KALASALINGAM
Academy of Research and Education
DEEMED TO BE UNIVERSITY
Estd.U/S 3 of UGC Act 1956. Accredited by NAAC with "A" Grade
Anand Nagar, Krishnankoil – 626126. Srivilliputtur (Via), Virudhunagar (Dt), Tamil Nadu | info@kalasalingam.ac.in | www.kalasalingam.ac.in

M.Tech

STRUCTURAL ENGINEERING

(Regulations 2022)

Curriculum and Syllabus

SCHOOL OF MECHANICAL, AUTO, AERO AND MECHANICAL ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

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SCHOOL OF MECHANICAL, AUTO, AERO AND MECHANICAL ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

VISION:

To be a Centre of Excellence in Civil Engineering through Quality Education and Research

MISSION:

1. To produce Civil Engineers of high caliber, technical skills and ethical values to serve society and nation
2. To inculcate acumen for lifelong learning, research and capability to adapt to various challenges in the domain of civil engineering
3. To practice ethics and provide sustainable environment conscious solutions to problems in civil engineering

PROGRAMME EDUCATIONAL OBJECTIVES

PEO	DESCRIPTION
PEO1	Graduates will be able to provide solutions in the field of structural engineering by adapting latest techniques and practices.
PEO2	Graduates will be able to contribute towards research and provide cost effective and environment friendly solutions to the problems in structural engineering.
PEO3	Graduates will contribute towards societal development by adapting professional attitude and ethics.

PROGRAMME OUTCOMES:

PROGRAMME OUTCOMES	DESCRIPTION
PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO4	An ability to evaluate, analyze and synthesize existing and new knowledge in structural design.
PO5	An ability in lifelong learning independently for professional advancement, demonstrate professional ethics, work culture and understanding of responsibility to contribute to community for sustainable development of society through the obtained knowledge of Structural Engineering

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M.Tech (Structural Engineering) Curriculum Structure

S.No	Course Component	Total number of credits
1	Program Core Courses	40
2	Experiential Electives Courses	15
4	Supportive Courses	5
5	Experiential Core Courses	20
6	Audit Courses	-
Total number of Credits		80

SEMESTER –I

Sl. No	Course Code	Course Title	Course Type	L	T	P	C
1	221MAT1101	Statistics and Computational Techniques	T	3	0	0	3
2	222STE1101	Advanced Concrete Materials and Technology	T	4	0	0	4
3	222STE1102	Dynamics of Structures & Earthquake Engineering	T	4	0	0	4
4	222STE1103	Advanced Concrete Design of Structures	T	4	0	0	4
5	222STE1104	Theory of Elasticity & Plasticity	T	4	0	0	4
6	222STE1205	Structural Engineering Laboratory	L	0	0	3	2
TOTAL CREDITS							**21**

SEMESTER –II

Sl. No	Course Code	Course Title	Course Type	L	T	P	C
1	222STE1106	Matrix Methods of Structural Analysis	T	4	0	0	4
2	222STE1107	Industrial Structures	T	4	0	0	4
3	222STE1108	Experimental Techniques	T	4	0	0	4
4	222STE1109	Structural Steel Buildings - Design and Practices	T	4	0	0	4
5	222STE1110	Prestressed and Prefabricated structures	T	4	0	0	4
6	221PGM1001	Research Methodology	T	2	0	0	2
8	222STE1211	Computer Aided Design Laboratory	L	0	0	3	2
TOTAL CREDITS							**24**

SEMESTER –III

Sl. No	Course Code	Course Title	Course Type	L	T	P	C
1	224STE2XXX	Experiential Elective Course I	T	3	0	0	3
2	224STE2XXX	Experiential Elective Course II	T	3	0	0	3
3	224STE2XXX	Experiential Elective Course III	T	3	0	0	3
2	224STE2XXX	Experiential Elective Course IV & V / Project (Industries / R&D labs / Interns)	T/P	3/0	0	0/12	6
TOTAL CREDITS							**15**

SEMESTER – IV

Sl. No	Course Code	Course Title	Course Type	L	T	P	C
1	223STE4XXX	Experiential Core Course – Major Project	L	0	0	40	20
TOTAL CREDITS							**20**

TOTAL CREDITS TO BE EARNED - 80

PROGRAM / EXPERIENTIAL ELECTIVE COURSES

CODE NO	COURSE TITLE	Course Type	L	T	P	C
224STE2112	Computer Aided Design	T	3	0	0	3
224STE2113	Design of Shell and Spatial Structures	T	3	0	0	3
224STE2114	Design of Steel Concrete Composite Structures	T	3	0	0	3
224STE2115	Design of Tall Buildings	T	3	0	0	3
224STE2116	Nonlinear Analysis of Structures	T	3	0	0	3
224STE2117	Offshore Structures	T	3	0	0	3
224STE2118	Finite Element Methods	T	3	0	0	3
224STE2119	Wind and Cyclone Effects on Structures	T	3	0	0	3
224STE2120	Stability of Structures	T	3	0	0	3
224STE2121	Characterization of Construction Materials	T	3	0	0	3
224STE2122	Sustainable Building Materials	T	3	0	0	3
224STE2123	Life Cycle Assessment for Sustainable Development	T	3	0	0	3
224STE2124	Fracture Mechanics of Concrete Structures	T	3	0	0	3
224STE2125	Optimization of Structures	T	3	0	0	3
224STE2126	Structural Health Monitoring	T	3	0	0	3
224STE2127	Design of Masonry Structures	T	3	0	0	3
224STE2128	Design and Execution of Pile Foundations	T	3	0	0	3
224STE2129	Bridge Engineering Practices	T	3	0	0	3

MAT18R5001	STATISTICS AND COMPUTATIONAL TECHNIQUES	L	T	P	C
		3	0	0	3
Course Category : Program Core	**Course Type** : Theory				

Course Objective

The main objective of this course is to demonstrate various analytical skills in applied mathematics and extensive experience with the tactics of problem solving and logical thinking applicable for engineering. This course will also help the students to identify, formulate, abstract and solve problems in engineering using mathematical tools from variety of mathematical areas, including matrix theory, probability, random variables, queueing theory, classical optimization and linear programming.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Describing the various statistical methods

CO#2: Apply the concept of data mining concept in real problems

CO#3: Describe the features of decision trees

CO#4: Apply the various processing methods.

CO#5: Perform regression analysis in real problems

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1			1		1
CO#2	3		3	3	
CO#3			1		1
CO#4	2		2	2	
CO#5	2	3	3		

3 – High; 2 – Medium; 1- Low

STATISTIAL METHODS

Probability concepts, Sampling Concepts, Generating Random Variables, Exploratory Data Analysis, Monte Carlo Methods for Inferential Statistics

DATA MINING

Data Partitioning, Probability Density Estimation, Statistical Pattern Recognition, Nonparametric Regression. Data Mining- data mining algorithms-Instance and Features, Types of Features (data), Concept Learning and Concept Description, Output of data mining Knowledge Representation;

DECISION TREES

Decision Trees- Classification and Regression trees constructing. Classification trees, Algorithm for Normal Attributes, Information Theory and Information. Entropy, Building tree, Highly-Branching Attributes, ID3 to c4.5, CHAID, CART, Regression Trees, Model Trees, Pruning.

PROCESSING METHODS

Preprocessing and Post processing in data mining – Steps in Preprocessing, Discretization, Manual Approach, Binning, Entropy- based Discretization, Gaussian Approximation, K-tile method, Chi Merge, Feature extraction, selection and construction, Feature extraction, Algorithms, Feature selection, Feature construction, Missing Data, Post processing

REGRESSION ANALYSIS

Association Rule Mining- The Apriori Algorithm. Multiple Regression Analysis, Logistic Regression, k- Nearest Neighbor Classification, Constructing new attributes for algorithms of decision trees. Induction, Quick, Unbiased and Efficient Statistical tree.

References

1. Wendy L. Martinez and Angel R, “Martinez Computational Statistics,” Chapman & Hall/CRC, 2002.
2. Ian H. Witten, “Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations”, Morgan Kaufmann, 2000.
3. Jiawei Han and Micheline Kamber, “Data Mining: Concepts and Techniques,” Morgan Kaufmann Publishers, 2001.
4. K. P. Soman, V. Ajay and Diwakar Shyam, “Insight into Data Mining: Theory and Practice”, Prentice Hall India, 2005.

222STE1101	ADVANCED CONCRETE MATERIALS AND TECHNOLOGY	L	T	P	C
		4	0	0	4
Course Category : Program Core	**Course Type** : Theory				

Course Objective

This course will provide the students with state-of-the art knowledge on durable and sustainable cement and concrete, on the various mineral additions and chemical admixtures to enhance the workability, strength, durability and sustainability aspects and will empower them in the decision making process regarding the various concrete products, construction procedures, performance test methods and recent concrete technology that will improve the durability and sustainability aspects of concrete.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Demonstrate the behavior and material properties for fresh concrete

CO#2: Demonstrate the behavior and material properties for hardened concrete

CO#3: Evaluate the mechanical and durability properties of concrete

CO#4: Apply mix proportion principles to proportion a concrete mix for field applications

CO#5: Describe the salient features of special concretes.

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	3	2	2	2	3
CO#2	3	2	2	2	3
CO#3	3	2	2	2	3
CO#4	3	3	2	2	2
CO#5	2		1	2	1

3 – High; 2 – Medium; 1- Low

FRESH CONCRETE

Chemical composition, Hydration of cement, structure of hydrated cement, special cements, water, chemical admixtures, Workability –Need-Factors affecting work ability-Segregation - Bleeding-Mixing of concrete- Compaction of concrete - Revibration-Self compacting concrete-Ready-mixed concrete – effect of retarders in slump retention in transportation of transit mixer—Pumped concrete-Preplaced concrete-Shotcrete-Analysis of fresh concrete

HARDENED CONCRETE

Strengths of Hardened Concrete - Stress–Strain Relationship and Constitutive Equations - Dimensional Stability—Shrinkage and Creep - Durability - Measurement of the permeability coefficient & diffusivity coefficient - Cracks in concrete - Corrosion of reinforcing steel - Alkali–aggregate reaction - Deterioration caused by freeze-thawing & sulfate attack - Durability in a marine environment - structural health monitoring of concrete – types of sensors for various applications

CONCRETE MIX DESIGN

Basic consideration-Factors in the choice of mix proportions-Mix design methods- A.C.I .Method - I.S. Method - British Method - Correction for moisture content-Bulking-Yield of concrete-Design of High strength concrete and Self compacting concrete- EFNARC Specifications and Design of SCC mixes- Design of concrete mix using mineral admixtures – Design mix for pumpability and effect of super plasticizers in water reduction.

SPECIAL CONCRETES

Fiber-Reinforced Cementitious Composites - High-Strength Cementitious Composites - Polymers in Concrete - Shrinkage-Compensating Concrete - Self-Compacting Concrete - Engineered Cementitious Composite - Tube-Reinforced Concrete - High-Volume Fly Ash Concrete - Structural Lightweight Concrete - Heavyweight Concrete - High performance concrete-self curing concrete - Nano materials and energy saving materials in concrete

FRACTURE MECHANICS

Linear Elastic Fracture Mechanics - The Crack Tip Plastic Zone - Crack Tip Opening Displacement - Fracture Process in Concrete - Nonlinear Fracture Mechanics for Concrete - Two-Parameter Fracture Model - Size Effect Model - The Fictitious Model by Hillerborg - R-Curve Method for Quasi-Brittle Materials

References

1.A. M. Neville, J. J. Brooks, Concrete Technology,Pearson Education, 2013
2.A. R. Shantha Kumar, Concrete Technology, Oxford University Press, 2007
3.M. S. Shetty, Concrete Technology, S. Chand & Co., 2010
4.Raft Siddique, Spacial Structural Concrete, Galgotia Publication, 2008

222STE1102	DYNAMICS OF STRUCTURES & EARTHQUAKE ENGINEERING	L	T	P	C
		4	0	0	4
Course Category : Program Core	**Course Type** : Theory				

Course Objective

The objective of this course is to provide the fundamental understanding of the structural dynamics and the problem solving ability for dynamic response in civil engineering design, analysis and research. The course is intended to provide necessary knowledge to make the students understand the basics of structural dynamics and earthquake engineering and to develop the ability to design an earthquake resistant structure,

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Execute vibration analysis of system/structures with a single degree of freedom and can explain the method of damping the systems

CO#2: Perform the dynamic analysis of system/structures with Multi degrees of freedom under free and forced vibration

CO#3: Derive a mathematical model of a continuous system and do a dynamic analysis under free and forced vibration

CO#4: Explain the causes and effects of an earthquake on structures

CO#5: Design masonry and RC structures for the earthquake forces as per their commendations of IS codes of practices

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	3		2		
CO#2	3		2		
CO#3	2	2	2	2	
CO#4	1		2	2	3
CO#5	2	3	3	2	3

3 – High; 2 – Medium; 1- Low

PRINCIPLES OF VIBRATION ANALYSIS

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

DYNAMIC RESPONSE OF MULTI-DEGREE OF FREEDOM SYSTEMS

Mathematical models of two-degree of freedom systems and multi-degree of freedom systems, free and forced vibrations of two-degree and multi-degree of freedom systems, normal modes of vibration, applications. orthogonality of normal modes, free and forced vibrations of multi-degree of freedom systems, Mode superposition technique, Applications.

DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS

Mathematical models of continuous systems, Free and forced vibration of continuous systems, Rayleigh-Ritz method – Formulation using Conservation of Energy – Formulation using Virtual Work, Applications. Damping in MDOF systems, Nonlinear MDOF systems, and step-by-step numerical integration algorithms.

EARTHQUAKE GROUND MOTION AND ITS EFFECTS ON STRUCTURES

Engineering Seismology Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Microzonation. Effect of Earthquake on Different Types of Structures - Lessons Learnt from Past Earthquakes -Evaluation of Earthquake Forces as per codal provisions - Response Spectra, Design Spectra

EARTHQUAKE RESISTANT DESIGN OF MASONRY AND RC STRUCTURES

Structural Systems - Types of Buildings - Causes of damage - Planning Considerations – effect of material of construction on the performance of structures - Philosophy and Principle of Earthquake Resistant Design - Guidelines for Earthquake Resistant Design - Earthquake Resistant Design of Masonry Buildings and R.C.C. Buildings. Design consideration - Rigid Frames – Shear walls - Lateral load analysis of structures- Capacity based Design and detailing

References

1. Anil K.Chopra, Dynamics of Structures, Fifth edition, Pearson Education, 2020
2. Leonard Meirovitch, Elements of Vibration Analysis, McGraw Hill,2014.
3 Mario Paz, Structural Dynamics -Theory and Computation, Kluwer Academic Publishers, Fifth Edition, 2006
4. Madhujit Mukhopadhyay," Structural Dynamics: Vibrations and Systems", Ane's Student Edition,2017
5. Duggal S K, "Earthquake Resistant Design of Structures", Oxford University Press, 2013

222STE1103	ADVANCED CONCRETE DESIGN OF STRUCTURES	L	T	P	C
		4	0	0	4
Course Category : Program Core	**Course Type** : Theory				

Course Objective

This course imparts the fundamental knowledge on the RCC deign concepts with various codes. In-elastic behavior and ultimate load analysis of RC sections for various end conditions including the rotational capacity will be discussed. Able to achieve skills pertaining to design and detailing of the special structures such as flat slabs, grid floors, deep beams, corbel, spandrels and storage structures etc.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Demonstrate design and problem-solving skills required to carry out design tasks

CO#2: Analyze the inelastic behavior of beams and evaluate ductility of joints.

CO#3: Perform reinforced concrete design for large span roof

CO#4: Analyse and design for storage structures

CO#5: Design special structures such as shear walls and corbels

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2		2	2	1
CO#2	2		3	2	2
CO#3	1	3	3	3	2
CO#4	1	3	3	3	3
CO#5	2	3	3	3	2

3 – High; 2 – Medium; 1- Low

DESIGN CONCEPTS

Basic Design Concepts - Limit state serviceability – deflection - short term deflection – long term deflection - mechanism of flexural cracking - crack width: IS, BS and ACI Codes – Shrinkage and thermal cracking - crack width

INELASTIC BEHAVIOUR OF MEMBER – JOINTS

Inelastic behavior of concrete beams – Moment – curvature curves – moment redistribution – Concept of Ductility – Design of beam-column joint for ductility – Detailing of joints

LARGE SPAN ROOF

Large span slabs - behaviour of flat slabs – direct design - codal provisions – waffle slabs -Grid floor – Domes

STORAGE STRUCTURES

Storage structures – liquid, Material - Classification of water tank - permissible stresses – codal provisions - Water Tank Design – circular – rectangular – storage bins – Retaining wall – stability check

SPECIAL STRUCTURES

Shear wall – classification - Design of shear wall – Corbels - Analysis of Forces in a Corbels - Design of Corbels - Design of Nibs.

References

1. Subramanian. N., “Design of Reinforced Concrete Structures”, Oxford University Press,New Delhi. 2013

2. S. UnnikrishnaPillai and DevadosMenon, Reinforced ConcreteDesign ,Tata McGraw-Hill Education, 2011

3.. P. C. Varghese, Advanced Reinforced Concrete Design, Prentice Hall, International Edition, 2008

4. Krishna Raju, “Advanced Reinforced Concrete Design”, CBS Publishers and distributors, New Delhi, 2016

222STE1104	THEORY OF ELASTICITY AND PLASTICITY	L	T	P	C
		4	0	0	4
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

By using the fundamental elasticity equations, the students may comprehend the concepts of elasticity. to familiarise students with polar and cartesian two-dimensional issues. To make students to familiar in understanding the principle of torsion of prismatic bars principal stresses and strains. Also this course improves the analytical abilities for the real world's problem-solving nature under beams on elastic foundation and plasticity concepts .

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Derive and write the fundamental equations of elasticity describing the linear behavior of elements and develop constitutive models based on material behavior

CO#2: Demonstrate the application of plane stress and plane strain in a given situation in both cartesian and polar coordinate systems

CO#3: Solve torsion problems in circular and non-circular cross-sections

CO#4: Analyse beams resting on elastic foundations

CO#5: Solve analytically the simple boundary value problems with elasto-plastic and strain hardening properties

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2	3	3	2	1
CO#2			2	2	
CO#3	1	2	2	2	2
CO#4	3	2	3	3	1
CO#5	2	1	3	3	1

3 – High; 2 – Medium; 1- Low

ELASTICITY

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

ELASTICITY SOLUTION

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

TORSION OF NON-CIRCULAR SECTION

St. Venant's approach - Prandtl's approach – Membrane analogy - Torsion of Thin Walled-Open and Closed sections-Design approach to open web section subjected to torsion - Finite Difference Method

BEAMS ON ELASTIC FOUNDATIONS

Beams on Elastic foundation – Methods of analysis – Elastic line method – Idealization of soil medium – Winkler model – Infinite beams – Semi-infinite and finite beams – Rigid and flexible – Uniform Cross Section – Point load and UDL – Solution by Finite Differences.

PLASTICITY

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

References

1. Timoshenko, S. and GoodierJ.N."Theory of Elasticity", McGraw Hill Book Co., Newyork, 2002.
2. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
3. Slater R.A.C, "Engineering Plasticity", John Wiley and Son, New York, 2001.
4. Hearn , E.J. "Mechanics of Materials", Vol.2, Pergamon Press, Oxford, 1995
5. Irving H.Shames and James, M.Pitarresi, "Introduction to Solid Mechanics", Prentice Hall of India Pvt. Ltd., Newl Delhi -2002.

222STE1205	STRUCTURAL ENGINEERING LAB	L	T	P	C
		0	0	3	2
Course Category : Program Core	**Course Type** : Laboratory				

Course Objective

The student will be able to determine the requirements of the fresh and hardened concrete properties and study the behavior of structural elements through various tests. To provide a detailed account of modern experimental techniques in construction Engineering research. The student can able to prepare the technical report through validation of test results.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Examine the workability requirements of conventional concrete

CO#2: Investigate the characteristics of self compacting concrete

CO#3: Execute the mechanical and durability test on concrete

CO#4: Evaluate the strength characteristics on concrete using NDT Methods

CO#5: Prepare the report based on test results and graphical analysis to interpret the experimental data

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	3	2	1	1	3
CO#2	3		2	2	3
CO#3	3	2	3	2	3
CO#4	3		1	2	3
CO#5	2	3	2	2	3

3 – High; 2 – Medium; 1- Low

List of Experiments

(A) Workability of Fresh Concrete

1. Slump cone
2. Compaction Factor
3. Vee Bee Test

(B) Flow Characteristics of Self Compacting concrete

1. V- Funnel
2. L -Box
3. U -Box
4. J -Ring

(C) Mechanical Properties of Hardened Concrete

1. Universal Testing Machine
2. Compression Testing Machine

(D) Durability Properties of Hardened Concrete

1. Rapid chloride penetration test of concrete
2. Acid attack
3. Sulphate attack
4. Permeability and Porosity of concrete

(E) NDT on hardened concrete - UPV, Rebound hammer

1. UPV Method
2. Rebound hammer Method

(F) Testing of RC beams in Loading Frame

222STE1106	MATRIX METHOD OF STRUCTURAL ANALYSIS	L	T	P	C
		4	0	0	4
Course Category : Program Core	**Course Type** : Theory				

Course Objective

The main objective is to expand the student knowledge of the stiffness and flexibility methods studied in the basic structural analysis courses. This course imparts the knowledge on solving planar, grid structures using matrix approach. Also covers matrix displacement analysis of space truss and space frames.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Compute static and kinematic indeterminacies for various types of structures.

CO#2: Generate the global stiffness matrix by assembling the element stiffness matrices

CO#3: Analyze the continuous beams, portal frames and trusses by matrix stiffness method

CO#4: Analyze the grid structures by using matrix flexibility method

CO#5: Calculate the displacement analysis for space truss and frames

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	1		1	2	2
CO#2		1	1	1	1
CO#3	2	2	2	2	1
CO#4	2	2	3	2	2
CO#5	1		3	3	2

3 – High; 2 – Medium; 1- Low

INTRODUCTION

Matrix Methods of Analysis of Skeletal Structures. Methods of Analysis. Displacement Method: Stiffness Relationships.

MATRIX DISPLACEMENT APPROACH

Introduction, Stiffness Matrix of a Bar Element subjected to Axial Force. Co-ordinate Transformations. Global Stiffness Matrix. Application to Pin- Jointed Frames. Stiffness Matrix of a Beam Element. Application to Continuous Beams.

MATRIX DISPLACEMENT ANALYSIS OF PLANAR

Matrix Displacement Analysis of Planar Rigid-Jointed Frames. Neglect of Axial Strain in the Analysis of Planar Rigid-Jointed Frames. Inclined Supports. Other Kinds of Loading & Other Kinds of Frames

MATRIX FLEXIBILITY ANALYSIS OF PLANAR & GRID

Matrix flexibility Analysis of Planar & Grillage or Grid. Co-ordinate Transformations. Element Stiffness Matrix & its Application

MATRIX DISPLACEMENT ANALYSIS OF THREE-DIMENSIONAL STRUCTURES

Matrix Displacement Analysis of Three-Dimensional Structures. Co-ordinate Transformations. Application to Space Trusses & Space Frames

References

1. Matrix & Finite Element Displacement Analysis of Structures: D.J.Dawe.
2. Computer Analysis of Structural Systems: John F. Fleming.
3. Matrix Methods of Structural Analysis: C.K.Wang.
4. Matrix Analysis of Framed Structures:Gere& Weaver.
5. Introduction to Matrix Methods of Structural Analysis: Martin,H.C

222STE1107	INDUSTRIAL STRUCTURES	L	T	P	C
		4	0	0	4
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

On end of this course the students will have good self-confidence in planning the layout requirements addressing planning and functional requirements such as lighting, ventilation and fire safety etc. The students performs better design skills in designing the major industrial structural components such as roofs, gantry girders, corbels, nibs and machine foundation etc. as well as power transmission structures and auxiliary structures.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Describe the planning requirements in considering lighting, ventilation and fire safety

CO#2: Design the components of industrial buildings

CO#3: Design the foundation elements for power plant structures

CO#4: Analyze and design the components of power transmission structures

CO#5: Formulate the concepts in design concepts of chimneys, bunkers and silos.

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2	2	1		3
CO#2		3	1	2	3
CO#3	2	3	3	3	3
CO#4		3	3	3	3
CO#5	2		2	3	2

3 – High; 2 – Medium; 1- Low

PLANNING AND FUNCTIONAL REQUIREMENTS

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

INDUSTRIAL BUILDINGS

Roofs for Industrial Buildings - Steel and RCC - Gantry Girders - Design of Corbels and Nibs – Machine foundations - - Vibration isolation systems

POWER PLANT STRUCTURES

Types of power plants – Design of Turbo generator foundation – Raw material handling systems - Conveyors (Belt and Pipe conveyors) - Stacking and storage mechanisms - Containment structures.

POWER TRANSMISSION STRUCTURES

Principles of analysis and design of lattice towers - Transmission towers and poles - cable sag tension calculation - Tower foundations - Testing Towers – Guy towers

AUXILLIARY STRUCTURES

Intro to Wind load calculations - Design of steel and RCC Chimneys - Bunkers and silos - Flat and conical bottoms– Pipe supporting structures

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, 1976.
4. Jurgen Axel Adam, KatharriaHausmann, Frank Juttner, Klauss Daniel, “Industrial Buildings: A Design Manual”, Birkhauser Publishers, 2004.
5. Procs. of Advanced course on “Industrial Structures”, Structural Engineering Research Centre, Chennai, 1982.

222STE1108	EXPERIMENTAL TECHNIQUES	L	T	P	C
		4	0	0	4
Course Category : Program Elective	**Course Type** : Theory Course				

Course Objective

The course brings the learning ability skills to measure the stress and Strains using different sources. The course also provides the detailed guidelines on using electrical resistance strain gauges with correction factor and non destructive testing methods. The basic aspects of experimental stress analysis that includes exhaustive treatment of the most versatile techniques like photoelasticity will be covered.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Perform force and strain measurement by selecting appropriate tools and technique.

CO#2: Use various vibration measuring instruments and analyse the structures using digital display unit

CO#3: Apply model analysis as an effective experimental technique

CO#4: Measure distress in the structures using various electronic equipment

CO#5: Carry out load test on structures and perform advanced NDT methods in accessing the quality of structures.

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	3	-	3	2	2
CO#2	3	2	3	2	1
CO#3	3	2	3	2	1
CO#4	3	-	3	2	2
CO#5	3	3	2	2	3

3 – High; 2 – Medium; 1- Low

FORCES AND STRAIN MEASUREMENT

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

VIBRATION MEASUREMENTS

Characteristics of structural vibrations - Linear variable differential Transformer (LVDT) - Transducers for velocity and acceleration measurements - Vibration meter - Seismographs - Vibration Analyzer - Display and recording of signals - Cathode Ray Oscilloscope - XY Plotter - Chart Plotters - Digital data Acquisition systems.- basics of signal processing

ACOUSTICS AND WIND FLOW MEASURES

Principles of Pressure and flow measurements - Pressure transducers - Sound level meter - Venturimeter and flow meters - Wind tunnel and its use in structural analysis - structural modeling - Direct and Indirect Model studies

DISTRESS MEASUREMENTS AND CONTROL

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

NON - DESTRUCTIVE TESTING METHODS

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

References

1. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi, 1996

2. Dalley .J.W and Riley.W.F, “Experimental Stress Analysis”, McGraw Hill Book Company, N.Y. 1991

3. Srinath.L.S, Raghavan.M.R, ingaiah.K, Gargesha.G, Pant.B and Ramachandra.K, Experimental Stress Analysis”, Tata McGraw Hill Company, New Delhi, 1984

4. Sirohi.R.S., Radhakrishna.H.C, “Mechanical Measurements”, New Age International (P) Ltd. 1997

5. Bray.D.E. and Stanley.R.K., “Course Material on Non-destructive Evaluation”, McGraw Hill Publishing Company, New York.1989

222STE1109	STRUCTURAL STEEL BUILDINGS - DESIGN AND PRACTICES	L	T	P	C
		4	0	0	4
Course Category : Program Core	**Course Type** : **Industry Supported Course – L&T**				

Course Objective

This course is designed by L&T Edu Tech to get an understanding of practical aspects of structural steel building design. This industry need course also covers Cover the various aspects like selection and planning of structural system and its components, evaluation of actual loads, integration of architectural and services requirements. Structural modelling, analysis & design, fabrication, execution and inspection of a structural steel building will be covered with a support of a project.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Ascertain the various aspects that govern the design of structural steel buildings

CO#2: Assess the actual loads

CO#3: Select and plan the structural system

CO#4: Analyse and design a low rise multi-storey framed structural steel building

CO#5: Analyse and design a medium rise multi-storey framed structural steel building

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	3		2	2	2
CO#2			1	2	
CO#3	2		1	2	
CO#4	2	3	3	2	2
CO#5	2	3	3	2	2

3 – High; 2 – Medium; 1- Low

INTRODUCTION TO STRUCTURAL STEEL BUILDINGS

Overview of the design & analysis process of Steel buildings as per code provisions, Structural steel and its mechanical properties, Structural steel sections and their classification, Design philosophies, and advantages of steel buildings in comparison with other types of structures

DESIGN ASPECTS OF A STEEL BUILDING

Inputs for the design of a steel building - Design basis report, covering Site Data, the geometrical, functional and structural requirements for its end usage - material specifications - Methods of designing a steel building- Load resisting elements and systems

LOADS ACTING ON A STEEL BUILDING

Calculating the various loads acting on a steel building - Vertical & Lateral loads - Effects of each loads separately and in combination – Dead, superimposed dead, live, temperature, MEP service loads - Lateral loads due to Wind (Pressure and force coefficient methods) and Seismic (Equivalent static and response spectrum methods) effects.

SELECTION OF LOAD RESISTING SYSTEMS

Studying the layout plans of the structure - Selection of load resisting systems - Load flow in each system - Satisfying Stability & strength of the structure - Vertical and Lateral load resisting systems. Serviceability requirements, BIM modelling aspects, Floor systems – beams, columns- Lateral and Vertical load resisting systems and its selection

MODELLING THE STRUCTURE

Computer aided modelling, analysis & design (STAAD.Pro) - Geometric & structural parameters of the structure - Loading the structure -analysis, Interpretation of the results of the software – Analysis & Design of a multi-storeyed building from a project for comprehending the design from a practical standpoint.

DESIGN OF VARIOUS ELEMENTS OF A STEEL BUILDING

Manual & Software aided design – Beams, columns, floors, bracings, purlins/girts & facades, base plates & anchor bolts – Various loads, different conditions of supports, exposure, and purpose of use - Design of Connections between the members – bolted and welded, moment and shear connections – Project based on excel spreadsheet development

DETAILING, FABRICATION & ERECTION ASPECTS

Study of General assembly drawings - Fabrication processes - Fabrication, transportation logistics & erection - Sequence of erection - Inspection of a completed structure

Field Visit & Case studies in L&T Site:

- A commercial building with multiple storeys with varying load conditions for each storey.

Project

- Analyse and design a low rise multi-storey framed structural steel building
- Analyse and design a medium rise multi-storey framed structural steel building

Software:

- STAAD.Pro, Excel Spread sheets

References

1. Subramanian .N, " Design of Steel Structures", Oxford University Press, 2012.
2. Dayarathnam.P, "Design of Steel Structures", A.H.Wheeler, India, 2007.
3. John E. Lothers, "Design in structural steel", Prentice Hall of India, New Delhi 1999.
4. Lynn S. Beedle, "Plastic Design of Steel Frames", John Wiley and Sons, New York 2003.
5. Wie Wen Yu, "Design of Cold Formed Steel Structures", McGrawHIll Book Company, New York, 2010.

222STE1110	PRESTRESSED AND PREFABRICATED STRUCTURES	L	T	P	C
		4	0	0	4
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

This course will provide a detailed coverage on behaviour of prestressed concrete, analysis and design for strength and serviceability of prestressed concrete members, such as beams and slabs including continuous members, and anchorage design and losses in prestress. Moreover the course will address the detailed design skills of continuous beams, temsion and compression members and connections of prefabricated structures.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Design pre-stressed concrete flexural members.

CO#2: Design profiles for pre-stressed continuous beams

CO#3: Design pre-stressed tension and compression members as per codal recommendations.

CO#4: Describe the salient features of prefabricated components

CO#5: Design the cross section and joints of prefabricated units

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2	2	1	2	2
CO#2	2	2	1	2	
CO#3	2	2	3	2	
CO#4			1		2
CO#5		2	2	2	

3 – High; 2 – Medium; 1- Low

DESIGN OF FLEXURAL MEMBERS

Principles of Prestressing - types and systems of prestressing & loss - 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.

DESIGN OF CONTINUOUS BEAMS

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

DESIGN OF TENSION AND COMPRESSION MEMBERS

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

PREFABRICATED STRUCTURES & COMPONENTS

Types of prefabrication, prefabrication systems and structural schemes - Need for prefabrication - Principles - Materials - Disuniting of structures - Handling and erection - Elimination of erection stresses - - Large panel constructions - Construction of roof and floor slabs - Wall panels - Columns - Shear walls -Production, Transportation & erection

DESIGN PRINCIPLES

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

References

1. Krishna Raju, “Prestressed Concrete”, Tata McGraw Hill Publishing Co,2000.
2. Sinha.N.C.and.Roy.S.K, “Fundamentals of Prestressed Concrete”, S.Chand and Co., 1998.
3. Lin.T.Y., “Design of Prestressed Concrete Structures”, John Wiley and Sons Inc,1981.
4. Evans, R.H. and Bennett, E.W., “Prestressed Concrete”, Champman and Hall, London, 1958.
5. Rajagopalan.N, Prestressed Concrete, Narosa Publications, New Delhi, 2008.

221PGM1001	RESEARCH METHODOLOGY	L	T	P	C
		2	0	0	2
Course Category : Supportive Course	**Course Type** : Theory				

Course Objective

This course imparts the fundamental knowledge on the basic research process and its various types. Also this course covers the idea for doing data collection and data procession methods. To educate the students on structured way of writing a thesis report and understand about the patents related process.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Describe the basic concepts of research and its methodologies.

CO#2: Arrive the relative research hypothesis

CO#3: Prepare a suitable data collection methods

CO#4: Adopt the relevant data processing methods

CO#5: Formulate the structured research report

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2		1		1
CO#2	3		2	2	2
CO#3	2	2	2	2	1
CO#4	2		2		2
CO#5	2	3	3	2	3

3 – High; 2 – Medium; 1- Low

BASICS OF RESEARCH

Definition of Research-Objectives- Characteristics-Methods of Research- Relevance of Research in decision making in various functional areas of management

RESEARCH DESIGN

Formulation of Research problem- literature survey developing Hypothesis- Research Design and Types- Determination of sampling plan- collection of Data-Analysis of Data-Testing of Hypothesis

DATA COLLECTION

Methods- merits & demerits – Sample size determination-Collection of Data (Methods Merits and Limitations-Designing a questionnaire –Types Construction procedure – Questionnaire vs Schedule

DATA PROCESSING

Editing and Coding Data- classification and usefulness of Statistical tools- Hypothesis testing – Tabulation Significance and guidelines- types of tables and diagrams used in research

RESEARCH REPORT & PATENTS

Research report-Types-Mechanics in writing report precautions – Structure of a report Appendix-bibliography- Executive Summary- Briefing –Evaluation of Research report Ethics in research - Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent

References

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”

2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction” Ranjit Kumar, 2 ndEdition, “Research Methodology: A Step by Step Guide for beginners”

222STE1211	COMPUTER AIDED ANALYSIS AND DESIGN LABORATORY	L	T	P	C
		0	0	3	2
Course Category : Program Core	**Course Type** : Laboratory				

Course Objective

The objective of this course is to provide practical training to students in structural analysis and design using modern software tools (STAAD pro and ANSYS). The laboratory provides an opportunity for students to learn and apply theoretical concepts to real-world engineering problems, which is essential for developing their analytical and problem-solving skills

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Understand the basic geometric models in a computer program.

CO#2: Create, design and analyze various civil engineering structures.

CO#3: Apply codal requirements in the design of buildings

CO#4: Simulate, model and analyze trusses, Steel beams, RC beams and columns.

CO#5: Prepare the report and interpret the results based on the analysis

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2	1	1	2	1
CO#2	1	1	1	2	2
CO#3	3	3	2	3	2
CO#4	3	2	3	3	3
CO#5	2	3	2	2	2

3 – High; 2 – Medium; 1- Low

List of Experiments

I. STAAD Pro Software

(A) Design and analysis of continuous beam for various loads

(B) Design and analysis of trusses

(C) Design and analysis of single storey building subjected to various loadings

(D) Design and analysis of multi storey building subjected to various loadings

(E) Design and analysis of water tank subjected to various loadings

II. ANSYS Software

(F) Finite Element Analysis of Beams

(G) Finite Element Analysis of Plates

III. Modelling

(H) Regression

(I) ANN

224STE2112	COMPUTER AIDED DESIGN	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

The main goals of this course are to provide students with a conceptual understanding and practice on modeling commands on the drafting softwares, performing analyze of structures, read and interpret the detailed drawing and preparing bill of materials quantity. Also this course imparts knowledge on the optimization techniques in the construction management sectors. Also helps in practicing various AI softwares.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Perform basic commands on the modeling aspects in the drafting softwares

CO#2: Analyze the structural performance through structural analysis softwares

CO#3: Estimate the bill of materials with the help of detailed drawings

CO#4: Apply suitable optimization technique in project scheduling aspects

CO#5: Practice the working approach in various AI softwares

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	1		1		
CO#2	3	2	3	2	2
CO#3	3	3	3	2	2
CO#4	3	2	3	3	2
CO#5	3	2	3	3	2

3 – High; 2 – Medium; 1- Low

COMPUTER GRAPHICS

Graphic primitives - Transformations - Basics of 2-D drafting - Modeling of curves and surfaces – Wire frame modeling - Solid modeling - Graphic standards – Drafting software packages and usage

STRUCTURAL ANALYSIS

Computer methods of structural analysis –Analysis through software packages.

STRUCTURAL DESIGN

Computer aided design of steel and RC Structural elements - Detailed drawing – Bill of materials

OPTIMIZATION

Application of linear programming - Simplex algorithm - Post-optimality analysis - Project scheduling - CPM and PERT applications

ARTIFICIAL INTELLIGENCE

Introduction - Heuristic search - knowledge based expert systems – Rules and decision tables – Inference mechanisms- Simple applications - Genetic algorithm and applications. Principles of Neural network - Architecture and applications of KBES - Expert system shells

References

1. Krishnamoorthy C.S and Rajeev S., “Computer Aided Design”, Narosa Publishing House, New Delhi, 1997.
2. GrooverM.P.andZimmers E.W. Jr.," CAD/CAM, Computer Aided Design and Manufacturing ", Prentice Hall of India Ltd, New Delhi, 1996.
3. Harrison H.B., “Structural Analysis and Design Vol.I and II”, Pergamon Press, 2001
4. Hinton E.and Owen D.R.J., “Finite Element Programming”, Academic Press 1977.

224STE2113	DESIGN OF SHELL AND SPATIAL STRUCTURES	L	T	P	C
		3	0	0	3
Course Category : Program Elective		**Course Type** : Theory			

Course Objective

This course's primary goal is to empower students to understand the classifications and design considerations for various shells folded plates structures w.r.t the codal provisions. Also this course facilitates to gain basic knowledge and understanding on the design and analysis of space frame using some special methods such as formex algebra, formian configuration and software packages.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Identify the types and classifications various shells

CO#2: Describe the structural behavior of folded plates

CO#3: Restate the general design principles and behavior of space frames

CO#4: Perform analysis and detailed design of space frames using softwares

CO#5: Adopt the special methods for performing the analysis of shells and space frames

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1			2	1	
CO#2	1	1	3	2	2
CO#3	1	2	3	3	
CO#4	2	3	3	2	1
CO#5	2	1	3	3	1

3 – High; 2 – Medium; 1- Low

CLASSIFICATION OF SHELLS

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

FOLDED PLATES

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

INTRODUCTION TO SPACE FRAME

Space frames - configuration - types of nodes - general principles of design Philosophy - Behaviour.

ANALYSIS AND DESIGN

Analysis of space frames – detailed design of Space frames – Introduction toComputer Aided Design and Software Packages.

SPECIAL METHODS

Application of Formex Algebra, FORMIAN for generation of configuration.

References

1. Billington.D.P, “Thin Shell Concrete Structures”, McGraw Hill Book Co., New York, 1982.
2. Santhakumar.A.R and Senthil.R, “Proceedings of International Conference on Space Structures”, Anna University, Chennai, 1997.
3. Subramanian.N ,”Principles of Space Structures”, Wheeler Publishing Co. 1999.
4. Ramasamy, G.S., “Design and Construction of Concrete Shells Roofs”, CBS Publishers

224STE2114	DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

This course intends to provide basic comprehensive knowledge on steel concrete composite construction Also this course provides the adequate knowledge in designing the various components of composite members and its connections. Also the students get an understanding skill in analyzing the facts through the case studies on steel-composite constructions in Indian buildings about its general and seismic performance.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Describe the salient features of steel concrete composite construction

CO#2: Apply the principles and concepts in designing the components of composite members

CO#3: Perform the design of connections in the composite structures

CO#4: Discuss the behavior of composite box girder bridges

CO#5: Illustrates the facts on the performance of steel concrete composite construction through some case studies.

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	1		1	2	
CO#2	3		2	3	1
CO#3	2	2	3	3	2
CO#4	2		2	2	
CO#5	2	2	3	3	3

3 – High; 2 – Medium; 1- Low

INTRODUCTION

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

DESIGN OF COMPOSITE MEMBERS.

Design of composite beams, slabs, columns, beam – columns - design of composite trusses.

DESIGN OF CONNECTIONS

Types of connections, Design of connections in the composite structures – shear connections. Degree of shear connection – Partial shear interaction

COMPOSITE BOX GIRDER BRIDGES

Introduction - behaviour of box girder bridges - design concepts.

MISCELLANEOUS

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

References

1. Johnson R.P., “Composite Structures of Steel and Concrete”, Blackwell Scientific Publications, UK, 2004.

2. Oehlers D.J. and Bradford M.A., “Composite Steel and Concrete Structural Members, Fundamental behaviour”, Pergamon press, Oxford, 1995.

3 Proceedings of Workshop on “Steel Concrete Composite Structures”, Anna University

224STE2115	DESIGN OF TALL BUILDINGS	L	T	P	C
		3	0	0	3
Course Category : Program Elective		**Course Type** : Theory			

Course Objective

The objective of this course is to develop thorough understanding of structural systems of Tall Structures. It also aim to expose students to analysis and design of high rise structures using software. The exposure of this course provides a detailed conceptual design, approximate methods of stability analysis, preliminary design and optimization, to safely carry over the gravity and lateral load configurations.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Express the design principles and various loading on tall buildings

CO#2: Describe the behavior of various structural systems of tall buildings

CO#3: Perform the analysis and design techniques on the tall structures

CO#4: Discuss the behavior of various structural elements in tall buildings

CO#5: Determine the stability analysis using various approximate methods

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	1	2	3	2	2
CO#2	1		3	2	1
CO#3	2	3	3	3	2
CO#4	1	2	3	2	1
CO#5	3	3	3	3	2

3 – High; 2 – Medium; 1- Low

DESIGN PRINCIPLES AND LOADING

Design philosophy, Loading, sequential loading, materials - high performance, concrete - Fibre reinforced Concrete - Light weight concrete - design mixes. Gravity loading Wind loading Earthquake loading

BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS

Factors affecting growth, Height and Structural form. High rise behaviour, Rigid frames, braced frames, Infilled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, futrigger - braced and hybrid mega systems..

ANALYSIS AND DESIGN

Modelling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural system considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist, computerized general three dimensional analysis.

STRUCTURAL ELEMENTS

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

STABILITY OF TALL BUILDINGS

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

References

1. Bryan Stafford Smith and Alexcoull, “Tall Building Structures - Analysis and Design”, John Wiley and Sons, Inc., 1991.
2. Taranath B.S., “Structural Analysis and Design of Tall Buildings”, McGraw Hill, 1988.
3. Gupta.Y.P.,(Editor), Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi,1995.
5. Lin T.Y and Stotes Burry D, “Structural Concepts and systems for Architects and Engineers”, John Wiley, 1988.
6. Beedle.L.S., “Advances in Tall Buildings”, CBS Publishers and Distributors, Delhi, 1986.

224STE2116	NONLINEAR ANALYSIS OF STRUCTURES	L	T	P	C
		3	0	0	3
Course Category : Program Elective		**Course Type** : Theory			

Course Objective

This course deals with the nonlinear elastic and in-elastic of flexural members subjected to varying dimensions, support and loading conditions. Also the student gets knowledge on vibrational analysis on the flexural members and plates under cyclic loading. The students can also get the basic understanding skills about the instability conditions of the elastically supported beams.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Describe the nonlinear elastic analysis of the flexural members on various conditions

CO#2: Describe the nonlinear inelastic analysis of the flexural members on various conditions

CO#3: Illustrate the behavior of flexural members under cyclic loadings

CO#4: Applying the various conditions for analyzing elastic and inelastic nature of plates

CO#5: Identify the suitable parameters for the instability conditions of beams

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2	2	3	2	1
CO#2	2	2	3	2	1
CO#3	1	1	3	2	2
CO#4	2	1	3	2	1
CO#5		2	3	2	

3 – High; 2 – Medium; 1- Low

ELASTIC ANALYSIS OF FLEXURAL MEMBERS

Introduction to nonlinear mechanics; statically determinate and statically indeterminate flexible bars of uniform and variable thickness.

INELASTIC ANALYSIS OF FLEXURAL MEMBERS

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

VIBRATION THEORY AND ANALYSIS OF OF FLEXURALMEMBERS

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

ELASTIC AND INELASTIC ANALYSIS OF PLATES

Elastic and inelastic analysis of uniform and variable thickness plates

NONLINEAR VIBRATION AND INSTABILITY

Nonlinear vibration and Instabilities of elastically supported beams.

References

1. Sathyamoorthy, M.,"Nonlinear Analysis of Structures", CRC Press, Boca Raton, Florida, 1997.
2. Fertis, D. G.,"Nonlinear Mechanics", CRC Press, Boca Raton, Florida, 1998.
3. Reddy.J.N, "Non linear Finite Element Analysis", Oxford University Press,2008

224STE2117	OFFSHORE STRUCTURES	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

The aim of the course is to provide for the basic knowledge on wave generation process, wave theories and various forces acts on the offshore structures. The students will gets an exposure on different types of offshore structures and various modeling aspects related to foundation, structural and other loading aspects. The course provides a broad idea related to the design of the other components of the offshore structures.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Describe the wave generation process and wave theories

CO#2: Illustrate the wind and wave forces acting on the offshore structures

CO#3: Illustrate the modeling aspects of offshore structures

CO#4: Applying the concept of static method of analysis to the offshore structures

CO#5: Design the various types of offshore structures

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1			3	2	
CO#2	1	2	3	2	2
CO#3	2	2	3	2	1
CO#4	2	2	3	3	1
CO#5		2	3	2	1

3 – High; 2 – Medium; 1- Low

WAVE THEORIES

Wave generation process, small and finite amplitude wave theories.

FORCES OF OFFSHORE STRUCTURES

Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

OFFSHORE SOIL AND STRUCTURE MODELLING

Different types of offshore structures, foundation modeling, structural modeling.

ANALYSIS OF OFFSHORE STRUCTURES

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

DESIGN OF OFFSHORE STRUCTURES

Design of platforms, helipads, Jacket tower and mooring cables and pipe lines.

References

1. Chakrabarti, S.K. "Hydrodynamics of Offshore Structures", Computational Mechanics Publications, 1987.
2. Dawson.T.H., "Offshore Structural Engineering", Prentice Hall Inc Englewood Cliffs, N.J. 1983
3. Brebia, C.A and Walker, S., "Dynamic Analysis of Offshore Structures", New Butterworths, U.K. 1979.
4. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls,Tex,2000.
5. Reddy, D.V. and Arockiasamy, M., "Offshore Structures", Vol.1 and Vol.2,Krieger Publishing Company, Florida, 1991.

224STE2118	FINITE ELEMENT METHODS	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

This subject will provide the fundamental concepts in the theory of finite element analysis and analyse problems related to bar, truss, beam and plane elements using finite element approach. To introduce the concepts of finite element analysis in problems related to mesh generation techniques and associated with non linear thermal analysis. This course also covers the application of FEA softwares.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Apply the boundary value conditions, displacement and shape functions for FE problems.

CO#2: Compute the stress analysis for the two dimensional FE problems

CO#3: Adopt the various mesh generation techniques for attempting the FEA solutions.

CO#4: Perform the non linear vibrational thermal analysis

CO#5: Practice the modeling and analysis functions using FEA softwares

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2	2	3	2	1
CO#2	1		3	2	1
CO#3	1		2	2	
CO#4	1	1	2	2	
CO#5	2	2	3	2	1

3 – High; 2 – Medium; 1- Low

INTRODUCTION

Boundary Value Problems – Approximate Solutions – Variational and Weighed Residual Methods – Ritz and Galerkin Formulations – Concept of Piecewise Approximation and Finite Element – Displacement and Shape Functions –Weak Formulation – Minimum Potential Energy – Generation of Stiffness Matrix and Load Vector

STRESS ANALYSIS

Two Dimensional problems – Plane Stress, Plane Strain and Axisymmetric Problems – Triangular and Quadrilateral Elements –Natural Coordinates – Isoparametric Formulation - Numerical Integration – Plate Bending and Shell Elements — Brick Elements –Elements for Fracture Analysis

MESHING AND SOLUTION PROBLEMS

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

NONLINEAR, VIBRATION AND THERMAL PROBLEMS

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

APPLICATIONS

Modelling and analysis using recent softwares.

References

1. S. S. Bhavikatti, “Finite Element Analysis”, New Age Publishers, 2007.
2. C. S. Krishnamoorthy, “Finite Element Analysis: Theory and Programming”, Tata McGraw-Hill, 2012
3. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
4. Bathe, K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall Inc., 1996.
5. Chandrupatla, R.T. and Belegundu, A.D., “Introduction to Finite Elements in Engineering”, Prentice Hall of India, 2007.

224STE2119	WIND AND CYCLONE EFFECT ON STRUCTURES	L	T	P	C
		3	0	0	3
Course Category : Program Elective		**Course Type** : Theory Course			

Course Objective

This course imparts knowledge on the basics of wind parameters such as speed, height, shape factor and aspect ratio etc and wind tunnel studies. Wind effects on flexible and rigid structures are covered in this course. The students can able to design the building structures, chimneys, roof, shelters, cladding and windows using Indian standards to withstand wind and cyclone effects.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Express the basic wind parameters required in designing the buildings

CO#2: Identifying the modeling requirements of aero-elastic models

CO#3: Illustrate the static and dynamic wind effects on rigid and flexible structures

CO#4: Design of buildings, chimneys, roofs and shelters as per the codal requirements

CO#5: Describe the cyclone effects on the cladding and window glass design.

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2	2	3	2	1
CO#2		1	2	1	
CO#3	2		2	2	1
CO#4	2	3	3	2	2
CO#5			2	1	

3 – High; 2 – Medium; 1- Low

INTRODUCTION

Introduction, Spectral studies, Gust factor, Wind velocity, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects.

WIND TUNNEL STUDIES

Wind Tunnel Studies, Types of tunnels, Modeling requirements, Interpretation of results, Aero-elastic models.

EFFECT OF WIND ON STRUCTURES

Wind on structures, Rigid structures, Flexible structures, Static and dynamic effects, Tall buildings, chimneys.

IS CODES AND SPECIAL STRUCTURES

Application to design, IS 875 code method, Buildings, Chimneys, Roofs, Shelters

CYCLONE EFFECTS

Cyclone effect on structures, cladding design, window glass design.

REFERENCES:

1. Cook.N.J., “The Designer's Guide to Wind Loading of Building Structures”, Butterworths, 1989.

2. Kolousek.V, Pirner.M, Fischer.O and Naprstek.J, “Wind Effects on Civil Engineering Structures”, Elsevier Publications, 1984

3. Peter Sachs, “Wind Forces in Engineering”, Pergamon Press, New York,1972.

224STE2120	STABILITY OF STRUCTURES	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory Course				

Course Objective

This course explains how and under what loading condition, a structure passes from a stable state to unstable state. Different structural members and systems are analysed for their stability conditions. This covers also includes the behavioral aspects of structural elements against lateral and torsional buckling conditions. Knowledge on finite element approach with various boundary conditions under critical loads will be discussed.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Formulate the equations for beam-column for various loading conditions.

CO#2: Evaluate the elastic buckling of bars and frames.

CO#3: Evaluate the in-elastic and torsion buckling of various sections.

CO#4: Derive the equation of simply supported beam subjected to lateral buckling.

CO#5: Analyze the stability conditions by finite element approach.

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	1	2	3	2	
CO#2			3	2	
CO#3			3	2	
CO#4	2	2	2	2	
CO#5	2	2	3	2	1

3 – High; 2 – Medium; 1- Low

BEAM COLUMNS

Differential equations for beam columns- beam columns with concentrated loads – continuous lateral loads-couples- beam columns with built in ends – continuous beams with axial load – application of trigonometrically series – Effects of initial curvature on deflections – Determination of allowable stresses.

ELASTIC BUCKLING OF BARS AND FRAMES

Elastic Buckling of straight columns – Effect of shear stress on buckling – Eccentrically and laterally loaded columns- Buckling of frames-large deflections of buckled bars-Energy methods- Buckling of bars on elastic foundations- Buckle line of bar with intermediate compressive forces – Buckling of bars with change in cross-section – Effect of shear force on critical load- built up columns.

IN ELASTIC & TORSION BUCKLING

Buckle line of straight bar- Double modulus theory – Tangent modulus theory, Inelastic lateral Buckling – Critical stress diagram various end conditions - Pure torsion of thin walled bars of open cross section – Non-uniform torsion of thin walled bars of open cross section- Torsional buckling – Buckling by torsion and flexure.

LATERAL BUCKLING OF SIMPLY SUPPORTED BEAMS

Beams of Rectangular cross-section subjected to pure bending. Buckling of simply supported Rectangular plates: Derivation of equation of plate subjected to constant compression in one and two directions.

STABILITY ANALYSIS BY FINITE ELEMENT APPROACH

Deviation of shape function for a two nodded Bernoulli – Euler beam element – element stiffness and element geometric stiffness matrices – assembled stiffness and geometric stiffness matrices for a discretized column with different boundary condition – calculation of critical loads - Buckling of pin jointed frames.

References

1.Stability of Structures by Kumar, Ashwini: Allied Publishers, New Delhi.
2.Principles of Structural Stability Theory by Chajes, A. Prentice-Hall.
3.Structural Stability by Chen, W.F. &Lui, E.M.: Elsevier.
4. Elastic Stability of Structural Elements by Iyengar, N.G.R.: Macmillan India.
5. Stability Analysis and Design of Structures by Gambhir, M.L.: Springer-Verlag.
6. Theory of Elastic Stability by Timoshenko & Gere, McGraw Hill.

224STE2121	CHARACTERIZATION OF CONSTRUCTION MATERIALS	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

The objective of the course is to provide students with an understanding of the behaviour and characterization of construction materials, particularly cement and concrete. By exploring the physics of these techniques and their application to cement science, students will develop a deeper comprehension of the mechanisms governing the performance of construction materials.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Perform the characterization study on the cement materials using calorimetry

CO#2: Identify the crystallographic structure of a cement material with X-ray diffraction method

CO#3: Differentiate the SEM image analysis in a cementitious materials

CO#4: Describe the working principles of NMR spectroscopy

CO#5: Identify the pore size distribution of a construction materials

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2	2	3	3	2
CO#2	2	2	3	3	2
CO#3	3	2	3	3	2
CO#4	2	2	2	2	2
CO#5	3	1	3	3	2

3 – High; 2 – Medium; 1- Low

CALORIMETRY

Introduction – characterization of construction materials- structure of construction materials- introduction to calorimetry and types- sample preparation, practical note and heat of hydration- applications

X- RAY DIFFRACTION AND THERMAL ANALYSIS

Introduction to X-ray & crystallography- crystal systems and history of XRD- diffractogram- calculations-qualitative phase analysis-sample preparation and applications in study of cements, thermal analysis – applications in construction materials.

SURFACE AREA MEASUREMENT AND OPTICAL MICROSCOPY

Surface area measurement- sampling and particle size distribution- different techniques- calculation and applications- optical and scanning microscopy- specimen preparation- features and functions- types of optical microscopy-SEM- parts and functioning-working principles- analysis of cementitious system- application of characterization techniques.

IMAGE ANALYSIS AND SPECTROSCOPY

Image analysis- basic operation and image mapping- spectroscopy techniques- AAS, AES, UV &IR, FTIR, And NMR- principles of NMR spectroscopy.

MERCURY INTRUSION AND IMPEDANCE ANALYSIS

Porosity and pore structure- introduction, significance of pore distribution- working of mercury intrusion porosimeter- electrical impedance analysis- principles and different methods- deliverables and interpretations- electro chemical testing using EIS.

References

1. Karen Scrivener, Ruben Snellings, Barbara Lothenbach, A Practical Guide to Microstructural Analysis of Cementitious Materials, CRC Press, 2015.
2. William D. Callister, Materials Science and Engineering: An Introduction, Sixth Edition, John Wiley and Sons, 2003. .
3. J. M. Illston and P. L. J. Domone, Construction Materials – Their Nature and Behaviour, Third Edition, Spon Press, 2001.
4. J.F. Young, S. Mindess, R.J. Gray and A. Bentur, The Science and Technology of Civil Engineering Materials, Prentice Hall, 1998.
5. Jan Skalny, Editor, Materials Science of Concrete, Volumes I – VII, American Ceramic Society, 1989 – 2005.

224STE2122	SUSTAINABLE BUILDING MATERIALS	L	T	P	C
		3	0	0	3
Course Category : Program Elective		**Course Type** : Theory			

Course Objective

The aim of this course is to familiarize students with sustainability concepts related to building and conventional engineered building materials. The course will cover achieving sustainability through the use of lower carbon cements, light weight aggregates, and recycled aggregate to reduce natural resource consumption, including water. The course will also explore topics such as indoor air quality, embodied, operational, and life cycle energy, and energy consumption reduction through optimal design.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Describe the role of cement towards sustainable energy calculation

CO#2: Utilize the waste materials in producing sustainable concrete

CO#3: Performing energy efficient design of building towards leed energy rating metrics

CO#4: Arriving the embodied energy calculation for the materials used in the buildings

CO#5: Achieving optimal design of buildings through operation energy calculation

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	3	2	2	2	3
CO#2	3	2	2	2	3
CO#3	2	2	3	2	2
CO#4	2	2	3	2	2
CO#5	2	2	3	2	2

3 – High; 2 – Medium; 1- Low

ROLE OF CEMENT AND SUSTAINABILITY

Role of Cement in Sustainability and Calculation of Chemical Energy- Fuel for Cement-Cementitious/ Supplementary Cementitious Materials and Their Characterization- Strength of Concrete With Supplementary Cementitious Materials and Composite Cements- Types of Composite Cements-Alternative Fuel for cement and Embodied Energy.

PROPERTIES OF SUSTAINABLE MATERIALS

Role of agro and industrial waste in concrete- types – their influence on physical and mechanical properties and durability of concrete–role of municipal solid waste in concrete- types- their influence on physical and mechanical properties and durability of concrete-fibers and polymers in concrete- types – properties – application- lightweight aggregates- types- influence on physical and mechanical, durability properties.

ENERGY RATING SYSTEM

Concept of green building-principles of green building-components of green building-environmental, economical, health and social benefits-ecofriendly materials / green materials-Major Energy efficient areas for buildings- energy efficient design of buildings-design strategies and green design process-green building rating system- GRIHA,LEED- Embodied Energy in Green Materials.

EMBODIED ENERGY AND CONCRETE SUSTAINABILITY

Introduction and definition of sustainability- fundamentals of sustainability-basics of carbon cycle- factors affecting carbon cycle- role of construction materials in emission of CO_2 –concept of embodied energy- embodied energy for material and building components- energy for production of building materials- transportation energy for building materials- total energy needed for building- calculation of embodied energy- case study for energy in building.

OPERATIONAL ENERGY IN BUILDING MATERIALS

Operational Energy- Bond's Law + Operational Energy: U-Value -Operational energy reduction and net zero building, Optimization for design of building for energy efficiency and example of optimization through use of Evolutionary genetic algorithm.

References

1. Newman, J. and Choo, Ban Sang, Advanced Concrete Technology-Processes, 1st Edition, Elsevier, 2003

2.Indian Building Congress, Practical Handbook on Energy Conservation in Buildings, 1st ed. Nabhi Publication, 2008.

3. Clarke, J.A., Energy Simulation in Building Design, Adam Hilger Ltd. 1985.

4. Leadership in Energy and Environmental Design (www.usgbc.org/LEED).

224STE2123	LIFE CYCLE ASSESSMENT FOR SUSTAINABLE DEVELOPMENT	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

To expose the students to impart the fundamental techniques to perform LCA for environmental sustainability. To make the students in understanding the LCA methodologies and its impact assessment. Also, this course teaches life cycle design and management, evaluation and its assessment on the case studies of treatment plants.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Categorize the LEED ratings in buildings

CO#2: Apply LCA concepts for industry's production issues

CO#3: Express the suitable life cycle impact assessment

CO#4: Illustrate the LCA designs strategies based on the needs

CO#5: Investigate the suitable approaches for adopting LCA in various case studies

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	1	2	2	2	2
CO#2	2	1	2	2	1
CO#3			2	1	1
CO#4	2	2	2	2	1
CO#5	2	1	2	2	1

3 – High; 2 – Medium; 1- Low

INTRODUCTION

Introduction to sustainability concept and life cycle analysis - material flow and waste management - environmental risk assessment - characteristics of environmental problems - measuring energy use in buildings - rating system selection - LEED

LCA METHODOLOGY

Environmental data collection issues - statistical analysis of environmental data - common analytical instruments - overview of LCA methodology - material production phase - manufacturing phase - operation and maintenance phase

LIFE CYCLE IMPACT ASSESSMENT

Classification - characterization - valuation - impact potentials - human and ecosystem health - critical volume approach - environmental defence

LIFE CYCLE DESIGN AND MANAGEMENT

Life cycle management - multi-stakeholders - internal elements - external factors - life cycle design process - need analysis - selection and synthesis of design strategies - design evaluation

LIFE CYCLE ASSESSMENT – CASE STUDIES

Odour removal for organics treatment plant - comparison of hand drying methods - biofuels for transportation etc – Case studies

References

1. Jeroen B. Guinee, Handbook on Life Cycle Assessment, Kluwer Academic Publishers, 2002
2. Reinout Hejungs and Sangwon Suh, The Computational Structure of Life Cycle Assessment, Kluwer Academic Publishers, 2002
3. U.S. EPA , Life Cycle Assessment: Principles and Practice (EPA 600/R-06/060).Cincinnati, OH: 2006.
4. U.S. EPA, Life Cycle Assessment:Inventory Guidelines and Principles (EPA 600/R92/245).Cincinnati, OH:Office of Research and Development, Risk Reduction Engineering Laboratory, February 1993.

224STE2124	FRACTURE MECHANICS OF CONCRETE STRUCTURES	L	T	P	C
		3	0	0	3
Course Category : Program Elective		**Course Type** : Theory			

Course Objective

The course covers the basic aspects of the Fracture Mechanics on concrete elements. A thorough understanding on the fracture mechanics of brittle and ductile materials. Exposure on the basics of linear-elastic fracture mechanics (LEFM) and elastic-plastic fracture mechanics (EPFM) and the role of photo-elasticity on the development of stress field equations in fracture mechanics. Focus on Modeling plastic zone at the crack-tip, crack models, time dependent fracture including creep and fatigue crack growth, fracture damage control mechanism.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Comprehend the fundamentals of fracture mechanics

CO#2: Categorize the structural crack

CO#3: Identify the fracture mechanism in concrete structures

CO#4: Apply fracture mechanics models to structural models.

CO#5: Compute the fracture damage

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	1		2	2	1
CO#2	2	1	2	2	2
CO#3	3	2	2	2	1
CO#4	2	1	3	2	
CO#5	2		3	2	1

3 – High; 2 – Medium; 1- Low

BASICS OF FRACTURE MECHANICS

Fundamentals of fracture mechanics – Brittle and ductile behavior - Sources of micro and macro cracks - types of cracks – stress intensity factor- Mechanisms of fracture - Fracture criteria – service condition affecting fracture

STRUCTURAL CRACKS

Modes of loading - Crack in a structure - mechanisms of fracture in structural concrete - crack growth - cleavage fracture - ductile fracture - fatigue and stress - corrosion crack growth - environment assisted crack

CRACK TIP PLASTICITY

Stress at crack tip - linear elastic fracture mechanics (LEFM) - Elastic-Plastic Fracture Mechanics (EPFM) - Griffith's criteria – stress-intensity factors - crack tip plastic zone - Erwin's plastic zone correction - R curves – compliance - J contour integral -concept of CTOD and CMD

MATERIAL MODELS

Crack concepts – Material models - crack models - models based on continuum damage mechanics - modeling of quasi brittle materials – photoelasticity - severity of a crack – application in concrete elements

COMPUTATIONAL FRACTURE MECHANICS

Time – dependent fracture mechanics – Fracture toughness measurement - fatigue control plan Factors – quasi-brittle materials failure surfaces – closure measurements – damage tolerance - finite element model for crack tip

References

1. Anderson L, "Fracture Mechanics: Fundamentals and Applications", 4th Edition, CRC Press; 2017

2. Surendra P Shah, Stuart E Swartz, Chengsheng Ouyang, "Fracture Mechanics of Concrete: Applications of Fracture Mechanics to Concrete, Rock and other Quasi- brittle Materials, John Wiley & Sons, 1995.

3. Alberto Carpinteri, "Applications of Fracture Mechanics to Reinforced Concrete", CRC Press, 2014

4. Prashant Kumar, "Elements of fracture mechanics", 1st Edition McGraw Hill Education; 2017.

5. Suri C. T. and Jin Z.H., "Fracture Mechanics", 1st Edition, Elsevier Academic Press, 2012

224STE2125	OPTIMIZATION OF STRUCTURES	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

The basic aim of this course is to introduce the concepts of design optimization and review major conventional and modern optimization methods used in structural optimization applications. To understand the formulation of structural optimization problems. Also this course provides the exposure to unconstrained and constrained optimization. To understand direct and indirect methods, direct search and gradient methods.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Apply the knowledge of engineering fundamentals to formulate and solve engineering problems by classical optimization techniques.

CO#2: Identify, formulate and solve engineering problems by linear and non-linear programming.

CO#3: Analyse the problem and reduce G.P.P to a set of simultaneous equations

CO#4: Apply the Engineering knowledge to understand the concept of dynamic programming.

CO#5: Design various structural elements with minimum weight.

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2		3	2	1
CO#2	2	2	3	2	1
CO#3	2	2	3	2	2
CO#4	1		2	2	1
CO#5	2	2	3	2	2

3 – High; 2 – Medium; 1- Low

BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES

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

LINEAR AND NON-LINEAR PROGRAMMING

Formulation of problems -Graphical solution – Analytical methods- Standard form - Slack, surplus and artificial variables – Canonical form – Basic feasible solution - simplex method – Two phase method – Penalty method- Duality theory – Primal – Dual algorithm, Dual Simplex method. Non-linear programming: One Dimensional minimization methods: Unidimensional - Unimodal function – Exhaustive and unrestricted search – Dichotomous search –Fibonacci Method – Golden section method -Interpolation methods.

GEOMETRIC PROGRAMMING

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.

DYNAMIC PROGRAMMING

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

STRUCTURAL APPLICATIONS

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.

References

1. Iyengar. N.G.R and Gupta. S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997

2. Rao, S.S. "Engineering Optimization: Theory and Practice", Fourth Edition, Wiley Eastern (P) Ltd., 2013.

3. Spunt, "Optimization in Structural Design", Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey 1971.

4. Uri Kirsch, "Optimum Structural Design", McGraw Hill Book Co. 1981.

5. Haftka, R. T. and Gurdal, Z., Elements of Structural Optimization, Springer, 3 rd Edition, 1992

224STE2126	STRUCTURAL HEALTH MONITORING	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

The basic aim of this course is to provide the comprehensive skills in the structural health monitoring process which includes installing sensors, data acquisition, data transfer, and diagnostics through which the structure's safety, strength, integrity, and performance are monitored / discussed through relevant applications / case studies. Also course provides a assess the health of structures using different techniques of SHM

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Describe the need, advantages and challenges of SHM

CO#2: Identify the different types of sensors and instrumentation techniques

CO#3: Apply concern static and dynamic measurement techniques for real problems

CO#4: Compare the various damage detection techniques

CO#5: Discuss the various data processing methods through case studies

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	2		1	1	
CO#2	2	1	2	2	2
CO#3	2		3	2	2
CO#4	2		2	2	1
CO#5	1	2	2	2	2

3 – High; 2 – Medium; 1- Low

INTRODUCTION TO STRUCTURAL HEALTH MONITORING

Need for SHM, Structural Health Monitoring versus Non-Destructive Evaluation, Methods of SHMLocal & Global Techniques for SHM, Short & Long-Term Monitoring, Active & Passive Monitoring, Remote Structural Health Monitoring- Advantages of SHM - Challenges in SHM

LINEAR AND NON-LINEAR PROGRAMMING

Sensors for measurements: Electrical Resistance Strain Gages, Vibrating Wire Strain Gauges, Fiber Optic Sensors, Temperature Sensors, Accelerometers, Displacement Transducers, Load Cells, Humidity Sensors, Crack Propagation Measuring Sensors, Corrosion Monitoring Sensors, Pressure Sensors, Data Acquisition – Data Transmission - Data Processing – Storage of processed data - Knowledgeable information processing

GEOMETRIC PROGRAMMING

Static measurement - Load test, Concrete core trepanning, Flat jack techniques, Static response measurement, Dynamic measurement -Vibration based testing- Ambient Excitation methods, Measured forced Vibration-Impact excitation, step relaxation test, shaker excitation method.

DYNAMIC PROGRAMMING

Damage Diagnostic methods based on vibrational response- Method based on modal frequency/shape/damping, Curvature and flexibility method, Modal strain energy method, Sensitivity method, Baseline-free method, Cross-correlation method, Damage Diagnostic methods based on wave propagation Methods-Bulk waves/Lamb waves, Reflection and transmission, Wave tuning/mode selectivity, Migration imaging, Phased array imaging, Focusing array/SAFT imaging

STRUCTURAL APPLICATIONS

Advanced signal processing methods -Wavelet, Hilbert-Huang transform, Neural networks, Support Vector Machine Principal component analysis, Outlier analysis. Applications of SHM on bridges and buildings, case studies of SHM in Civil/ Structural engineering.

References

1. Daniel Balageas, Peter Fritzen, Alfredo Guemes, Structural Health Monitoring, John Wiley & Sons,2006.

2. Douglas E Adams, Health Monitoring of Structural Materials and Components Methods with Applications, Wiley Publishers, 2007

3. Hua-Peng Chen, Structural Health Monitoring of Large Civil Engineering Structures, Wiley Publishers, 2018

4. Ansari, F Karbhari, Structural health monitoring of civil infrastructure systems, V.M,Woodhead Publishing, 2009

224STE2127	DESIGN OF MASONRY STRUCTURES	L	T	P	C
		3	0	0	3
Course Category : Program Elective	**Course Type** : Theory				

Course Objective

The basic aim of this course is to introduce the basic principles of design of masonry elements, Apply the analysis procedures to find the member forces in connecting elements, understand the behavior of masonry units under various loads with and without reinfrocing. To understand the formulation of structural optimization problems. Also this course provides the exposure to apply the design principles of earthquake resistant masonry structures and retrofitting techniques.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Explain the properties of a masonry unit and the various components

CO#2: Design a masonry structure for compression

CO#3: Design a masonry structure for lateral loads

CO#4: Design an earthquake-resistant masonry wall

CO#5: Perform retrofitting techniques for existing masonry walls

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1			1	1	1
CO#2	2	3	2	2	1
CO#3	2	3	3	2	1
CO#4	2	3	3	2	1
CO#5			2	2	2

3 – High; 2 – Medium; 1- Low

BEHAVIORAL ASPECTS

Introduction – Masonry construction – National and International perspective – Historical development, Modern masonry, Material Properties – Masonry units: clay and concrete blocks, Mortar, grout and reinforcement, Bonding patterns, Shrinkage and differential movements.

DESIGN OF COMPRESSION MEMBER

Principles of masonry design, Masonry standards: IS 1905 and others - Masonry in Compression – Prism strength, Eccentric loading -Kern distance. Structural Wall, Columns and Plasters, Retaining Wall, Pier and Foundation – Prestressed masonry

DESIGN OF MASONRY UNDER LATERAL LOADS

Masonry under Lateral loads – In-plane and out-of-plane loads, Ductility of Reinforced Masonry Members Analysis of perforated shear walls, Lateral force distribution -flexible and rigid diaphragms. Behaviour of Masonry – Shear and flexure – Combined bending and axial loads – Reinforced and unreinforced masonry – Infill masonry

EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES

Structural design of Masonry – Consideration of seismic loads –concepts of confined masonry – Cyclic loading and ductility of shear walls for seismic design -Code provisions- Working and Ultimate strength design – In-plane and out-of-plane design criteria for load-bearing and infills, connecting elements and ties. Modeling Techniques, Static Push Over Analysis and use of Capacity Design Spectra – use of Software.

RETROFITTING OF MASONRY

Seismic evaluation and Retrofit of Masonry – In-situ and non-destructive tests for masonry – properties – Repair and strengthening of techniques

References

1. Drysdale, R. G. Hamid, A. H. and Baker, L. R, “Masonry Structures: Behaviour & Design”, Prentice Hall Hendry, 1994.
2. A.W. Hendry, B.P. Sinha and Davis, S. R, “Design of Masonry Structures”, E & FN Spon, UK, 2017.
3. R.S. Schneider and W.L. Dickey, “Reinforced Masonry Design”, Prentice Hall, 3rd edition, 1994.
4. Paulay, T. and Priestley, M. J. N., “Seismic Design of Reinforced Concrete and Masonry Buildings”, John Wiley, 1992.
5. A.W. Hendry, “Structural Masonry”, 2nd Edition, Palgrave McMillan Press, 1998.

224STE2128	DESIGN AND EXECUTION OF PILE FOUNDATIONS	L	T	P	C
		3	0	0	3
Course Category : Program Core	**Course Type** : **Industry Supported Course – L&T**				

Course Objective

This course is designed by L&T Edu Tech to get an understanding of practical aspects related to design, construction and case studies of bored cast in-situ pile, driven cast in-situ pile, precast driven piles, precast concrete piles in pre-bored holes & under reamed piles, pile selection criteria. Also to understand the lateral and vertical capacity of Piles and testing, design of piles, materials and equipment for construction, pile grouping and pile caps.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Explain the concept of Piling works and design requirements for a pile

CO#2: Elaborate the construction procedures which are involved in the Piling works

CO#3: Explain the different load test which needs to be conducted on the pile

CO#4: Understand the Environmental, Health and Safety standards which need to be in place for the handling of the pile works.

CO#5: Perform exercises on bill of quantities

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1	3	2	3	2	1
CO#2	3	3	3	2	2
CO#3	2	1	2	2	2
CO#4	1	3	2	2	2
CO#5		3	3	3	2

3 – High; 2 – Medium; 1- Low

INTRODUCTION TO PILE FOUNDATIONS AND IS CODE PROVISIONS

Overview of Pile foundations, Selection Criteria, Common Design considerations, General Terminologies and Indian standard codes.

DESIGN AND CONSTRUCTION AND WORKMANSHIP OF PILES IN SOILS AND ROCKS

Materials and Equipment, Construction procedures, Vertical and Lateral Capacity calculations, Load tests and Case Studies of

1. Bored cast in-situ piles
2. Driven cast in-situ piles
3. Precast driven piles
4. Precast driven piles in prebored holes
5. Under-reamed piles

Design procedure for all the above type of Piles, IS Code requirements and optimization from practical considerations. QA/QC/ HSE Plan for Pile foundations

GROUPING AND SETTLEMENT OF PILES AND TESTING

Introduction to Grouping and Settlement of piles, Pile Group efficiency and Spacing, Capacity of Pile group, Settlement of Pile group, Case studies Introduction & Types of testing on piles and General requirements for testing, Pile Integrity tests - Equipment Types of Pile Integrity test, Data Recording & Interpretation of results, quality assurance of piles, General requirement, Quality Control of BCIS, DCIS piles, Quality records and checklists. Software demonstrations (e.g., PLAXIS) and design techniques for deep foundations.

SPECIAL TYPES OF PILES

Materials, Equipment, manufacturing procedure, Design and installation, suitability and application and failure modes of Spun piles, Helical piles, Micro piles, CFA piles, Steel / Composite piles

BILL OF QUANTITIES, CONSTRUCTION CHALLENGES AND SOFTWARE

Introduction to Bill of quantities for Bored cast in-situ, Driven Cast in-situ, Precast driven and Precast driven piles in prebored holes and undreamed piles. Challenges in bored and driven piles, Introduction to types of Piling software, Modelling in Plaxis 2D

❖ **Field Visit & Case studies in L&T Site**

- Case studies of under reamed pile for a residential project.
- Case studies of settlement of pile group for a building project.
- BOQ for Driven Precast, Precast piles in Pre-bored holes & UR piles

❖ **Software Used: Plaxis 2D, Excel Spread Sheet**

224STE2129	BRIDGE ENGINEERING PRACTICES	L	T	P	C
		3	0	0	3
Course Category : Program Core	**Course Type** : **Industry Supported Course – L&T**				

Course Objective

This course is designed by L&T Edu Tech to get an insight knowledge into bridge engineering, to explain various components of Bridges & their Structural behavior, identify various loads, steps involved from concept to execution and Construction methodologies for long span prestressed precast/ steel /cable stayed bridges, Familiarize Students with the Industrial Practices in each module of course. Problems are taken from projects in each module to impart knowledge on field challenges to the students.

Course Outcomes

Upon the successful completion of the course, the students will able to

CO#1: Explain the planning requirements of various classification of bridges

CO#2: Perform structural modelling and analysis of super- structure of bridge

CO#3: Design the components of bridge according to given specification

CO#4: Describe the features of miscellaneous components of bridge

CO#5: Identify and perform the activities during inspection and maintenance of bridge

CO-PO Mapping

CO / PO	**PO#1**	**PO#2**	**PO#3**	**PO#4**	**PO#5**
CO#1			1	1	2
CO#2	2	2	3	3	2
CO#3	1	2	3	2	2
CO#4			2	1	
CO#5	2	3	3	2	3

3 – High; 2 – Medium; 1- Low

CONCEPTUAL PLANNING OF BRIDGES

Introduction, Historical developments, Classification of Bridges, Components of Bridges, Planning, Surveys and Investigations considered, Geometrical aspects - as per Indian codes.

STRUCTURAL MODELLING AND ANALYSIS OF SUPER- STRUCTURE FOR DIFFERENT ALIGNMENTS

Types of Loads, Forces and Load Effects, Load combinations according to IRC recommendations, Introduction & Types of Analysis Methods, Grillage Modeling and Analysis of Super Structure, Transverse Analysis of Super Structure, Introduction to FEM methods of Analysis.

DESIGN OF SUPER-STRUCTURE

Limit state design according to IRC, Slab and Beam types, Pre-stressing systems, Detailing requirements, Introduction & Standards- IRC 24 provisions, Steel composite Girder Bridge- Theory, Composite Girder - Modelling and Design.

DESIGN OF SUB-STRUCTURE AND FOUNDATION

Types of Substructure Systems, Cantilever type- Theory and design, Abutments- Theory, Portal type piers Theory, Pier-cap design, Bearings, Pedestals & seismic restrainers, Types of Foundations, Open Foundation, Pile Foundation and Well Foundation- Theory and design

BRIDGE APPURTANCES AND CROSS DRAINAGE STRUCTURE

Introduction, Single Cell Box Culvert Design, Retaining Structures, Seismic Isolation devices, hold down systems, Expansion Joint, Crash Barrier, Miscellaneous Item

INSPECTION, MONITORING & MAINTENANCE OF BRIDGES

Construction stage monitoring, Installation of sensors for service stage Pos-construction monitoring & analysis, Periodic inspection methods.

❖ **Field Visit & Case studies in L&T Site**

- ➢ PSC I girder type of bridges- Pre-tensioned & Post-tensioned
- ➢ Steel Truss Bridges
- ➢ Balanced Cantilever Bridge
- ➢ Cable Stayed Bridge

❖ **Software: Autocad, Midas and Staad Pro**

AUD18R5001	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		1	0	0	0
Course Category : Audit Course	**Course Type** : - Theory				

Course Objective

Students will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

Syllabus

Unit 1

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

(4 hours)

Unit 2

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

(4 hours)

Unit 3

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature

(4 hours)

Unit 4

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

(4 hours)

Unit 5

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

(4 hours)

AUD18R5002	PEDAGOGY STUDIES	L	T	P	C
		1	0	0	0
Course Category : Audit Course	**Course Type** : - Theory				

Course Objective

To enable the students to understand the concepts of pedagogy and the improvement of teaching methods

Syllabus

Unit 1

Aims and rationale, Policy background, Conceptual framework and terminology -Theories of learning, Curriculum, Teacher education. -Conceptual framework, Research questions. - Overview of methodology and Searching.

(4 hours)

Unit 2

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.- Curriculum, Teacher education.

(4 hours)

Unit 3

Methodology for the in depth stage: quality assessment of included studies - Pedagogic theory and pedagogical approaches. -Teachers' attitudes and beliefs and Pedagogic strategies

(4 hours)

Unit 4

Alignment with classroom practices and followup support - Peer support - Support from the head teacher and the community - 3 Curriculum and assessment - Barriers to learning: limited resources and large class sizes

(4 hours)

Unit 5

Research design – Contexts - Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

(4 hours)