERM PAPER

The introduction of Term paper ensures preparedness of students to undertake major projects / dissertation. Every candidate shall be permitted to undertake a Term paper of his choice related to his / her discipline in consultation with the Head of the Department. The Term paper 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 Term paper shall be evaluated based on the mini-project 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.

TOTAL : 30 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Identify the issues with the existing research and offer appropriate alternatives. ***(Apply)***
- **CO2** - Solve the problem statement by applying engineering principles. ***(Apply)***
- **CO3** - Analyze structural engineering problems reviewing available literature. ***(Analyze)***
- **CO4** – Analyze different techniques for complex structural systems. ***(Analyze)***
- **CO5** – Interpret experimental and theoretical work as per the specified methodology / design. ***(Evaluate)***
- **CO6** - Present the case study or solutions to the real world complex problems to the Peers and present a Report. ***(Respond)***

SEMESTER III

21PSE301	DISSERTATION PHASE I	L	T	P	C
		0	0	12	6

COURSE OBJECTIVES :

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop 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 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. The planning of laboratory work/ modeling / 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.

TOTAL : 180 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1 -** Analyze and review the research literature critically and evolve suitable methodologies for solving the complex engineering problem ***(PO1, PO3) – (K4-Analyze)***
- **CO2 -** Analyze the complex engineering problem critically to provide optimal solution after considering public health, safety, ethical, societal and environmental factors. ***(PO2)(K4- Analyze)***
- **CO3 -** Design/Develop sustainable solutions after independently carrying out research and investigation to solve practical problems. ***(PO3) (K6-Create)***
- **CO4 -** Utilize modern engineering and IT tools, techniques including prediction and modeling for complex engineering activities and augment the effectiveness of the solution with an understanding of the limitations ***(PO4) (K3-Apply)***
- **CO5 -** Write effective reports and make clear presentation to the engineering community and society ***(PO5) (Psychomotor Domain)***
- **CO6 -** Engage in learning for effective project implementation with a commitment to improve knowledge and competence in context of technological updation. ***(PO6) (Affective Domain)***

SEMESTER IV

21PSE401	DISSERTATION PHASE II	L	T	P	C
		0	0	24	12

COURSE OBJECTIVES :

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop 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 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.

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.

TOTAL : 270 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1 -** Analyze and review the research literature critically and evolve suitable methodologies for solving the complex engineering problem ***(PO1, PO3) – (K4-Analyze)***
- **CO2 -** Analyze the complex engineering problem critically to provide optimal solution after considering public health, safety, ethical, societal and environmental factors. ***(PO2) (K4- Analyze)***
- **CO3 -** Design/Develop sustainable solutions after independently carrying out research and investigation to solve practical problems. ***(PO3) (K6-Create)***
- **CO4 -** Utilize modern engineering and IT tools, techniques including prediction and modeling for complex engineering activities and augment the effectiveness of the solution with an understanding of the limitations ***(PO4) (K3-Apply)***
- **CO5 -** Write effective reports and make clear presentation to the engineering community and society ***(PO5) (Psychomotor Domain)***
- **CO6 -** Engage in learning for effective project implementation with a commitment to improve knowledge and competence in context of technological updation. ***(PO6) (Affective Domain)***

PROGRAMME ELECTIVES

21PSE501	DESIGN OF INDUSTRIAL STRUCTURES	L	T	P	C
		3	0	0	3

COURSE 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.

UNIT I	PLANNING AND FUNCTIONAL REQUIREMENTS	9

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

UNIT II	INDUSTRIAL BUILDINGS	9

Roofs for Industrial Buildings - Steel and RCC - Gantry Girders - Design of Corbels and Nibs – 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: 45 PERIODS

[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,

- **CO1** - Prepare the layout of Industrial buildings as per requirements. ***(Apply)***
- **CO2** - Draw the reinforcement detailing of various industrial structures as per IS code.***(Apply)***
- **CO3** - Analyze the safety and serviceability requirements of various industrial structural elements such as R.C corbels, bunkers and Silos as per IS code. ***(Analyze)***
- **CO4** -Plan industrial structures for functional requirements. ***(Analyze)***
- **CO5** - Analyze the safety and serviceability requirements of foundation for Towers, transmission line towers and Chimneys as per IS Codal provisions***.(Analyze)***
- **CO6** - Construct the models / prototype of Industrial structures as per IS Codal provisions by adopting suitable scale values. ***(Create)***

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, 3rd Rev.

21PSE502	CONSTITUTIVE MODELS AND MODES OF FAILURE	L	T	P	C
		3	0	0	3

COURSE 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 learning the contents of this course, the student would be able to,

- **CO1** - Apply elasticity solutions to Simple two dimensional problems in Cartesian and polar Coordinates. ***(Apply)***
- **CO2** - Apply energy theorems and formulations for beams and simple structures. ***(Apply)***
- **CO3** - Analyze different mechanical models in relation to actual events. ***(Analyze)***
- **CO4** - Analysis and Design of Structural Elements Made of Cement Composite. ***(Analyze)***
- **CO5** - Make an analysis on -one, two and three dimensional models with practical model. (***Analyze***)
- **CO6** - Develop engineering models for materials and structural elements. ***(Create)***

REFERENCES:

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.

21PSE503	DESIGN OF SUB STRUCTURES	L	T	P	C
		3	0	0	3

COURSE 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 learning the contents of this course, the student would be able to,

- **CO1** – Choose the best foundation design for the various soil strata. ***(Apply)***
- **CO2** - Design the foundation based on the load carrying capacity and settlement with appropriate consideration for safety. ***(Apply)***
- **CO3** - Determine the earth pressure, safe load, and settlement to offer a suitable foundation considering the safety and economic conditions ***(Apply)***
- **CO4** - Incorporate the principles of numerous theories, excavation methods, and in-situ testing to analyse the bearing capability of various foundations.. ***(Analyse)***
- **CO5** - Recommend a suitable foundation based on soil condition and bearing capacity at a specific area.***(Evaluate)***
- **CO6** - Investigate geotechnical issues with knowledge of subsurface investigation, earth pressure analysis, and testing methods. ***(Evaluate)***

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.

21PSE504	DESIGN OF BRIDGES	L	T	P	C
		3	0	0	3

COURSE 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	9

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	9

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

UNIT 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 : 45 Periods

[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 learning the contents of this course, the student would be able to,

- **CO1** – Explain the basic design fundamentals of bridge structures and its components. ***(Understand)***
- **CO2** – Apply the basic concept to determine the loads acting on the various types of bridges as per Codal Provisions. ***(Apply)***
- **CO3** – Analyze the RCC solid slab and girder bridges with different loading conditions as per IRC & Railway Specifications. ***(Analyze)***
- **CO4** – Analyze the design and detailing of RCC Bridges, Steel Bridges and Prestressed Concrete bridges with IRC Specifications. ***(Analyze)***
- **CO5** – Design and detailing of substructure and super structure components of various types of bridges as per IRC Recommendations. ***(Design / Evaluate)***
- **CO6** – Investigate the loads, BM & SF for different components of various bridges by theoretical analysis and any one of software packages. ***(Analyze / Modern tool Usage)***

REFERENCES:

1. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill,2008.
2. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. NewDelhi,6th Edition 2007.
3. Jagadeesh.T.R. andJayaram.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 (4^{th}Edition).
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: 22-2008 Standard Specifications and Code of Practice for Road Bridges, Section VI – Composite Construction (Limit States Design) (Second Revision).
7. IRC: 24-2010 Standard Specifications and Code of Practice for Road Bridges, Steel Road Bridges (Limit State Method)Third Revision).
8. IRC: 83-1999 (Part-I) Standard Specifications and Code of Practice for Road Bridges, Section IX – Bearings, Part I : Metallic Bearings (First Revision).
9. IRC: 83-1987 (Part II) Standard Specifications and Code of Practice for Road Bridges,
10. Section IX – Bearings, Part II: Elastomeric Bearings. IRC: 83-2002 (Part III) Standard Specifications and Code of Practice for Road Bridges,
11. Section IX – Bearings, Part III: POT, POT-CUMPTFE,PIN and Metallic Guide Bearings.
12. Pigeaud"s curves

21PSE505	DESIGN OF STORAGE STRUCTURES	L	T	P	C
		3	0	0	3

COURSE 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.

UNIT I	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.

UNIT II	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.

UNIT III	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 pre-stressing – Design of prestressed concrete circular water tanks.		
		TOTAL : 45 Periods

COURSE OUTCOMES:

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

- **CO1** - Make use of the IS code to design rectangular steel water tanks. ***(Apply)***
- **CO2** - Design steel and concrete bunkers and silos. ***(Apply)***
- **CO3** - Analyze the reinforcement detailing of various storage structures as per IS code**.*(Analyze)***
- **CO4** – Analyze the design of storage structures. ***(Analyze)***
- **CO5** – Analyze the pre-stressed concrete circular water tanks and rectangular water tank. ***(Analyze)***
- **CO6** – Investigate the procedures used to develop bunkers, silos, and water tanks. ***(Evaluate)***

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.

21PSE506	ADVANCED CONCRETE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE 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	NON-DESTRUCTIVE 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.

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1 -** Apply the rules to do mix designs for concrete by various methods. ***(Apply)***
- **CO2 -** Practice Better use of resources by having an effective structure along its lifetime. ***(Apply)***
- **CO3** - Compare the concepts of conventional concrete and its differences with other concretes like no fines, light weight etc***. (Analyze)***
- **CO4** - Intrepret the significance of Ready Mixed Concrete, Sprayed and pumped concrete in multistoried building construction. ***(Evaluate)***
- **CO5** - Measure Interfacial transition zone in concrete and its influence on strength and durability. ***(Evaluate)***
- **CO6** - Design and develop the self-compacting and high performance concrete. ***(Create)***

REFERENCES:

1. Gambhir., 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

21PSE507	DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

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

UNIT I	INTRODUCTION	9

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

UNIT II	DESIGN OF COMPOSITE MEMBERS	9

Design of composite beams - Deflections, slabs, columns - Introduction and Column Behavior- Flexural Capacity - P-M interaction - 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 –IS Code Provisions - Design Procedure .

UNIT V	CASE STUDIES	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 – 1985 are permitted in the End Semester Examinations]

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Outline the composite action and interpret the effect of composite action on structural component behavior. ***(Apply)***
- **CO2** - Apply the Limit State Concepts for the design of composite beams, columns and trusses.***(Apply)***
- **CO3** - Apply the Limit State Concepts for the design of shear connectors in composite Structures. ***(Apply)***
- **CO4** - Analyze the behavior and design concepts of box girder bridges.***(Analyze)***
- **CO5** - Analyze the Safety and Serviceability requirements of composite beams and Columns as per IS codes. ***(Analyze)***
- **CO6** - Assess the behavior of Composite Structures under various loading Conditions. ***(Evaluate)***

REFERENCE BOOKS:

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

21PSE508	DESIGN OF FORMWORK	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

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

UNIT I	INTRODUCTION AND FORM WORK MATERIALS	9

Requirements and Selection of Formwork. Timber, Plywood, Steel, Aluminum, Plastic, and Accessories. Horizontal and Vertical Formwork Supports. Construction planning and site constraints, Materials and construction of the common formwork and false work systems, Planning for maximum reuse – Economical form construction, Special and proprietary forms.

UNIT II	FORM WORK DESIGN	9

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

UNIT III	FORMWORK DESIGNFORSPECIALSTRUCTURES	9

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

UNIT IV	FLYING FORMWORK	9

Table Form, Tunnel Form, and Slip Form, Form work 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 learning the contents of this course, the student would be able to,

- **CO1** – Select proper formwork, accessories and material***.(Understand)***
- **CO2** – Design the form work for Beams, Slabs, columns, Walls and Foundations. ***(Apply)***
- **CO3** – Design the formwork for Special Structures***.(Apply)***
- **CO4 -** Appraise and demonstrate the recent advances in the formwork design ***(Apply)***
- **CO5 -** Analyze the Various Conditions of flying formwork ***(Analyze)***
- **CO6** – Evaluate the various formwork failures in construction projects***-(Evaluate)***

REFERENCE BOOKS:

1. Formwork for Concrete Structures,Peurify,McGrawHillIndia,2015.
2. Formwork for Concrete Structures, Kumar Neeraj Jha, Tata McGraw Hill Education,2012.
3. IS14687:1999,FalseworkforConcreteStructures - Guidelines, BIS

21PSE509	DESIGN OF PRESTRESSED CONCRETE STRUCTURES	L	T	P	C
		3	0	0	3

COURSE 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 COMPOSITE MEMBERS	9

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

UNIT V	DESIGN OF PRESTRESSED CONCRETE BRIDGES	9

Design of Composite bridge elements – pre – tensioned deck slab – post tensioned (partial prestressing) girders – RCC Piers

TOTAL : 45 Periods

[Note: Use of IS1343:2012and IRC-18-2000 codes are permitted in the End Semester Examinations]

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Design the pre & post-tensioned members satisfying the strength& serviceability Conditions. (***Apply***)
- **CO2** - Estimate the short and long-term losses in pre stressing .(***Apply***)
- **CO3** - Analyze the behaviour of prestressed, statically determinate and Indeterminate members. (***Analyze***)
- **CO4** - Analyze the stresses in end anchorage zones for PSC members. (***Analyze***)
- **CO5** - Make an analysis on continuous, composite beams that have been partially prestressed. (***Analyze***)
- **CO6** - Appraise and demonstrate the recent advances in the PSC technology. (***Evaluate)***

REFERENCE BOOKS:

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.,andBurns.H "Design of Prestressed Concrete Structures", John Wiley and \ SonsInc, 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. IRC-18-2000- Design Criteira for Prestressed Concrete Bridges (Post – Tensioned Concrete) Publised by the indian roads congress, Jamnagar House, Shahjahan Road, New Delhi – 110011.
3. IS 3370 Code of practice for concrete structures for the storage of liquids Part III Prestressed concrete structures.
4. IS 3370 Code of practice for concrete structures for the storage of liquids Part IV Design Tables.6

21PSE510	EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES	L	T	P	C
		3	0	0	3

COURSE 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.

UNIT I	EARTHQUAKES AND GROUND MOTION	9

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 TECHNIQUES9	9

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

TOTAL : 45 Periods

[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 learning the contents of this course, the student would be able to,

- **CO1** - Calculate earthquake induced lateral force on the structure. ***(Apply)***
- **CO2** - Apply the ductile design and detailing provisions to beam, columns and shear Walls. ***(Apply)***
- **CO3** - Identify the special confining reinforcement provisions in structural members. ***(Analyze)***
- **CO4** - Summarize the solution technique for dynamics of structural systems. ***(Evaluate)***
- **CO5** - Evaluate the guidelines for earthquake resistant design ***(Evaluate)***
- **CO6** - Design and develop analytical skills to calculate natural frequencies and mode shape. ***(Create)***

REFERENCE BOOKS:

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. PankajAgarwal 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.

21PSE511	EXPERIMENTAL STRESS ANALYSIS AND TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To familiarize the students about the measurement of strain and effects of vibrations and wind blow
- To make the students analyse the structure by non-destructive testing method
- To train the students to perform model analysis

UNIT I	STRAIN MEASUREMENT	9

Methods of Measurement -Calibration-Load calibration of testing machines-I.S. Code provisions - Measurement system- Mechanical, Optical and Acoustical extensometers -Strain measurement- Electrical resistance strain gauges- Principle, Types, Performance, Uses- Strain Rosettes- Wheatstone Bridge-Electronic load cells-Proving rings

UNIT II	MEASUREMENT OF DISPLACEMENT VIBRATION	9

Measurement of vibration-Vibration galvanometers- Vibrometer-Characteristics of Structural vibration-Pressure gauges-Velocity transducers- Seismic transducers - Linear Variable Differential Transformer-Cathode ray oscilloscope - X Y Plotter- Wind Tunnels-Flow meters- Venturimeter-Digital Data Acquisition systems

UNIT III	DISTRESS MEASUREMENT	9

Diagnosis of distress in structures-Cracks in structures-Formation of cracks- Types of cracks-Causes of cracks- Crack measurement- Monitoring and measurement of crack movement- Corrosion of reinforcement in RCC- Half-cell-Construction and use-Damage assessment-Controlled blasting for demolition

UNIT IV	PHOTOELASTICITY	9

Photo elasticity-Two dimensional photo elasticity, Sources of light - photo elastic effects - stress optic law -Interpretation of fringe pattern- Compensation and separation techniques- Photo elastic materials. Introduction to three dimensional photo elasticity

UNIT V	MODEL ANALYSIS	9

Model laws- Laws of similitude-Model materials- Model testing- Necessity for Model Analysis-Advantages-Applications- Types of similitude- Scale effect in Models- Indirect model study- Direct model study-Limitations of model investigations- Structural problems that may demand model studies-Usage of influence lines in model studies

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1 -** Develop a basic knowledge of experimentally based stress/strain analysis***.(Remember)***
- **CO2 -** Exhibit a fundamental knowledge of the experimental techniques frequently employed in experimental solid mechanics and image correlation***.(Apply)***
- **CO3 -** Write a complete lab report and present their findings in a logical and systematic manner***.(Apply)***
- **CO4 -** Analyze contact stresses in components forced against each other***.(Analyze)***
- **CO5 -** Evaluate the experimental data and make sound, convincing inferences from it in light of comparisons to theoretical forecasts and further experimental evidence***.(Evaluate)***
- **CO6 -** Acquire the knowledge of how brittle and bi-refrigent coatings work and how strain gauges work***.(Understand)***

REFERENCE BOOKS:

1. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 2006
2. J. W. Dally and W. F. Riley, Experimental Stress Analysis, McGraw-Hill, Inc. New York, 1978.
3. L. S. Srinath, Experimental Stress Analysis, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1984.
4. C. S. Rangan, Instrumentation Devices and Systems, Tata McGraw-Hill Publishing Co. Ltd.,New Delhi, 1983.

21PSE512	MATRIX METHODS FOR STRUCTURAL ANALYSIS	L	T	P	C
		3	0	0	3

COURSE 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 analyze 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 from 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 Centre gradience

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 learning the contents of this course, the student would be able to,

- **CO1** – Compute reactions for plane trusses, beams, and frames. ***(Apply)***
- **CO2** - Apply Stiffness Approach to Pin Jointed Plane Trusses, Continuous Beams, Frames, and Grid- Space Trusses. ***(Apply)***
- **CO3** - Analyze the transfer of force and displacements from systems to elements. ***(Analyze)***
- **CO4** - Analyze solutions for structural elements using flexibility method and direct stiffness method. ***(Analyze)***
- **CO5** - Interpret the methods of measuring the Strain energy in systems and in elements. ***(Evaluate)***
- **CO6** - Formulate the transformation of forces and displacement. ***(Create)***

REFERENCE BOOKS:

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

21PSE513	GREEN BUILDING MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To impart knowledge to students on Eco friendly building concepts.
- To train students in the Building certification systems as per Indian and International Standards.
- To give exposure to students in performance rating.

UNIT I	INTRODUCTION TO GREEN BUILDING CONCEPT	9

Introduction to Green Buildings Concept and sustainable development-Necessity- Principles of green building -typical features of green buildings, benefits of green buildings towards sustainable development. – Selection of site and Orientation of the building – usage of low energy materials – effective cooling and heating systems – effective electrical systems – effective water conservation systems.

UNIT II	INTRODUCTION TO GREEN RATING SYSTEMS	9

History of green Rating systems - LEED, GRIHA, BREEAM, IGBC - Need and Structure of the rating systems - Purpose - Key highlights - Point System with Differential weight age- Selection of the appropriate rating system-Zero Energy Building.

UNIT III	ALTERNATIVE CONSTRUCTION MATERIALS AND METHODS	9

Green Building Materials-Reusable building Construction Materials - Salvaged Materials - Manufactured Materials - Recycled Content – Eco Block - Volatile Organic Compounds (VOC's)- Natural Non-Petroleum Based Materials - Alternative Construction Methods - Waste Management and Recycling - Design For Deconstruction.

UNIT IV	PERFORMANCE TESTING	9

Cost Performance Benchmarking - Building Energy Modeling - Cost Benefit Analysis - Energy, Shell and Systems Installation Testing - Blower Door - Duct Tightness - Thermal Imaging- Air Quality - Moisture Testing - Commissioning, Metering, Monitoring -Weatherization - Air Sealing – HVAC - Moisture Control - Energy Retrofits and Green Remodels.

UNIT V	FUTURE OF BUILDING RATING SYSTEMS	9

Role of Green building consultant - Green Accreditation examinations - Energy modeling and energy auditing in green building ratings - Consultancy scope and services for green rating systems - Codes and Certification Programs - Green Rating Registration - Green Remodeling - International Green Construction Codes – Service life of Building- Case Study.

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Apply various Green Buildings rating tools for project management***.(Apply)***
- **CO2** - Implement building rating systems to perform the role of a green building consultant.***(Apply)***
- **CO3** - Compare the various green rating systems in the market***.(Analyze)***
- **CO4** - Analyze the various scope of future building rating system available in the market***.(Analyze)***
- **CO5** - Analyze the various alternative construction materials and methods in green building.***(Analyze)***
- **CO6** - Evaluate the energy modeling and energy auditing in various types of buildings.***(Evaluate)***

REFERENCE BOOKS:

.

1. Linda Reeder, "Guide to green building rating systems ", John Wiley & Sons, 3rd Edition 2010.

2. Dru Meadows," Preparing a Building Service Life Plan for Green Buildings", McGraw-Hill Publications, 1st Edition, 2014.

3. Abe Kruger," Green Building: Principles and Practices in Residential Construction", Cengage learning India Pvt Ltd, 1st Edition, 2012.

21PSE514	INNOVATION, ENTREPRENEURSHIP & VENTURE DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To impart knowledge on innovation and creativity
- To train students on Scope of entrepreneurship and joint ventures.
- To apply creative and design thinking to a real-world situation

UNIT I	CREATIVITY	9

Types of Intelligence-Types of Thinking- Pattern Breaking - Critical thinking vs. Creative thinking – Barriers to Creative thinking –Exercises for Lateral thinking – Six thinking hats Methods and tools for Creativity – Stimulation of new ideas - Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation. Case Studies. Brain-twisters and puzzles.

UNIT II	INNOVATION	9

Invention vs. Innovation. Product Development Strategies related to Innovation-Traits of Innovative people-Types of Innovation-Need driven innovation-Radical Innovation-Case Studies of technology-push products, Platform products, Customized products, Quick build products and complex systems. Social Innovation- Understanding social problems- Human-Centered Design. Sustainable innovation – Technological Innovation – Innovation in business & Entrepreneurship

UNIT III	ENTREPRENEURSHIP	9

Introduction - Definition of Entrepreneur, Entrepreneurial Traits, and Entrepreneur vs. Manager, Entrepreneur vs. Entrepreneur. decision process. Role in Economic Development, Ethics and Social responsibility of Entrepreneurs. Opportunities- Woman as Entrepreneur. Case study on successful entrepreneurs .

UNIT IV	PRODUCT DEVELOPMENT	9

Plan and establish product specifications. Concept Generation– search externally and internally-Explore systematically - reflect on the solutions and processes. Concept Selection - methodology - benefits. Implications - Product change - variety - component standardization - product performance – manufacturability. Concept Testing Methodologies. Planning and Development of Prototypes.

UNIT V	VENTURE MANAGEMENT	9

Sources of new Ideas, creating problem solving, product planning and development process-sources of capital, recruitment, motivating and leading teams, Marketing and sales controls. Institutional support to Entrepreneurship- Role of Directorate of Industries, District Industries, Centers (DICs), Industrial Development Corporation (IDC), State Financial corporation (SFCs), Commercial banks Small Scale Industries Development Corporations (SSIDCs), Khadi and village Industries Commission (KVIC), National Small Industries Corporation (NSIC), Small Industries Development Bank of India (SIDBI).

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Apply processes and methods of creative problem solving. ***(Apply)***
- **CO2** - Follow modularity concept in producing successful entrepreneurs***..(Apply)***
- **CO3** - Analyze the social problems and offer creative and innovative solutions. ***(Analyze)***
- **CO4** – Analyze the various joint ventures for innovation and creativity in launching a product. ***(Analyze)***
- **CO5** – Investigate the various steps to be followed in conceiving the idea to product development. ***(Investigate)***
- **CO6** - Create design for manufacturing principles to produce a prototype. ***(Create)***

REFERENCE BOOKS:

1. Karl T.Ulrich and Steven D.Eppinger, "Product Design and Development", 5th edition Mcgraw Higher Ed.2016.
2. Clayton M. Christensen Michael E. Raynor, "Innovator's Solution: Creating and Sustaining Successful Growth", Harvard Business School Press India Limited, 2013.
3. A.K. Chitale, R. C. Gupta, "Product Design and Manufacturing", Prentice Hall India Learning Private Limited 6thedition, 2014.
4. Floyd Hurr, "Rousing Creativity: Think New Now", ISBN 1560525479, Crisp Publications Inc. 1999.
5. Donald A. Norman, "Emotional Design", Perseus Books Group New York, 2004.
6. John E. Arnold, John Arnold Jr. , Arcturus IV Case Study, Amazon Digital Services LLC, 2017.

21PSE515	OFFSHORE STRUCTURES	L	T	P	C
		3	0	0	3

COURSE 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 analyze and design offshore structures.

UNIT I	WAVE THEORIES	9

Wave generation process - small and finite amplitude wave theories.

UNIT II	FORCES OF OFFSHORE STRUCTURES	9

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	9

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

UNIT V	DESIGN OF OFFSHORE STRUCTURES	9

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

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Identify the forces influencing offshore structures. ***(Apply)***
- **CO2** - Design platforms, helipads and pipelines. ***(Apply)***
- **CO3** - Analyze coastal engineering issues such the linear wave theory, wave energy propagation, shoaling, refraction, diffraction, and breaking. ***(Analyze)***
- **CO4** - Analyze the static and dynamic conditions of offshore constructions. ***(Analyze)***
- **CO5** - Evaluate the maximum forces on an offshore structure due to fixed platforms and mooring cable platforms. ***(Evaluate)***
- **CO6** - Simulate offshore foundation and structural components. ***(Create)***

REFERENCE BOOKS:

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 SwamidasA.S.J.,Essential of offshore structures.CRC Press.2013

21PSE516	PRECAST AND PREFABRICATED STRUCTURES	L	T	P	C
		3	0	0	3

Course Learning Objectives

- To enhance knowledge on the design principles, analysis and design of prefabricated elements.
- To provide an overview of connections involved in prefabricated units.
- To outline the design considerations in the process of prefabrication of various structural elements.

UNIT I	DESIGN PRINCIPLES	9

General Civil Engineering requirements - specific requirements for planning and layout of prefabrication plant. IS codal specifications - Modular co-ordination- Standardization - Disuniting of Prefabricates – Handling and Erection of Stresses - Design of rectangular beams, I beams & Symmetric Frames - Deflection control.

UNIT II	PREFABRICATED ELEMENTS	9

Behavior of structural components – Construction of roof and floor slabs – Columns – Roof and floor panels, ribbed floor panels – wall panels – Shear walls - footings – Joints for different structural connections – Effective sealing of joints for water proofing – Provisions for non-structural fastenings – Expansion joints in pre-cast construction.

UNIT III	PRODUCTION & HOISTING TECHNOLOGY	9

Choice of production setup – Manufacturing methods – Stationary and mobile production – Planning of production setup – Storage of precast elements – Dimensional tolerances – Acceleration of concrete hardening. Equipment for hoisting and erection – Techniques for erection of different types of members like Beams, Slabs, Wall panels and Columns – Vacuum lifting pads.

UNIT IV	DESIGN FOR ABNORMAL LOADS	9

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

UNIT V	INDUSTRIAL BUILDINGS AND SHELL ROOFS	9

Designing and detailing of precast unit for factory structures – Purlins, Principal rafters, roof trusses, lattice girders, gable frames, corbels and columns. Cylindrical, Folded plate and hyper-prefabricated shells - Erection and jointing, joint design, hand book based design.

TOTAL : 45 Periods

[Note: IS 15916:2011 – Code of practice for design and erection using prefabricated concrete. IS 11447: 1985 – Code of practice for construction with large panel prefabricates are permitted in the End Semester Examinations]

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Explain the behavior, types and general design requirements of various prefabricated components. ***(Understand)***
- **CO2** - Design the various prefabricated units as per IS Standards. ***(Apply)***
- **CO3** - Design the Precast components of Industrial Buildings and Shell Roofs. ***(Apply)***
- **CO4** - Outline the progressive collapse assessment for a framed prestressed precast RC structure. ***(Analyze)***
- **CO5** - Compare the conventional system with modular system of prefabrication. ***(Analyze)***
- **CO6** - Examine the customer needs and labor-related difficulties, and diversifies the Modern Methods of Construction (MMC) in order to increase productivity. ***(Evaluate)***

REFERENCE BOOKS:

1. "Precast Concrete Structures" by Kim S. Elliott · 2019
2. "Precast Concrete Structures" by Alfred Steinle, Hubert Bachmann, Mathias Tillmann · 2019
3. "Design in Modular Construction" by Mark Lawson, Ray Ogden, Chris Goodier · 2014
4. "Prefab Architecture - A Guide to Modular Design and Construction" by Ryan E. Smith · 2011
5. "Structural Design Manual", Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 2009
6. Koncz T., "Manual of precast concrete construction", Vol. I, II and III, Bauverlag, GMBH, 1976.

STANDARDS:

1. IS 15916:2011 – Code of practice for design and erection using prefabricated concrete.
2. IS 11447: 1985 – Code of practice for construction with large panel prefabricates

21PSE517	SMART MATERIALS AND SMART STRUCTURES	L	T	P	C
		3	0	0	3

COURSE 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	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 learning the contents of this course, the student would be able to,

- **CO1** - Examine the functionality and suitability of different smart materials. ***(Analyze)***
- **CO2** - Perform simulations for the use of smart materials and constructions. ***(Apply)***
- **CO3** - Apply various principles to operate sensors and actuators. ***(Apply)***
- **CO4** - Analyze the functions and response of instrumented structures. ***(Analyze)***
- **CO5** - Evaluate signal processing and control systems for smart structures. ***(Evaluate)***
- **CO6** - Create simple models of intelligent materials and buildings**.(Create)**

REFERENCES:

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. W. Dally & W. F. Riley, "Experimental Stress Analysis", Tata McGraw Hill Company

21PSE518	STRUCTURAL HEALTH MONITORING	L	T	P	C
		3	0	0	3

COURSE 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	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 learning the contents of this course, the student would be able to,

- **CO1** - Document the structure's distress, its causes, and the factors involved.. ***(Apply)***
- **CO2** - Choose the appropriate procedure for case study-related repair, strengthening, rehabilitation, and retrofitting.. ***(Apply)***
- **CO3** - Assess the health of structure using static and dynamic field tests. ***(Apply)***
- **CO4** - Analyze the causes and mitigation strategies for monitoring structure health. ***(Analyze)***
- **CO5** - Investigate the state of the structures by using structural audit to determine the type of deterioration and the best way to solve it. ***(Evaluate***)
- **CO6** - Suggest appropriate health monitoring technique and demolition technique ***(Create)***

REFERENCE BOOKS:

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

21PSE519	VULNERABILITY AND RISK ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To teach risk analysis in structures
- To impart the knowledge on Vulnerability assessment of Buildings
- To prepare them to study risk estimation in different projects

UNIT I	INTRODUCTION	9

Concepts and Components of Risk: Introduction to Hazard, vulnerability, exposure and risk; Estimation of risk from components for an earthquake hazard.

UNIT II	VULNERABILITY ASSESSMENT OF BUILDINGS	9

Empirical and analytical approaches, building topology, use of intensity scales for estimating seismic vulnerability, Hazus methodology, displacement-based approach (Capacity design method).

UNIT III	RISK ESTIMATION	9

Convolution of hazard, vulnerability and exposure to quantify risk, loss ratios, indoor and outdoor casualty rates; Case studies of different projects.

UNIT IV	RISK COMMUNICATION	9

Role of planners, architects, engineers, banks and insurers; Rating of damage assessment, disaster impact analysis

UNIT V	EARTHQUAKE DAMAGE STUDIES	9

Earthquake damage surveys, data to be collected, handling and processing of data, classification of damage, and Estimation of fragility from damage data.

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Apply risk concepts to earthquake hazards. ***(Apply)***
- **CO2** - Perform Post Earthquake Damage Studies and communicate risk. ***(Apply)***
- **CO3** - Estimate the fragility from damaged data. ***(Apply)***
- **CO4** - Analyze the various risks involved in construction projects***.(Analyze)***
- **CO5** - Analyze the rating of damage assessment in projects**.** ***(Analyze)***
- **CO6** - Evaluate seismic vulnerability and exposure to quantify risk characteristics of structures. ***(Evaluate)***

REFERENCES:

1. Krammer, S. L., “Geotechnical Earthquake Engineering”, Pearson Education, 2018.
2. Reiter, L. “Earthquake Hazard Analysis, Issues and Insights”, Columbia University Press, 2019.
3. Coburn, A. and Spence R., “Earthquake Protection”, John Wiley and Sons, Ltd. 2020.

21PSE520	ENGINEERING FRACTURE MECHANICS	L	T	P	C
		3	0	0	3

COURSE 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 - Dug dale approach-Path independence, Critical J integral–Evaluation of CTOD-Relationship between CTOD, K1 and G1 for small scale yielding

UNIT IV	FATIGUE CRACK GROWTH	9

Fatigue crack growth 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 learning the contents of this course, the student would be able to,

- **CO1** - Estimate the residual life of fatigue Crack Growth in structure. ***(Apply)***
- **CO2** - Apply the principles of fracture mechanics and design for failure against fracture. ***(Apply)***
- **CO3** - Analyze the Brittle materials that are subjected to linear elastic fracture mechanics.***(Analyze)***
- **CO4** - Analyze the relationship between SIF, ERR, and crack tip opening displacement, and apply these parameters to ductile and brittle materials. ***(Analyze)***
- **CO5** - Predict a material's cause of failure accurately using observations of the fracture surface. ***(Evaluate)***
- **CO6** - Investigate experimental techniques and simulations utilized for failure analysis of various components and interpret the probable reasons for failure. ***(Investigate)***

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.

21PSE521	MECHANICS OF COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To explain the behavior 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 : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Apply various techniques for suitable composite material with required enhanced properties. ***(Apply)***
- **CO2** - Analyze the suitability of composite materials under various conditions. ***(Analyze)***
- **CO3** - Analyze the stress –strain relationships for orthotropic and anisotropic materials. ***(Analyze)***
- **CO4** - Analyze of residual stresses in an isotropic layered structure using classical laminate theory.***(Analyze)***
- **CO5** - Evaluate the performance composite materials for engineering applications.***(Evaluate)***
- **CO6** - Investigate different areas of Mechanics of Composite Materials.***(Evaluate)***

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.

21PSE522	OPTIMIZATION OF STRUCTURES	L	T	P	C
		3	0	0	3

COURSE 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.

UNIT I	BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES	9

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

UNIT II	LINEAR AND NON-LINEAR PROGRAMMING	9

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

UNIT III	GEOMETRIC PROGRAMMING	9

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

UNIT IV	DYNAMIC PROGRAMMING	9

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

UNIT V	STRUCTURAL APPLICATION	9

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

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Apply the various optimization techniques in industry. ***(Apply)***
- **CO2** - Solve optimization problems using linear and non-linear programming techniques***.(Apply)***
- **CO3** - Optimize structural elements such as continuous beams, sine story frames and truss. ***(Apply)***
- **CO4** - Apply the various optimization methodologies applied to structural engineering***.(Apply)***
- **CO5** - Compare the various constrained and unconstrained problems with zero difficulty. ***(Analyze)***
- **CO6** - Analyze the various methods of dynamic programming in structures***.(Analyze)***

REFERENCE BOOKS:

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

21PSE523	THEORY AND APPLICATIONS OF CEMENT COMPOSITES	L	T	P	C
		3	0	0	3

COURSE 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	9

Ferrocement, SIFCON and Fibre Reinforced Concrete

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Analyze and Design of Cement Composite Structural Elements. ***(Apply)***
- **CO2**- Employ the applicability of cement composites in structural elements. ***(Apply)***
- **CO3** - Analyze and design structural elements made of cement composites. ***(Analyze)***
- **CO4** - Classify mechanical properties of cement composites & applications. ***(Analyze)***
- **CO5** - Estimate strain constants using theories applicable to composite materials. ***(Evaluate)***
- **CO6** – Combine materials as per orthotropic and anisotropic behavior. ***(Create)***

TEXT BOOKS:

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

REFERENCES:

1. DovKominetzky.M.S.,-Design and Construction Failures, Galgotia, Publications Pvt.Ltd.,2001
2. Ravishankar.K. Krishnamoorthy.T.S, Structural Health Monitoring, Repair And Rehabilitation of Concrete Structures, Allied Publishers, 2004.
3. Hand book on Seismic Retrofit of Buildings, CPWD and Indian Buildings Congress, Narosa Publishers, 2008.
4. Hand Book on "Repair and Rehabilitation of RCC Buildings"–Director General works CPWD ,Govt of India , New Delhi–2002

21PSE524	THEORY OF PLATES AND SHELLS	L	T	P	C
		3	0	0	3

COURSE 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	9

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

UNIT II	RECTANGULAR PLATES	9

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

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	9

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

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Determination of Navier solution for simply- supported rectangular plate under various loadings. ***(Apply)***
- **CO2** - Analyze the use of superposition for the axisymmetric analysis of circular plates (***Analyze)***
- **CO3** - Analyze under axi- symmetric loading, governing differential equation in polar co-ordinates. (***Analyze)***
- **CO4** - analyze the circular plates on elastic foundation, asymmetric bending of circular plates***.(Analyze***)
- **CO5** - Evaluate the cylindrical and conical shells, application to pipes and pressure vessels, thermal stresses in plate/shell. ***(Evaluate)***
- **CO6** - design folded plate components based on proven empirical methods ***(Create)***

REFERENCES:

1. Timoshenko, S. and Krieger S.W. “Theory of Plates and Shells”, McGraw Hill Book Company, NewYork, 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.

21PSE525	MAINTENANCE, AND REHABILITATION OF STRUCTURES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To acquire the knowledge on Quality of concrete, durability aspects, causes of deterioration, assessment of distressed structures, repairing of structures and demolition procedures.

UNIT I	IMAINTENANCE AND REPAIR STRATEGIES	9

Maintenance, Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance, Various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration.

UNIT II	STRENGTH AND DURABILITY OF CONCRETE	9

Quality assurance for concrete–Strength, Durability- Cracks, different types, causes–Effects due to climate, temperature, Sustained elevated temperature, Corrosion

UNIT III	SPECIAL CONCRETES	9

Polymer concrete, Sulphur infiltrated concrete, Fibre reinforced concrete, High strength concrete, High performance concrete, Vacuum concrete, Self compacting concrete, Geopolymer concrete, Reactive powder concrete, Concrete made with industrial wastes.

UNIT IV	TECHNIQUES FOR REPAIR AND PROTECTION METHODS	9

Non-destructive Testing Techniques, Load Test for Stability-Epoxy injection, Shoring, Underpinning, Corrosion protection techniques–Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic protection.

UNIT V	REPAIR, REHABILITATION AND	9

Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, leakage, earthquake-Transportation of Structures from one place to other –Structural Health Monitoring-

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Apply the repair and maintenance strategies for structures ***(Apply)***
- **CO2** - Apply suitable post repair techniques for structures ***(Apply)***
- **CO3** - Suggest suitable materials for repair based on damage level, deterioration mechanism and durability requirements of the distressed structures***.(Analyze)***
- **CO4** - Analyze rehabilitation procedure for structurally distressed members ***(Analyze)***
- **CO5** - Recommend repair techniques for rehabilitation of damaged structural elements based on deterioration level, serviceability and durability requirements***.(Evaluate)***
- **CO6** - Investigate the effects due to climate, temperature, chemicals, wear and erosion on structures. ***(Evaluate)***

REFERENCES:

1. Shetty.M.S.ConcreteTechnology-Theory and Practice,S.Chandand Company, 2008.
2. Vidivelli.B Rehabilitation of Concrete Structures Standard Publishes Distribution.1st edition 2009.
3. Varghese.P.C Maintenance Repair and Rehabilitation & Minor works of building, Prentice Hall India Pvt Ltd 2014.
4. Dodge Woodson.R Concrete Structures, Protection, Repair and Rehabilitation, Butterworth-Heinemann, Elsevier,New Delhi 2012

LIST OF OPEN ELECTIVE

21PPE605	SMART CITY TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES :

- To familiarise students with the basic knowledge of smart cities and learn how to plan, analyse, implement and compare existing smart cities
- To gain a deep understanding of smart city design and development, learn about the state-of-the-art strategies for smart cities
- To give an overview of the concepts and real-life practices in the development, feasibility and sustainability of Smart Cities across the world.

UNIT I	INTRODUCTION TO SMART CITIES	9

Introduction : Definition – Drivers - barriers - benefits of smart cities - characteristics and factors of Smart cities–Feasibility Analysis of Smart Cities - understanding Liveability - Affordability and Inequality - Development standards -Smart indicators - 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 - Public safety and Payments. Smart city enablers: instrumentation and control – connectivity – interoperability - security and privacy - data management - computing resources - process of building a smart city roadmap.

UNIT III	SMART AND SUSTAINABLE URBAN DEVELOPMENT	9

Principles of sustainable development and smart growth - low carbon and renewable energy technologies –water management –waste management - carbon management - pollution prevention - climate adaptation and resilience - integrated environmental systems management, smart buildings and infrastructure.

UNIT IV	SMART TECHNOLOGIES	9

Big Data Analytics: big data platforms and cloud computing - urban informatics - GIS and spatial analysis – measuring impact and data visualization Smart Technologies: Urban informatics - Internet of things(IoT) - remote sensing and communication technologies..

UNIT V	TOWARDS SMART CITIES IN INDIA	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 learning the contents of this course, the student would be able to,

- **CO1** - Analyze the characteristics of the smart cities based on livability and affordability***(Analyze)***
- **CO2** - Analyze the framework of smart cities in terms of connectivity, security, privacy and data management***.(Analyze)***
- **CO3** - Evaluate the impact of smart infrastructure on environmental systems management ***(Evaluate)***
- **CO4** - Apply the capabilities of the data analytics in developing urban informatics***.(Apply)***
- **CO5** - Evaluate the identification parameters for qualifying a city to become smart city ***(Evaluate)***
- **CO6** - Apply Internet of Things, remote sensing and communication technologies to make cities safer and smart. ***(Apply)***

TEXT BOOKS:

1. Allen G.Noble, "Regional Development and Planning for the 21stCentury: New Priorities and New Philosophies", Routledge Publishers, 2019.

2. Andy Pike, Andres Rodriguez-Pose, John Tomaney, "Handbook of Local and Regional Development", Routledge Publishers, 2016.

REFERENCES:

1. Daniel G. Parolek, AIA, Karen Parolek, Paul C. Crawford, FAICP, "Form Based Codes: A Guide for Planners, Urban Designers, Municipalities, and Developers", John Wiley & Sons, 2008..

2. 2.AndreasFaludi and Sheryl Goldberg, "Fifty years of Dutch National Physical Planning", Alexandrine Press, Oxford, 1991.

LIST OF MANDATORY CREDIT COURSE

21PGM701	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

COURSE 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	FORMULATION OF RESEARCH PROBLEM	9

Meaning of research problem, Sources of research problem, Criteria- good research problem, and selecting a research problem, Scope and objectives of research problem. Defining and formulating the research problem - Necessity of defining the problem – Types of Literature Review- Sources for Literature Review - Identifying gap areas from literature review.

UNIT II	RESEARCH DESIGN AND ETHICS	9

Research Design – Different Research designs- Sampling design- Types of sampling, Methods of Data collection- primary data, secondary data Plagiarism, Application of results and ethics - Environmental impacts - Ethical issues - ethical committees

UNIT III	DATA ANALYSIS AND TESTING OF HYPOTHESES	9

Data Processing and Analysis strategies -Types of Analysis- Statistics in Research - Measures of Central Tendency - Measures of Dispersion - Measures of Asymmetry (Skewness) -Measures of Relationship - Simple Regression Analysis - Multiple Correlation and Regression Testing of Hypotheses - Chi-square test, Taguchi and ANOVA

UNIT IV	REPORT AND RESEARCH PROPOSAL WRITING	9

Significance of Report Writing - Different Steps in Writing Report - Layout of the Research Report – Types of Reports - Oral Presentation - Mechanics of Writing a Research Report - Bibliography, types of referencing, citations. Format of research proposal -Research Proposal writing - assessment by a review committee

UNIT V	INTELLECTUAL PROPERTY AND PATENT	9

Nature of Intellectual Property – Patents- Designs, Trade and Copyright- Geographical Indications. Process of Patenting and Development – Patent Search- Invention, Innovation-Documents for Patent filing - Examination- Grant of Patent. Scope of Patent Rights - Case Studies

TOTAL : 45 Periods

COURSE OUTCOMES :

After learning the contents of this course, the student would be able to,

- **CO1** - Analyze the literature to identify the research gap in the given area of research. ***(Analyze/Problem Analysis)***
- **CO2** - Design suitable research methodology to pursue the research in scientific and systematic procedure with statistical / IT Tools***.(Analyze/ Design & Development of Solutions)***
- **CO3** - Analyze and synthesize the data using research methods and knowledge to provide scientific interpretation and conclusion***.(Analyze/Investigation)***
- **CO4** - Prepare research reports and proposals by properly synthesizing, arranging the research documents to provide comprehensive technical and scientific report. ***(Organizing/Affective Domain)***
- **CO5** - Conduct patent database search in various countries for the research problem identified. ***(Analyze).***
- **CO6** - Apply ethical principles in research and reporting to promote healthy scientific practice ***(Apply)***

REFERENCES:

1. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
3. Wadehra, B.L. 2000. Law relating to patents, Trade Marks, Copy right designs and Geographical indications. Universal Law Publishing.
4. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.

ADDITIONAL READING

1. https://www.editage.com/insights/how-to-write-the-literature-review-of-your-research-paper
2. https://www.ee.iitb.ac.in/~apte/CV_PRA_TAGUCHI_INTRO.htm

LIST OF AUDIT COURSES

21PGM801	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	2

COURSE 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 learning the contents of this course, the student would be able to

- **CO1** - Utilize the pedagogical concepts in development of syllabus and lesson plans that align with learning outcomes. ***(Apply)***
- **CO2** - Use technology to enhance teaching and learning. ***(Apply)***
- **CO3** - Categorize the appropriate teaching-learning strategies in relevance to the needs of the learners. ***(Analyze)***
- **CO4** - Devise the assessment methodologies by concluding the rubrics for the assessment and inculcate the innovate assessment techniques based on attainment analysis. ***(Analyze)***
- **CO5** – Elaborate the pedagogical practices using theoretical teaching approaches and techniques ***(Create)***
- **CO6** - Design learning outcomes and relate learning outcomes to appropriate assessments. ***(Create)***

REFERENCES:

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

21PGM802	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSE 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 I	INTRODUCTION TO RESEARCH	6

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

UNIT II	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 III	METHODOLOGY, RESULTS & DISCUSSION AND CONCLUSION	6

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 IV	SUBMISSION OF RESEARCH PAPER	6

References – Citations and Checking the Citations – Various forms of Citation - Guidelines 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 learning the contents of this course, the student would be able to,

- **CO 1 -** Write analytical and coherent research articles including original research with primary and secondary sources ***(K3 – Apply)***
- **CO 2 -** Analyze, interpret and synthesize the information to write research papers that are well structured with logical explanation and valid conclusion ***(K4-Analyze)***
- **CO 3 -** Apply professional ethics in research by avoiding plagiarism, conflict of interest and use paraphrasing in citing research articles ***(K3 – Apply)***
- **CO 4 -** Apply the principle of citation by acknowledging the relevant written text with proper referencing ***(K3 – Apply)***
- **CO 5 -** Evaluate and modify the research article based on the comments and write point by point responses for the comments of the reviewers ***(K5- Evaluate)***

TEXT BOOKS:

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, NewYork 2009.