GALGOTIAS UNIVERSITY

Syllabus of

M.Tech Structural Engineering

Name of School: School of Engineering

Department: Civil Engineering

Year: 2015-17

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Civil Engineering

Program: M. Tech in Structural Engineering

Scheme: 2015 – 2017

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Curriculum

Semester 1									
Sl. No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	MATH502	Advanced Numerical and Statistical Methods	3	1	0	4	20	50	100
2	CLE511	Structural Dynamics	3	0	0	3	20	50	100
3	CLE512	Matrix Methods of Structural Analysis	3	0	0	3	20	50	100
4	CLE513	Advanced Concrete Technology	3	0	0	3	20	50	100
5	CLE514	Design of Concrete Structural Systems	3	0	0	3	20	50	100
6	CLE551	Matrix methods of Structural Analysis Lab (STAAD PRO)	0	0	2	1	50	-	50
7	CLE552	Design of Concrete and Structural Systems Lab (STAAD PRO)	0	0	2	1	50	-	50
Semester II									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	CLE521	Finite Element Analysis	3	0	0	3	20	50	100
2	CLE522	Theory of Elasticity and Plasticity	3	0	0	3	20	50	100
3	CLE523	Limit State Design of Steel Structures	3	0	0	3	20	50	100
4		Elective - 1	3	0	0	3	20	50	100
5		Elective – 2	3	0	0	3	20	50	100
6		Elective - 3	3	0	0	3	20	50	100
7	CLE541	Structural Engineering lab (CASTING)	0	0	2	1	50	-	50
8	CLE542	Finite Element Analysis Lab (STAAD PRO)	0	0	2	1	50	-	50
Semester III									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	CLE631	Application of Numerical Methods in Structural Engineering	3	0	0	3	20	50	100
2		Elective – 4	3	0	0	3	20	50	100
3		Elective – 5	3	0	0	3	20	50	100

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4	GUC501	Seminar (or) Mini Project	- -	- -	2	1	50	-	50
5	CLE663	Comprehensive Examination	-	-	-	2	50	-	50
6	CLE698	Project (Phase I)	0	0	0	5	50	-	50
7	ENG584P	Professional and Communication Skills	0	0	4	2	50	-	50
Semester IV									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	CLE699	Project (Phase II)	0	0	0	15	50	-	50

List of Electives

Sl No	**Course Code**	**Name of the Electives**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	CLE561	Advanced Foundation Engineering	3	0	0	3	20	50	100
2	CLE562	Design of Concrete Bridges	3	0	0	3	20	50	100
3	CLE563	Design of Industrial Structures	3	0	0	3	20	50	100
4	CLE564	Earthquake Resistant Design	3	0	0	3	20	50	100
5	CLE565	Design of Tall Buildings	3	0	0	3	20	50	100
6	CLE566	Energy Efficient Buildings	3	0	0	3	20	50	100
7	CLE567	Environmental Engineering Structures	3	0	0	3	20	50	100
8	CLE568	Experimental Stress Analysis	3	0	0	3	20	50	100
9	CLE569	Machine Foundations	3	0	0	3	20	50	100
10	CLE661	Maintenance & Rehabilitation of Structures	3	0	0	3	20	50	100
11	CLE662	Theory and Design of Plates & Shells	3	0	0	3	20	50	100
12	CLE663	Off Shore Structures	3	0	0	3	20	50	100
13	CLE664	Prefabricated Structures	3	0	0	3	20	50	100
14	CLE665	Pre-stressed Concrete Structures	3	0	0	3	20	50	100
15	CLE666	Soil Structure Interaction	3	0	0	3	20	50	100
16	CLE667	Stability of Structures	3	0	0	3	20	50	100
17	CLE668	Structural Optimization	3	0	0	3	20	50	100
18	CLE669	Composite Structures	3	0	0	3	20	50	100

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Detailed Syllabus

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Name of The Course	Structural Dynamics				
Course Code	CLE511				
Prerequisite	-				
Corequisite	-				
Antirequisite	-				
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To find the behaviour of structures subjected to dynamic loads such as wind, earthquake and blast loads.
2. To study different dynamic analysis procedures for calculating response of structures.

COURSE OUTCOMES:

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

CO1	Solve the problems on single degree of freedom system.
CO2	Understand the concept of harmonic loading and impulse loading and the related analysis procedures.
CO3	Understand the concept of multi degree of freedom system.
CO4	Evaluate the mode shapes for different structures.
CO5	Know the orthogonality condition.

TEXT BOOKS

1. Mario Paz, (2004), Structural Dynamics - Theory and Computation, Second Edition, CBS Publishers, ISBN-13: 9788123909783.

REFERENCE BOOKS

1. J. Humar, (2012), Dynamics of Structures, Third Edition, CRC Press, ISBN-13: 9780415620864.
2. Anil K. Chopra, (2003), Dynamics of Structures - Theory and Applications to Earthquake Engineering, Third Edition, Pearson India, ISBN-13: 9788131713297.

COURSE CONTENT

Unit I:SDOF Systems 8 lecture hours Single Degree of Freedom System - Introduction - Alembert's principle - Mathematical models for SDOF systems - Free vibration - Damped and undamped - Critical damping - Logarithmic decrement.
Unit II: Harmonic and Impulse Loading 8 lecture hours Response to Harmonic Loading and Impulse Loading - Analysis of undamped system - damped system - general dynamic loading.
Unit III: Vibration Analysis 8 lecture hours

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Vibration Analysis - Rayleigh's method - Approximate Analysis - Improved Rayleigh method.
Unit IV:MDOF Systems 8 lecture hours Multi degree of Freedom System - Evaluation of structural property matrices - Mode shape - Orthogonality conditions - Undamped and damped system - Mode superposition method.
Unit V: Continuous Systems 8 lecture hours Continuous Systems - Differential equation of motion - Transverse vibration of linearly elastic beams - Analysis of undamped free vibration of simply supported and cantilever beams - Orthogonality condition.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Matrix Methods of Structural Analysis			
Course Code	CLE512			
Prerequisite	Structural Analysis			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES:

1. The course is intended to teach the basic concepts of indeterminate structures, static indeterminacy and kinematic indeterminacy.
2. Different matrix methods will be taught and their uses will be explained in the class.

COURSE OUTCOMES:

On completion of this course, the students will be able to

CO1	Solve different structures by flexibility matrix method and stiffness matrix method.
CO2	Visualize and analyze plane trusses and plane frames.
CO3	Understand the effect of settlement of supports.
CO4	Analyze space trusses and plane frames.
CO5	Solve any problem on grid.

TEXT BOOKS

1. Pundit G.S. & Gupta S.P., (2008), Structural Analysis (A matrix approach), Second Edition, Tata McGraw Hill Education, ISBN-13: 9780070667358.

REFERENCE BOOKS

1. J. S. Przemieniecki, (1985), Theory of Matrix Structural Analysis, New Edition, Dover
   Publication, ISBN-13: 97804866494.
2. Richard B. Nelson, Lewis P. Felton, (1997), Matrix Structural Analysis, John Wiley & Sons, Imported Edition, ISBN-13: 9780471123248.

COURSE CONTENT

Unit I: Introduction to flexibility matrix and stiffness matrix 8 lecture hours

Concept of static indeterminacy and kinematic indeterminacy - concept of flexibility matrix and stiffness matrix - properties of matrices - coordinate system - solution of simple problems - derivation of stiffness matrix of beam element from strain energy.

Unit II: Analysis of plane structures by flexibility matrix method 8 lecture hours

Analysis of continuous beam, plane truss and plane frame by flexibility matrix method - Internal forces due to thermal expansion and lack of fit – effect of settlement of supports.

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Unit III: Analysis of plane structures by stiffness matrix method 8 lecture hours Analysis of continuous beam, plane truss and plane frame by stiffness matrix method - Internal forces due to thermal expansion and lack of fit – effect of settlement of supports
Unit IV: Space truss 8 lecture hours Analysis of space truss by flexibility matrix method and stiffness matrix method.
Unit V: Analysis of space structures by stiffness matrix method8 lecture hours Analysis of space frame and grid structures by stiffness matrix method

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Advanced Concrete Technology			
Course Code	CLE513			
Prerequisite	Concrete Technology			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This course mainly aims to develop the knowledge about properties of cement concrete and importance of admixtures in concrete.
2. To make the students to understand Mix Design Method.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Know the various materials used in concrete and admixtures.
CO2	Do the Mix design by different methods.
CO3	Get a thorough knowledge of various types of cement, aggregates and properties of special concrete.
CO4	Know the different procedures for testing concrete.
CO5	Understand different types of special concrete.

TEXT BOOKS

1. Shetty. M. S., (2008), Concrete Technology, Seventh Edition, S. Chand & Company Ltd.ISBN-13: 9788121900034.

REFERENCE BOOKS

1. M. L. Gambhir, (2013), Concrete Technology, Fifth Edition, McGraw Hill Education India Pvt. Ltd., ISBN-13: 9781259062551.
2. A. R. Santha Kumar, (2006), Concrete Technology, First Edition, Oxford University Press, ISBN-13: 9780195671537.

COURSE CONTENT

Unit I:Material, reinforcement and admixtures **8 lecture hours** Materials - Concrete materials - Reinforcements and admixtures.
Unit II:Mix design **8 lecture hours** Mix Design – Specifications - Design of concrete mixes by IS code method - ACI method - Road Note No: 4 methods – High strength concrete.

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Unit III:Modern trends in concrete 8 lecture hours Behaviour of Concrete - Modern trends in concrete manufacture and placement techniques - Behaviour of fresh concrete and hardened concrete - Resistance to static and dynamic loads.
Unit IV: Concrete testing 8 lecture hours Testing of Concrete - Non-destructive testing and quality control – Durability - Corrosion protection and fire resistant.
Unit V:Special concrete8 lecture hours Special Concrete - Pre-cast concrete - Light weight concrete - Under water concrete – Pump concrete - Polymer concrete - Composites and fibre reinforced concrete.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Design of Concrete Structural Systems				
Course Code	CLE514				
Prerequisite	Design of Concrete Structures				
Corequisite	-				
Antirequisite	-				
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. This subject is intended to teach the concept of advanced concrete design.
2. The practical aspects of various designs of structure will be explained in the classes

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand rotation capacity of a RC section and moment curvature relationship.
CO2	Analyse and design deep beams.
CO3	Design flat slabs.
CO4	Understand the concept of designing slender columns and shear walls.
CO5	Design different types of water tanks.

TEXT BOOKS

1. Krishnaraju N., (2013), Advanced Reinforced Concrete Design, Second Edition, CBS Publisher, *ISBN-13: 9788123912257.*

REFERENCE BOOKS

1. P. C. Varghese, (2009), Advanced Reinforced Concrete Design, Second Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120327870.
2. M. L. Gambhir, (2009), Design of Reinforced Concrete Structures, First Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120331938.
3. P. Dayaratnam, (2011), Design of Reinforced Concrete Structures, Fourth Edition, Oxford & IBH – Pubs Company, ISBN-13: 9788120414198.
4. B. C. Punmia, Ashok Kr. Jain, Arun Kr. Jain, (2006), R. C. C. Designs, Laxmi Publication (P) Ltd., ISBN-13: 9788131809426.

COURSE CONTENT

Unit I:Limit state design of beams 8 lecture hours

Limit state analysis and design of beams in flexure, , - Behaviour of reinforced concrete Members in bending - Plastic hinge – Rotation capacity – Factors affecting rotation

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capacity of a section –Plastic moment – Moment curvature relationship – Redistribution of moments, effect of duration of loading on stress-strain curve
Unit II:Deep beams **8 lecture hours** Limit state design of deep beams.
Unit III: Flat Slabs **8 lecture hours** Design of Flat Slabs using BIS 456.
Unit IV: Columns and shear walls **8 lecture hours** Design of slender columns subjected to combined bending moment and axial force using SP: 16, Design of shear walls, Ductile detailing.
Unit V: Design of Water Tanks **8 lecture hours** Types of water tanks, Design of underground rectangular water tanks, Design of overhead water tank (Intze type tank), Design of staging.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Finite Element Analysis			
Course Code	CLE521			
Prerequisite	Matrix Methods of Structural Analysis			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. The course is intended to teach the basic concepts of finite element analysis.
2. The practical application of finite element method and their advantages and disadvantages will be explained in the class.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Carry out finite element analysis of beam.
CO2	Understand the concept of displacement polynomials.
CO3	Analyse plane trusses, plane frames and grids.
CO4	Calculate strain-displacement matrix and stress-strain matrix for plane stress elements.
CO5	Know the concepts of isoparametric elements.

TEXT BOOKS

1. C. S. Krishnamoorthy, (2008), Finite Element Analysis, Second Edition, Tata McGraw Hill Education Pvt. Ltd., ISBN-13: 978007462100.

REFERENCE BOOKS

1. Cook R. D., Malkas D. S. &Plesha M. E, (2008), Concepts and applications of Finite element analysis, Fourth Edition, Wiley India Pvt. Ltd., ISBN-13: 9788126513369.
2. Reddy, (2005), An Intro. To The Finite Element Methods, Third Edition, Tata McGraw Hill Education Pvt. Ltd., ISBN-13: 9780070607415.

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3. Singiresu S. Rao, (2010), The Finite Element Method in Engineering, Fifth Edition, Elsevier Science, ISBN-13: 9780080952048.

COURSE CONTENT

Unit I:Introduction to FEM8 lecture hours Introduction - Background - General description of the method – Analysis procedure - Stress and strain vectors – Stain displacement equations – Linear constitutive equations – Overall stiffness matrix – Overall load matrix - Analysis of beams.
Unit II: Displacement models 8 lecture hours Theory of Finite Element - Concept of an element - Various elements shapes - Displacement polynomials - Convergence requirements - Shape functions - Element strains and stresses - Direct formulation of element stiffness matrix for beam element and plane truss element.
Unit III:Analysis of structures by FEM 8 lecture hours Overall Problems - Discretization of a body or structure - Minimization of band width - Construction of stiffness matrix and loads for the assemblage - Boundary conditions - Analysis of plane truss, space truss, plane frame and grid.
Unit IV: Plane stress and plane strain 8 lecture hours Plane stress - Plane strain - CST, LST & QST elements – Rectangular element - solutions of problems.
Unit V:Isoparametric elements 8 lecture hours Natural Coordinate - Isoparametric Formulation - Natural coordinates (area and volume) - Isoparametric Bar element - Plane bilinear isoparametric element - Plane stress element - Quadratic plane stress elements - Application of Gauss Quadrature formulation.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Theory of Elasticity and Plasticity			
Course Code	CLE522			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart knowledge on theory of elasticity and plasticity.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Analyse the stresses and strains for two dimensional and three dimensional elements.
CO2	Understand the equilibrium and compatibility conditions.
CO3	Know the concept of Prandle's membrane analogy.
CO4	Solve the problems on Torsion for different shaped bars.
CO5	Understand the concept of plasticity.

TEXT BOOKS

1. Timoshenko and Goodier, (1970), Theory of Elasticity, Third Edition, McGraw Hill Professional, ISBN-13: 9780070858053.

REFERENCE BOOKS

1. Srinath, (2002), Advanced Mechanics of Solids, Third Edition, Tata McGraw Hill Pvt. Ltd., ISBN-13: 9780070139886.
2. D. Peric, E. A. de Souza Neto& D. R. J. Owen, (2011), Computational Methods for Plasticity, Wiley, ISBN-13: 9781119964544.

COURSE CONTENT

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Unit I: Stresses and strains 8 lecture hours Analysis of Stress and Strain - Elasticity approach – Definition and notation of stress – Components of stress and strain – Generalized Hooke's law -Two dimensional Problems in Cartesian Coordinates - Plane stress and plain strain problems with practical examples - Equations of equilibrium and compatibility conditions in Cartesian coordinates – Airy's stress function - Bending of simply supported beams..
Unit II: Axi-symmertic problems 8 lecture hours Two dimensional Problems in Polar Coordinates - Equations of equilibrium and compatibility conditions in polar coordinates – Axi-symmetrical problems - Thick cylinder under uniform pressure - Circular arc beams subjected to pure bending
Unit III: Prandle's membrane analogy 8 lecture hours Principal stresses and strains for three dimensional element – Equations of equilibrium and compatibility conditions for 3D problems in Cartesian co-ordinates - Transformation of stresses and strains.
Unit IV: Torsion 8 lecture hours Torsion - Torsion of various shaped bars - Pure torsion of prismatic bars - Prandtle's membrane analogy - Torsion of thin walled tubes and hollow shafts.
Unit V: Introduction to plasticity 8 lecture hours Introduction to plasticity – Stress – Strain diagram – Plastic analysis – Yield criteria – St. Venant's theory – Von Mises criterion – Plastic work – Strain hardening.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Limit State Design of Steel Structures			
Course Code	CLE523			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. To know how to design and use the different types of steel structural elements.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Design different types of connections.
CO2	Design members for pitched roof truss, bracings and purlins.
CO3	Understand the design of plate girders and gantry girders.
CO4	Design chimney.
CO5	Understand the concept of plastic analysis.

TEXT BOOKS

1. Dayarathnam. P., (1996), Design of Steel Structures, Second Edition, S. Chand and Publishers, ISBN-13: 0788121923200.

REFERENCE BOOKS

1. Duggal S. K., (2014), Limit State Design of Steel Structures, Second Edition, McGraw Hill, ISBN-13: 9789351343509.
2. Ramchandra, VirendraGehlot, (2010), Limit State Design of Steel Structures: Based on IS: 800-2007 IN S. I. Units, Scientific Publishers, ISBN-13: 9788172336141.

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COURSE CONTENT

Unit I: Eccentric and Moment Cconnections 8 lecture hours Different types of beam-column connections – Design of rigid and semi rigid connection.
Unit II: Industrial Buildings 8 lecture hours Roof Trusses - Calculation of dead load, live load and wind load - Design of joints – Design of members for pitched roof truss – Bracings – Design of Purlins.
Unit III: Plate Girder and Gantry Girder 8 lecture hours Elements of plate girders – Shear strength of web - Design of plate girders - Curtailment of flange plates – Design of stiffeners – Design of gantry girder
Unit IV: Chimney8 lecture hours Calculation of wind load and seismic load, Design of chimney, Design of foundation of chimney
Unit V: Plastic Analysis 8 lecture hours Plastic Analysis of Structures – Introduction - Shape factors – Mechanisms - Plastic hinge - Analysis of beams and portal frames - Design of continuous beams.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Application of Numerical Methods in Structural Engineering			
Course Code	CLE631			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart knowledge on numerical methods in structures.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Solve the linear simultaneous equations.
CO2	Use the Finite difference method.
CO3	Calculate bending moment, slope and deflection for beams using Simpson's rule and Gauss Quadrature method.
CO4	Understand the concept of finite strip method of analysis of plates.
CO5	Evaluate the eigen values and eigen vectors for stability problems.

TEXT BOOKS

1. N. Krishnaraju& K. U. Muthu, (2008), Numerical Methods for Engineering problems, Second Edition, Macmillan India Ltd., ISBN-13: 9780333924242.

REFERENCE BOOKS

1. Jain M. K., Iyengar, R. K. & Jain R. K. (2004), Numerical Methods: Problems and Solutions, Second Edition, New Age International (P) Ltd., ISBN-13: 9788122415346.

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2. Klaus-Jsrgan Bathe, (2008), Finite Element Procedures, First Edition, Prentice Hall of India, ISBN-13: 9788120310759.

COURSE CONTENT

Unit I: Simultaneous equations 8 lecture hours Solution of linear simultaneous equations – Gauss elimination method, Gauss-Jordan method, Gauss-Siedal method - Banded - Semi-banded matrix– Skyline technique.
Unit II: Finite difference method 8 lecture hours Finite difference method – Solution of simultaneous equations – Bending moment - Slope and deflection in beams - Membrane analogy using finite difference method for slabs-slope and deflection of slabs.
Unit III: Numerical methods 8 lecture hours Numerical Methods – Numerical integration (Trapezoidal and Simpson's rule) for determining shear, moment and deflection in beams– Gauss Quadrature formula.
Unit IV: Finite Strip method for analysis of plates8 lecture hours Finite Strip Method – Shape Functions – Strain - Displacement Relationship – Strip Stiffness Matrix – Load Matrix – Solution of Problems.
Unit V: Eigen values and Eigen Vectors 8 lecture hours Mass Matrix - Stiffness matrix - Dynamic Analysis - Eigen values & Eigen Vectors.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Matrix Methods of Structural Analysis Lab (STAAD PRO)			
Course Code	CLE551			
Prerequisite	Matrix Methods of Structural Analysis			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	0	0	2	1

List of experiments:

1. Analysis of propped cantilever beam
2. Analysis of two span continuous beams
3. Analysis of statically determinate plane truss
4. Analysis of statically indeterminate plane truss
5. Analysis of kinematically indeterminate plane truss
6. Analysis of one bay – one storey plane frame
7. Analysis of multi bay – multi storied plane frame
8. Analysis of space truss
9. Analysis of grid
10. Analysis of space frame

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

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Name of The Course	Design of Concrete and Structural Systems lab (STAAD PRO)			
Course Code	CLE552			
Prerequisite	Design of Concrete and Structural system			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	0	0	2	1

List of experiments:

1. Design of Continuous beams
2. Design of Deep beams
3. Design of T-beams
4. Design of Columns
5. Design of Shear walls

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

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Name of The Course	Structural Engineering Laboratory (CASTING)			
Course Code	CLE541			
Prerequisite	Design of Concrete Structures			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	0	0	2	1

List of experiments:

1. To determine the compressive strength of fibre reinforced concrete by testing cubes specimen.
2. Casting and testing of simply supported RCC beams for flexural failure.
3. Casting and testing of simply supported RCC beams for shear failure.
4. To determine tensile strength on a steel reinforcement bar.
5. To determine shear strength of steel bar under double shear.
6. To conduct bending test of I-section steel beam.
7. To conduct bending test of steel channel section.
8. To study rebound hammer test on concrete blocks.
9. To study ultra sonic pulse velocity test

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

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Name of The Course	Finite Element Analysis Lab (STAAD PRO)			
Course Code	CLE542			
Prerequisite	Matrix Methods of Structural Analysis Lab			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	0	0	2	1

List of experiments:

1. Analysis of three span continuous beams.
2. Analysis of propped cantilever beam.
3. Analysis of statically determinate plane truss.
4. Analysis of statically indeterminate plane truss.
5. Analysis of one bay – one storey plane frame.
6. Analysis of two bays – one storey plane frame.
7. Analysis of a 2-D building frame subjected to dead load, live load and seismic load.
8. Analysis of beam with concentrated and distributed loads.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

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Name of The Course	Seminar (or) Mini project				
Course Code	GUC501				
Prerequisite	-				
Corequisite	-				
Antirequisite	-				
		L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

1. To make literature survey for various recently emerging technologies.
2. To select any topic of interest and to review the related literature in detail.
3. To compare and analyze the various topologies for the selected topic of interest.
4. To conclude the advantages, drawbacks and future scopes of the technique.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Get familiarity with the recently advanced techniques.
CO2	Get detailed information about the topic of interest.
CO3	Know how to do literature survey.
CO4	Develop the interest in different research areas of Structures.

TEXT BOOKS

Depending upon their area of interest, students may choose any text book of relevant field or any article from Journal.

REFERENCE BOOKS

Depending upon their area of interest, students may choose any reference book of relevant field.

COURSE CONTENT

Depending upon their area of interest, students will choose any topic.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

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Name of The Course	Project (Phase I)				
Course Code	CLE698				
Prerequisite	-				
Corequisite	-				
Antirequisite	-				
		L	T	P	C
		0	0	0	5

Course Objectives

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to civil engineering domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

Course Outcomes

On completion of this course, the students will be able to

CO1	Submit a project synopsis comprising of the application and feasibility of the project.
CO2	Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care, safety and sustainability.
CO3	Work and communicate efficiently in multidisciplinary teams.
CO4	Identify, formulate, and solve engineering problems.
CO5	Develop an understanding of professional and ethical responsibility.

TEXT BOOKS

Depending upon their area of interest, students may choose any text book of relevant field or any article from Journal.

REFERENCE BOOKS

Depending upon their area of interest, students may choose any reference book of relevant field.

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Depending upon their area of interest, students will choose any topic.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

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Name of The Course	Project (Phase II)			
Course Code	CLE699			
Prerequisite	Project (Phase I)			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	0	0	0	15

Course Objectives

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to civil engineering domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

Course Outcomes

On completion of this course, the students will be able to

CO1	Submit a project synopsis comprising of the application and feasibility of the project.
CO2	Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care, safety and sustainability.
CO3	Work and communicate efficiently in multidisciplinary teams.
CO4	Identify, formulate, and solve engineering problems.
CO5	Develop an understanding of professional and ethical responsibility.

TEXT BOOKS

Depending upon their area of interest, students may choose any text book of relevant field or any article from Journal.

REFERENCE BOOKS

Depending upon their area of interest, students may choose any reference book of relevant field.

COURSE CONTENT

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Depending upon their area of interest, students will choose any topic.

Continuous Assessment Pattern

Internal Assessment (IA)	End Term Test (ETE)	Total Marks
50	50	100

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PROGRAM ELECTIVES

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Name of The Course	Advanced Foundation Engineering				
Course Code	CLE561				
Prerequisite	Geotechnical Engineering –II (Foundation Engg.)				
Corequisite	-				
Antirequisite	-				
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart the knowledge in the area of analysis and design of foundations and earth retaining structures.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand the concepts of shallow foundations.
CO2	Design the retaining walls and sheet piles.
CO3	Know the concept of pile group.
CO4	Design pile foundation.
CO5	Know the types well foundations.

TEXT BOOKS

1. Gopal Ranjan and A S R Rao (2000), Basic and Applied Soil Mechanics, Second Edition, New Age International, ISBN-13: 9788122412239.

REFERENCE BOOKS

1. J. E. Bowles, (2000), Foundation Analysis and Design, Fifth Edition, McGraw Hill Education India Pvt. Ltd., ISBN-13: 9781259061035.
2. P. C. Verghese, (2009), Design of Reinforced Concrete Foundations, First Edition, PHI
Learning Pvt. Ltd., ISBN-13: 9788120336155.

COURSE CONTENT

Unit I: Shallow foundation **8 lecture hours**

Shallow Foundations – Spread footings – Contact pressure – Structural design of individual footings – Pedestals – Combined footings (Rectangular and trapezoidal) – Eccentrically loaded footings – Mat foundations

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Unit II: Deep foundation 8 lecture hours Pile Foundations – Types of piles – Static and dynamic pile formula – Pile groups – Efficiency of pile group
Unit III: Pile foundations 8 lecture hours Settlement of piles – Batter piles – Analysis of pile groups – Structural design of piles and pile caps
Unit IV: Retaining structures 8 lecture hours Retaining Structures – Stability of walls – Design of cantilever and counter fort walls – Design of gravity walls – Coffer dams – Braced coffer dams – Stability of bottom excavation – Anchorage – Walls and tie rods
Unit V:Well foundations8 lecture hours Well Foundations – Types of wells or caissons – Components – Shapes of wells – Forces acting – Construction– Design of drilled caissons

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Design of Concrete Bridges				
Course Code	CLE562				
Prerequisite	Reinforced Concrete Structures				
Corequisite	-				
Antirequisite	-				
		L	T	P	C
		3	0	0	3

Course Objectives

1. To understand the design and codal concepts of different types of bridges.

Course Outcomes

On completion of this course, the students will be able to

CO1	Understand IRC Code.
CO2	Use Pigeauds curves for designing deck slab for T-beam Bridge.
CO3	Understand Courbon's method of load distribution to analyze and design girders for T-beam Bridge.
CO4	Design plate girders and steel truss bridges.
CO5	Design piers and abutments.

Text Books

1. Victor D. J. (2008), Essentials of Bridge Engineering, 6th Edition, Oxford University Press, ISBN: 9788120417175.
2. Ramachandra (2004), Design of Steel structures, 4th Edition, Standard Publishers Distributors, ISBN: 9780071544115.

Reference Books

1. Duggal S. K. (2008), Design of Steel Structures, 3rd Edition, Tata McGraw-Hill, ISBN: 9780070260689.
2. IRC Bridge Code.

COURSE CONTENT

Unit I: Introduction and design of slab culvert	8 lecture

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hours Site selection, various types of bridges, loads on bridges according to IRC codes, Design of RC bridges under concentrated loads using effective width method
Unit II: Deck slab of T-Beam Bridges 8 lecture hours Pigeauds curves, Calculation of bending moments, Design of deck slab for T-beam Bridge for different types of vehicles
Unit III: Girders of T-Beam Bridge 8 lecture hours Courbon's method of load distribution, Analysis and design of girders for T-beam Bridge for different types of vehicles, Concept of box culverts.
Unit IV: Design of Plate Girders and Steel Trussed Bridges 8 lecture hours Design principles, Design and detailing of plate girder bridges, Types of trusses, Design of steel trussed bridges.
Unit V: Design of Substructures 8 lecture hours Types of piers, Forces acting on piers, Design of piers, General features of abutments, Forces acting on abutments, Design of abutments.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Design of Industrial Structures			
Course Code	CLE563			
Prerequisite	Construction Technology			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart a broad knowledge in the area of industrial structures.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Know the requirements of various industries.
CO2	Get an idea about the materials used and planning.
CO3	Know the construction techniques.
CO4	Learn about circulation, communication and transport.
CO5	Understand the functional requirements.

TEXT BOOKS

1. El Reedy, (2010), Construction Management and Design of Industrial Concrete and Steel Structures, Taylor & Francis Group, ISBN-13: 9781439815991.

REFERENCE BOOKS

1. Nelson G. L., (1988), Light Agricultural and Industrial Structures: Analysis and Design
   Kluwer Academic Publisher, ISBN-13: 9780442267773.
2. Dr. Raja Rizwan Hussain, (2011), Pre-Cast Concrete for Multi-Storey Structures, Createspace Publisher, ISBN: 9781467918220.

COURSE CONTENT

Unit I: Industrial requirements **8 lecture hours**
General - Specific requirements for industries like textile, sugar, cement, chemical, etc - Site layout and external facilities.
Unit II: Planning of building works **8 lecture hours**

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Planning of Building Work – Standards - Structural materials including plastics – Polymers - Fibre glass - Pressed card boards, etc - Multi-storey buildings - Steel skeletal structures - Reinforced concrete frames – Workshops - Ware houses - Single storey buildings - Sheds in steel and reinforced concrete - North-lights - Single span spherical and other special constructions - Cooling towers and chimneys - Bunkers and silos' prefabrication - Construction.
Unit III: Construction techniques 8 lecture hours Construction Techniques - Expansion joints - Machine foundations - Other foundations - Water proofing - Roofs and roofing - Roof drainage - Floors and flooring joists - Curtain walling - Outer wall facing - Sound and shock proof mountings - Use of modern hoisting and other construction equipments.
Unit IV: Circulation 8 lecture hours Circulation - Communication and Transport - Fixed points (central cores) – Staircases - Grid floor sections - Lifts refuse disposals - Utilization of waste materials – Cranes - Continuous conveyors - Mobile cranes – Transporters – Doors - Sliding gates.
Unit V:Functional Requirements8 lecture hours Functional Requirements – Lighting: Natural lighting - Protection from the sun - sly lights - window cleaning installations -Services: Layout – wiring – fixtures - cable and pipe bridges - electrical installations - lighting substation - Effluent. Ventilation and fire protection: Ventilation - Air-conditioning - Fire escapes and chutes - Fire alarms - Extinguishers and hydrants.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Earthquake Resistant Design			
Course Code	CLE564			
Prerequisite	Structural Dynamics			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. To impart the knowledge about the earthquake and its occurrence.
2. To know about the mathematical modeling of structures subjected to earthquakes and their behaviour

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand about the basic of seismology.
CO2	Evaluate the behaviour of structures under dynamic loadings.
CO3	Know methodology for earthquake resistant design for shear walls.
CO4	Design the buildings using capacity design method.
CO5	Design seismic resistant multi storied building.

TEXT BOOKS

1. Anil K. Chopra, (2011), Dynamics of Structures – Theory and Applications to Earthquake Engineering, Second Edition, Ingram International Inc., ISBN-13: 9780132858038.

REFERENCE BOOKS

1. Pankaj Agarwal and Manish Shrikhande, (2007), Earthquake Resistant Design of Structures, First Edition, Prentice-Hall India Pvt Ltd, ISBN-13: 9788120328921.
2. Gupta B. L., (2010), Principles of Earthquake Resistant Design of Structures & Tsunami, Standard Publishers & Distributors, ISBN-13: 9788180141485.

COURSE CONTENT

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:Basic of seismology &Theory of vibrations 6 lecture hours Brief Introduction: Elements of Seismology – Definitions of magnitude – Intensity – Epicentre – General features of tectonics of seismic regions – Seismographs Free vibrations of single degree freedom systems – Computations of dynamic response to time dependent forces –Solution of problems.
Unit II: Dynamic analysis of building 9 lecture hours Dynamic analysis of building – MDOF system – Eigen values and eigen vectors – Mode shape – Calculation of storey shear.
Unit III: Earthquake resistant design of shear wall 9 lecture hours Determination of design lateral forces – Design of shear wall – Detailing of reinforcements as per IS: 13920.
Unit IV: Capacity design method 8 lecture hours Capacity – Design Principles – Design criteria for strength – Stiffness and ductility – Earthquake Analysis – Concept of earthquake resistance design – Code provisions for design of RCC building – IS: 1893 and IS: 4326 – Energy absorption capacity - Behaviour and design of masonry buildings subjects to earthquake ground motion.
Unit V: Multi storey building analysis 8 lecture hours Seismic analysis and design of a multi storied building – Seismic retrofitting strategies for RC and masonry buildings.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	**Design of Tall Buildings**				
Course Code	**CLE565**				
Prerequisite	Design of Steel Structures, Structural analysis				
Corequisite	-				
Antirequisite	-				
		L	**T**	**P**	**C**
		3	0	0	3

COURSE OBJECTIVES

1. This course is intended to teach the concept of tall structures.
2. Various methods to analyse the tall structure will be explained in the classes.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Know the types of tall buildings.
CO2	Analyze the plane frame systems by different methods.
CO3	Design the shear wall systems.
CO4	Know the details of in filled frame systems.
CO5	Perform the three dimensional analysis.

TEXT BOOKS

1. Bryan Stafford Smith and Alex Coull, (2011), Tall Building Structures: Analysis and Design, Wiley India, ISBN-13: 9788126529896.

REFERENCE BOOKS

1. SarwarAlamRaz, (2002), Structural Design in Steel, Second Edition, New Age International, ISBN-13: 9788122432282.
2. Ghali. A., Neville. A. M and Brown T. G, (2009), Structural Analysis - A unified classical and Matrix Approach, Sixth Edition, Span press, ISBN-13: 9780415774338.

COURSE CONTENT

Unit I: Classification of buildings **8 lecture hours**

Introduction - Classification of buildings according to NBC – Types of loads – wind load – Seismic load – Quasi static approach

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Unit II: Plane frame systems 8 lecture hours Plane Frame System - Calculation of wind load – Approximate method – Portal - Cantilever and factor methods – Kani's method – Substitute frame method for dead load and live loads.
Unit III: Shear wall system 8 lecture hours Shear Wall System - Rosman's analysis – Design aspect – RC frame and shear wall interaction – Equivalent frame method
Unit IV: In-filled frame system 8 lecture hours In-filled Frame Systems - Importance – Methods of analysis – Equivalent truss and frame method – Force-displacement method – Effect of perforation in the in-filled frame.
Unit V:Three dimensional analysis8 lecture hours Three Dimensional Analysis - Basic principles – Centre of rotation of a rigid floor – Force displacement method.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Energy Efficient Buildings			
Course Code	CLE566			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This course aims to highlight importance of Energy- Efficient Buildings within the context of Energy issues in the 21st century.
2. To familiarize students with the concept of Energy efficiency, Renewable sources of energy and their effective adaptation in green buildings
3. To give a full understanding of Building Form and Fabric, Infiltration, ventilation, Lighting, cooling and water conservation.
4. To highlight the importance of Environmental Management as well as Environmental impact Assessment methods in Energy efficient buildings.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand to make buildings energy efficient.
CO2	Have a fuller grasp on Renewable Energy mechanisms such as Passive Solar heating and collection, Photovoltaics, and Ground source heat pumps, and their adaption to green building concepts.
CO3	Understand the concepts of Site and Climate, Building Form, Building Fabric, Infiltration and ventilation, Lighting, Heating, Cooling, Energy Management and water conservation.
CO4	Have the necessary skills to undertake an Environmental Impact Assessment study for Energy Efficient Buildings. They shall be equipped with the associated cutting-edge management strategies too.
CO5	Monitor energy consumption.

TEXT BOOKS

1. William T. Meyer, (2007), Energy Economics and Building Design, McGraw - Hill, ISBN: 9780070417519.

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REFERENCE BOOKS

1. Sim Van Der Ryn and Stuart Cowan, "Ecological Design", Annotated Edition, Island Press ISBN-13: 9781597261418.
2. Richard D. Rush, (1991), The Building System Integration Handbook., Butterworth – Heinemann Ltd, ISBN-13: 9780750691987.

COURSE CONTENT

Unit I: Green Buildings, Energy and Environment 8 lecture hours Green Buildings within the Indian Context - Types of Energy - Energy Efficiency and Pollution - Better Buildings - Reducing energy consumption - Low energy design.
Unit II: Renewable Energy, Site and Climate 8 lecture hours Renewable Energy sources that can be used in Green Buildings - Solar energy - Passive Solar Heating - Passive Solar collection - Wind and other renewable - A passive solar strategy - Photovoltaics - Climate and Energy - Macro and Microclimate - Indian Examples.
Unit III: Building Form and Fabric 8 lecture hours Building Form - Surface area and Fabric Heat Loss - utilizing natural energy - Internal Planning - Grouping of buildings - Building Fabrics - Windows and doors - Floors - Walls - Masonry - Ecological walling systems - Thermal Properties of Construction Material.
Unit IV: Infiltration, Ventilation, Lighting, Cooling and Water Conservation 8 lecture hours Infiltration and ventilation - Natural ventilation in commercial buildings - passive cooling - modelling air flow and ventilation - Concepts of daylight factors and day lighting - daylight assessment - artificial lighting - New light sources - Cooling buildings - passive cooling - mechanical cooling - Water conservation- taps, toilets and urinals, novel systems - collection and utilization of rain water.
Unit V: Energy Awareness 8 lecture hours Energy awareness - monitoring energy consumption - Building Environmental Assessment - environmental criteria - assessment methods - assessment tools (e.g. LEED) – Ecohomes - Sustainable architecture and urban design - principles of environmental architecture - Benefits of green buildings - Energy Conservation Building code – NBC.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Environmental Engineering Structures			
Course Code	CLE567			
Prerequisite	Design of Concrete Structures			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart the knowledge in the area of analysis and design of pipes and sewage structures.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand the concepts of pipe network and design.
CO2	Design the water tanks and concrete roofing systems.
CO3	Understand the economic analysis of tanks.
CO4	Design the special purpose structures.
CO5	Understand the concepts of filter walls and clarifiers.

TEXT BOOKS

1. P. Dayaratnam, (2011), Design of Reinforced Concrete Structures, Fourth Edition, Oxford & IBH – Pubs Company, ISBN-13: 9788120414198.

REFERENCE BOOKS

1. M. L. Gambhir, (2009), Design of Reinforced Concrete Structures, First Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120331938.
2. Krishna Raju, (2004), Pre-stressed Concrete (Problems and Solutions), Second Edition, CBS Publishers & Distributors, ISBN-13: 9788123902174.

COURSE CONTENT

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Unit I:Pipe design 8 lecture hours Design of Pipes - Structural design of concrete - Pre-stressed concrete steel and cast iron piping mains - Sewerage tanks design - Anchorage for pipe – Massive outfalls – Structural design and laying – Hydrodynamic considerations.
Unit II: Water tank design 8 lecture hours Analysis and design of water tanks - Design of concrete roofing systems using cylindrical, spherical and conical shapes using membrane theory and design of various types of folded plates for roofing using concrete - IS Codes for the design of water retaining structures.
Unit III: Economic analysis 8 lecture hours Design of circular, rectangular, spherical and Intze type of tanks using concrete - Design of pre-stressed concrete cylindrical tanks – Economic analysis.
Unit IV: Swimming pools 8 lecture hours Design of Special Purpose Structures - Underground reservoirs and swimming pools - Intake towers - Structural design including foundation of water retaining structures such as settling tanks, clarifloculators, aeration tanks etc. – Effect of earth pressure and uplift considerations – Selection of materials of construction.
Unit V:Mixing tank8 lecture hours Design of filter walls and clarifiers - Mixing tanks.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Experimental Stress Analysis			
Course Code	CLE568			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart knowledge about the instruments and its applications.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Know the working principle of strain gauges.
CO2	Perform the model analysis using different theorems.
CO3	Know the concepts of photo elasticity and its applications.
CO4	Understand the processes of scattered light photo elasticity.
CO5	Use the various Non-destructive testing methods.

TEXT BOOKS

1. Jindal, (2012), Experimental Stress Analysis, Pearson India, ISBN-13: 9788131759103.

REFERENCE BOOKS

1. J. Srinivas, (2012), Stress Analysis and Experimental Techniques: An Introduction, Alpha Science International Ltd, ISBN-13: 9781842657232.
2. Sadhu Singh, (2009), Experimental Stress Analysis, Khanna Publishers, ISBN-13: 9788174091826.

COURSE CONTENT

Unit I: Strain gauges **8 lecture hours**

Strain Gauges - Mechanical and optical strain gauges – Description and operation – Electrical resistance- Inductance and capacitance gauges – Detailed treatment on resistant gauges – Measurement of static and dynamic strains – Strain rosettes – Effect of transverse

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strains – Use of strain recorders and load cells.
Unit II: Model Analysis 8 lecture hours Model Analysis - Structural similitude – Use of models – Structural and dimensional analysis – Buckingham Pi Theorem – Muller Breslau's principle for indirect model analysis – Use of Begg's and Eney'sdeformeters – Moment indicators – Design of models for direct and indirect analysis.
Unit III: Two dimensional photo elasticity 8 lecture hours Two dimensional photo elasticity - Stress optic law – Introduction to polariscope – Plane and circular polariscope – Compensators and model materials – Material and model fringe value – Calibration of photo elastic materials – Isochromatic and isoclinic fringes – Time edge effects.
Unit IV: Three dimensional photo elasticity 8 lecture hours Three dimensional photo elasticity - Introduction – Stress freezing techniques – Stress separation techniques – Scattered light photo elasticity – Reflection polariscope
Unit V: Non-destructive testing8 lecture hours Miscellaneous Methods - Brittle coating method – Birefringence techniques – Moire fringe method – Non-destructive testing – Ultrasonic pulse velocity technique – Rebound hammer method – X-ray method – Gamma-ray method.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Machine Foundations			
Course Code	CLE569			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart the knowledge of dynamic behaviour of soils, effects of dynamic loads and the various design methods.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Know the basic principles of soil dynamics.
CO2	Understand the elastic properties of soil.
CO3	Learn the multi degree freedom system.
CO4	Know the mathematical models for dynamic analysis.
CO5	Understand the concepts of stiffness, damping, inertia, guide lines for design.

TEXT BOOKS

1. K. G. Bhatia, (2007), Foundations for Industrial Machines: Handbook for Practicing Engineers, D-Cad Publishers, ISBN-13: 9788190603201.

REFERENCE BOOKS

1. Srinivasulu P. and Vaidyanathan C. V., (2004), Hand Book of Machine Foundations, First Edition, Tata Education Pvt. Ltd., ISBN-13: 9780070966116.
2. Shambhu P. Dasgupta&Indrajit Chowdhury, (2009), Dynamics of Structures and Foundations: A Unified Approach: Fundamentals (Volume 1), First Edition, Taylor & Francis Publishers, ISBN-13: 9780415471459.

COURSE CONTENT

Unit I: Introduction **8 lecture hours**
Introduction: Elements of soil dynamics – Basic definitions – Importance of dynamics analysis – general requirements of machine foundations – types of machine foundation

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Unit II: Properties of soil 8 lecture hours Elastic properties of soils – Elastic deformation of soils and elastic constants - co-efficient of elastic uniform compression of soils - co-efficient of elastic non-uniform compression of soil, co-efficient of elastic uniform shear of soil, effect of vibration on the dissipatice properties of soil, effect of vibration on the porosity and hydraulic properties of soils, elements of the theory of residual settlements of decrease the residual dynamic settlement of foundations
Unit III: Design parameters 8 lecture hours Theory of massive machine foundation – theory of single and multi degree freedom, system – Evaluation of Design parameters – vertical vibrations of foundations, rocking, vibration of foundations, vibration of pure shear, vibration of foundations accompanied by simultaneous rotations
Unit IV: Block foundation 8 lecture hours Analysis and Design of foundation - models of vibration of block foundation – method of analysis for block foundation, design procedure from block foundations – relevant code for design of foundation, foundations for impact load and cyclic load – design data – Barker's Empirical procedures, analog models for dynamic analysis of single pile. Dynamic bearing capacity, earth pressure, dynamic soil structure interaction
Unit V: Vibration isolation 8 lecture hours Vibration isolation – active and passive types of isolation – methods of isolation in machine foundation – properties of isolating materials – guide lanes for design and construction details of machine foundation

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Maintenance & Rehabilitation of Structures			
Course Code	CLE661			
Prerequisite	Concrete Technology			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject imparts a broad knowledge in the area of repair and rehabilitation of structures

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand the properties of fresh and hardened concrete.
CO2	Know the strategies of maintenance and repairing.
CO3	Get an idea of repairing techniques.
CO4	Understand the properties of repairing materials.
CO5	Know about weathering wear, fire leakage and marine exposure.

TEXT BOOKS

1. Shetty M. S., (2008), Concrete Technology, Seventh Edition, S. Chand & Company Ltd.ISBN-13: 9788121900034.

REFERENCE BOOKS

1. Ravindra K. Dhir, M. Roderick Jones & Li Zheng, (2005), Repair and Renovation of Concrete Structures, American Society of Civil Engineers, ISBN-13: 9780727734051.
2. A. R. Santha Kumar, (2006), Concrete Technology, First Edition, Oxford University Press, ISBN-13: 9780195671537.

COURSE CONTENT

Unit I:Properties of concrete	8 lecture hours

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Serviceability and Durability of Structures - Quality Assurance for concrete construction - Fresh concrete properties – Strength – Permeability - Cracking - Effects due to climate – Temperature – chemicals - Wear and erosion - Design and construction errors - Corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection – Inhibitors - Resistant steels – Coatings - Cathodic protection
Unit II: Repairing materials 8 lecture hours Diagnosis and Assessment of Distress - Visual inspection – Non destructive tests – Ultrasonic pulse velocity method – Rebound hammer technique – ASTM classifications – Pullout tests – Core test
Unit III: Repairing techniques 8 lecture hours Materials for Repairing - Special concretes and mortar - Concrete chemicals - Special elements for accelerated strength gain - Expansive cement - Polymer concrete – Ferro cement, Fibre reinforced concrete - Fibre reinforced plastics.
Unit IV: Repairs to structures 8 lecture hours Techniques for Repair - Rust eliminators and polymers coatings for rebars during repair - Foamed concrete - Mortar and dry pack - Vacuum concrete - GModulee and shotcrete - Epoxy injection - Mortar repair for cracks - Shoring and underpinning.
Unit V: Example of Repairs to Structures8 lecture hours Example of Repairs to Structures - Repairs to overcome low member strength – Deflection – Cracking - Chemical disruption - Weathering wear - Fire leakage - Marine exposure

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Theory and Design of Plates & Shells			
Course Code	CLE662			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart knowledge about the behavior of plates and shells.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand the concept of thin plates.
CO2	Analyse laterally loaded circular plates.
CO3	Analyse laterally loaded thin plates.
CO4	Understand the concept of shells.
CO5	Analyse and design of doubly curved shells

TEXT BOOKS

1. G. S. Ramaswamy, (1996), Design and Construction of Concrete Shell Roofs, First Edition, CBS Publishers and distributors. ISBN-13: 9780812390995.

REFERENCE BOOKS

1. Timoshenko and Krieger, (2010), Theory of Plates and Shells, Second Edition, Tata McGraw Hill Education Pvt. Ltd., ISBN-13: 9780070701250.
2. K. Bhaskar, (2013), Plates: Theories and Applications, First Edition, Ane Books Pvt. Ltd., ISBN-13: 9789382127024.

COURSE CONTENT

Unit- I:Thin plates **8 lecture hours**

Introduction:- Assumptions in the theory of thin plates – Pure bending of Plates –Relations between bending moments and curvature - Particular cases of pure bending of rectangular plates, Cylindrical bending - immovable simply supported edges – Synclastic bending and Anticlastic bending – Limitations - Boundary conditions.

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Unit- II: Circular plates 8 lecture hours Laterally Loaded Circular Plates:- Differential equation of equilibrium – Uniformly loaded circular plates with simply supported and fixed boundary conditions – Annular plate with uniform moment and shear force along the boundaries.
Unit III: Plate bending 8 lecture hours Laterally loaded thin plates – Differential equation of plates - Navier's solution and Levy's method – Rectangular plates with various edge conditions
Unit IV: Theory of shells 8 lecture hours Types of shells – Structural action – Membrane theory – Limitations – Beam method of analysis.
Unit V: Curved shell 8 lecture hours Analysis and design of doubly curved shells – Elliptic paraboloid - Conoid and hyperbolic paraboloid roofs.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Offshore Structures				
Course Code	CLE663				
Prerequisite	-				
Corequisite	-				
Antirequisite	-				
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart knowledge about analysis and design of offshore structures.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand the effect of wind on structures.
CO2	Know about wave generation and propagation.
CO3	Calculate wave forces.
CO4	Design plat forms, derrick, jacket towers.
CO5	Learn the principles of jacketing towers.

TEXT BOOKS

1. Gerwick, (1999), Construction of Marine and Offshore Structure, Second Edition, CRC

Press, ISBN-13: 9780849374852.

REFERENCE BOOKS

1. Lymon C. Reese, Bruce J. Muga& James F. Wilson, Offshore Structures, Second Edition, John Wiley & Sons, ISBN-13: 978047121264675.
2. Templetion J. S., (2007), Offshore Technology in Civil Engineering, Hall of Fame, Papers from the Early Years, Volume-2, American Society of Civil Engineers, ISBN-13: 9780784409251.

COURSE CONTENT

Unit I: Rigid and flexible structures **8 lecture hours**
Wind on structures - Rigid structures - Flexible structures - Static and Dynamic effects.

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Unit II: Wave generation **8 lecture hours** Wave generation and Propagation - Small and finite amplitude wave theories - Wave energy and pressure distribution.
Unit III: Wave forces **8 lecture hours** Wave forces on structures - Environmental loading - Use of Morrison equation.
Unit IV: Types of structures **8 lecture hours** Loads - Design of platforms – Derricks – Helipads – Design.
Unit V:Design of platform, helipad etc8 lecture hours Principles and examples of Jacket towers - Mooring cables.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Prefabricated Structures			
Course Code	CLE664			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart the knowledge in the area of prefabricated structures.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Know the types of prefabrication systems.
CO2	Understand about handling and erection stresses.
CO3	Learn about construction and expansion joints.
CO4	Understand the process of erection of R.C. structures.
CO5	Design pre fabricated modules.

TEXT BOOKS

1. Hass, A. M., (1995) Precast concrete Design and Applications, Applied Science Publishers, England.

REFERENCE BOOKS

1. Promyslov, V. (1998), Design and Erection of Reinforced concrete structures, MIR Publishers, Moscow.ISBN: 0719024323.
2. Levit, M., (2000), Precast concrete materials, Manufacture properties and usage, Applied Science Publishers, London. ISBN 0-203-79881-3.

COURSE CONTENT

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Unit I:Introduction 8 lecture hours Types of foundation - Modular co-ordination – Components - Prefabrication systems and structural schemes - Design considerations - Economy of prefabrication - Prefabrication of load-carrying members - DisModuleing of structures - Structural behaviour of pre cast structures.
Unit II: Handling and erection stresses 8 lecture hours Handling and erection stresses - Application of pre stressing of roof members - Floor systems - Two way load bearing slabs - Wall panels
Unit III: Dimensioning and detailing of joints 8 lecture hours Dimensioning and detailing of joints for different structural connections - Construction and expansion joints.
Unit IV: Erection of structures 8 lecture hours Production - Transportation and Erection - Organising of production - Storing and erection equipment - Shuttering and mould design - Dimensional tolerances, Erection of R.C. structures, Total prefabricated buildings
Unit V:Design of pre fabricated Modules8 lecture hours Prefabricated Modules for Industrial structures - Multi-storied buildings and Water tanks - Application of pre stressed concrete in prefabrication

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	**Pre-stressed Concrete Structures**				
Course Code	**CLE665**				
Prerequisite	Reinforced Concrete Structures				
Corequisite	-				
Antirequisite	-				
	L	**T**	**P**	**C**	
	3	0	0	3	

COURSE OBJECTIVES

1. This subject is taught to give the concepts of pre-stress.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Know the concepts, methods and materials of pre-stressing systems.
CO2	Design the pre-stressed concrete members.
CO3	Calculate the deflections in pre-stressed concrete members.
CO4	Design anchorage zones and composite pre-stressed concrete members.
CO5	Know the concepts of pre-stressed concrete beams.

TEXT BOOKS

1. Krishna Raju.N, (2004), Pre stressed Concrete, Third Edition, Tata McGraw Hill Co

REFERENCE BOOKS

1. Rajagopal.N, (2005), Prestressed Concrete, Second Edition, Narosa Publishing House. ISBN 13, : 9788173195433

2. Dayarathnam P, (2004), Prestressed Concrete Structures, S.Chand Publishers.

3. Sinha.N.C and Roy.S.K, (2000), Fundamentals of Pre-stressed Concrete, S.Chand& Company.

COURSE CONTENT

Unit I:Materials and losses in pre stress	**8 lecture hours**
Difference between reinforced and pre-stressed concrete – Principles of pre-stressing –	

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Methods and systems of pre-stressing – Principles of pre-stressing – Classification of pre-stressed concrete structures – Materials – High strength concrete and High strength steel – Stress-strain diagram - Losses in pre-stress.
Unit II: Design of pre-stressed concrete beams 8 lecture hours Design of prismatic pre-stressed concrete members for bending at service load.
Unit III: Deflections 8 lecture hours Simple cable profiles – Calculation of deflections – Design of beams for shear and torsion at working and ultimate loads.
Unit IV: Anchorage design 8 lecture hours Design of Anchorage zone by Guyon's method – Concept of Magnel's method – IS:1343 recommendations.
Unit V: Composite prestressed concrete beams 8lecture hours Pre-stressed concrete beams – Design procedure – Calculation of stresses at important stages both for propped and unpropped constructions – Shrinkage stresses - Statically indeterminate structures – Concept of concordant cable and profile – Sketching of pressure lines for continuous beams.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Soil Structure Interaction			
Course Code	CLE666			
Prerequisite	Geotechnical Engineering			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart knowledge on soil structure interaction analysis, its influences in the design parameters.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand the concept of different soil models.
CO2	Calculate modulus of subgrade for different types of soil.
CO3	Carry out soil structure interaction for shallow foundation.
CO4	Do the elastic analysis of piles and pile groups.
CO5	Know non-linear soil properties.

TEXT BOOKS

1. Desai, C. and Christian, I.T., (2003), Numerical methods in Geo-technical Engineering,
   Khanna Publishers ISBN-978-3-642-01461-1.

REFERENCE BOOKS

1. Selvadurai A.P.S., Elastic Analysis-Soil foundation interaction.ISBN 13: 9780444416636

2. Hetenyi, M; Beams on elastic foundation. ISBN: 0472084453
3. Baker, A.L.L. Raft foundation, The Soil line method of design ISBN 10: 8122410782
4. Nainan P. Kurian, Design of foundation systems (Narosa) ISBN: 978-81-7319-939-4
5. Structure –Soil interaction – State of art report, Institute of Structural Engineers, 1978
6. ACl-336 suggested Analysis and design practice, for combined footings and mats. American Concrete Institute, Delhi - 1988.

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7. Poulous, H.G. and Davis, E.H, Pile foundation analysis and design, John Wiley, 1980. ISBN 10: 0471020842

COURSE CONTENT

Unit I:Mathematical model, Winkler model, Two parameter model 8 lecture hours Soil models: single parameter model (Winkler), two parameter models – Filonenko - Borodich model, Pasternak model, Heteni model, visco elastic model, elastic continuum model, contact pressure distribution below the flexible and rigid footing and. raft parameter affecting conduct pressure.
Unit II: Modulus of subgrade, reaction 8 lecture hours Contact pressure and subgrade modulus and beams on elastic foundation method - analysis of contact pressure distribution – modulus of subgrade reaction – classical solution for beam of infinite length subjected to concentrated load and moment, beams of finite length (formulation of basic equation for slabs resting on elastic foundation), Application of design of combined footing.
Unit III: Beams and slabs 8 lecture hours Plates in elastic medium – soil structure interaction for shallow foundation – interface behaviour - Thin and thick plates – analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates, simple solutions, Baker's method for rafts.
Unit IV: Analysis of piles 8 lecture hours Soil pile interaction : Introduction – elastic analysis of single pile, theoretical solutions for settlement and load distribution analysis of pile group interaction analysis – Load distribution with groups with rigid cap – elastic continuum and elasto-plastic analysis of piles and pile groups (Ultimate lateral resistance of piles by various approaches).
Unit V:Pile displacement8 lecture hours Laterally loaded pile and piled raft: Non-linear load – deflection response P-Y reactions, non-linear soil properties lift capacity of piles and anchors, Piles raft system – soil structure interaction in framed structures. FEM modules use of approximately software packages

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	**Stability of Structures**			
Course Code	**CLE667**			
Prerequisite	Structural analysis			
Corequisite	-			
Antirequisite	-			
	L	**T**	**P**	**C**
	3	0	0	3

COURSE OBJECTIVES

1. This subject is taught to impart the knowledge in the area of stability of structures.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand the behaviour of columns.
CO2	2. Learn the theory of the beam columns.
CO3	3. Analyse the frame stability.
CO4	4. Understand the concept of plate buckling.
CO5	5. Understand the concept of buckling of shells.

TEXT BOOKS

1. Aswini Kumar, (2002), Stability theory of structures, Tata McGraw Hill Publishing Co.
   Limited, New Delhi.

REFERENCE BOOKS

1. Timoshenko & Gere (2000), Theory of Elastic Stability, McGraw Hill. **ISBN**-13: 978-0-486-47207-2
2. N.G.R. Iyengar (1996), Structural Stability of Columns and Plates, Affiliated East West Press, **ISBN** 81-85814-24-4. 3.

COURSE CONTENT

Unit I :Column analysis	**8 lecture hours**
Introduction - Static equilibrium – Governing equation for columns – Analysis for various boundary conditions - Analysis of Eccentrically loaded column.	

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Unit II: Beam column analysis **8 lecture hours** Beam Columns – Theory of Beam column – Stability analysis of beam column with different types of loads – Failure of beam columns.
Unit III: Frames stability **8 lecture hours** Analysis and stability of frames
Unit IV: Plates **8 lecture hours** Plates subjected to inplane forces - Differential equation – Analysis – Approximate techniques - Analysis for various boundary conditions – Wood and Armer equation for analysis and design.
Unit V: Shells **8 lecture hours** Buckling of shells – Differential equation – Analysis – Application

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Structural Optimization			
Course Code	CLE668			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

1. This course is intended to teach the importance of Optimization problems in the Structural Engineering.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Understand the concepts of Optimization problems in the Structural Engineering.
CO2	Know the different methods for the Optimization problems.
CO3	Understand the concepts of Linear and Non-Linear Programming techniques.
CO4	Understand the concepts of Stochastic Optimization Methods.
CO5	Understand the concepts of Genetic Algorithm based Optimization Methods.

TEXT BOOKS

1. S.S.Rao, (1996), Engineering Optimization: Theory and Practice, Third Edition, John Wiley &Sons,Inc.ISBN 0-471-55034-5

REFERENCE BOOKS

1. Smith, D. R., "Variational Methods in Optimization," Dover Publications, 1998. ISBN, 0486404552,
2. Haftka, R. T. and Gurdal, Z., "Elements of Structural Optimization," Kluwer Academic Publishers, 1992. ISBN, 0792315049
3. Bendsoe, M. P. and Sigmund, O., "Topology Optimization: Theory, Methods, and Applications," Springer, 2003. ISBN-10: 3540429921

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COURSE CONTENT

Unit I:Formulation of Structural Optimization problems. 8 lecture hours Formulation of Structural Optimization problems: Design variables - Objective function - constraints. Fully stressed design.
Unit II: Linear Programming techniques 8 lecture hours Review of Linear Algebra: Vector spaces, basis and dimension, canonical forms.
Unit III: Non-Linear Programming techniques 8 lecture hours Linear Programming: Revised Simplex method, Application to structural Optimization.
Unit IV: Stochastic Optimization Methods 8 lecture hours Nonlinear Programming: Deterministic Methods_ Unconstrained and constrained Optimization - Kuhn-Tucker conditions, Direct search and gradient methods - One dimensional search methods - DFP and BFGS algorithms, constrained Optimization - Direct and Indirect methods - SLP, SQP and SUMT, Application of NLP methods to optimal structural design problems. Optimality criteria based methods, Reanalysis techniques - Approximation concepts - Design sensitivity Optimization of sections, steel and concrete structures - framed structures, bridge structures.
Unit V: Genetic Algorithm based Optimization Methods 8 lecture hours Genetic Algorithm based Optimization Methods

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Name of The Course	Composite Structures				
Course Code	CLE669				
Prerequisite	-				
Corequisite	-				
Antirequisite	-				
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To know the types of composites
2. To understand the need for stress strain relation
3. To understand the fabrication methods
4. To understand the laminated plates
5. To study and understand the different methods & analysis of composite materials.

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1	Analyze composite structures
CO2	Do microscopic and macroscopic analysis
CO3	Analyze sandwich and laminated plates
CO4	Understand the failure criteria for composites.
CO5	Know the fabrication techniques

TEXT BOOKS

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1. Calcote, L R. “The Analysis of laminated Composite Structures”, Von – Noastrand Reinhold Company, New York 1991.ISBN0-324-06680-5
2. Jones, R.M., “Mechanics of Composite Materials”, McGraw-Hill, Kogakusha Ltd., Tokyo, 1915.ISBN 81-297-0277-0

REFERENCE BOOKS

1. Agarwal, B.D., and Broutman, L.J., “Analysis and Performance of Fibre Composites”, John Wiley and sons. Inc., New York. ISBN 0-324-06680-5
2. Lubin, G., “Handbook on Advanced Plastics and Fibre Glass”, Von Nostrand Reinhold Co., New York.ISBN 0-324-06680-5
3. J. N. Reddy, “Mechanics of Laminated Composite Plates and Shells - Theory and Analysis”, CRC Press (USA) ISBN 9780849315923

COURSE CONTENT

Unit I: Stress Strain Relationship 8 lecture hours Introduction - advantages and application of composite materials, reinforcements and matrices - Generalised Hooke’s Law - Elastic constants for anisotropic, orthotropic and isotropic materials.
Unit II: Finite Element Analysis of Plates 8 lecture hours Introduction - concept of mesh - Displacement function - Stress-Strain Matrix – Stiffness matrix of plate element – Solution of problem
Unit III: Methods of Analysis 8 lecture hours Micro mechanics - Mechanics of materials approach, elasticity approach to determine material properties - Macro Mechanics - Stress-strain relations with respect to natural axis, arbitrary axis - Determination of material properties - Experimental characterization of lamina.
Unit IV: Laminated Plates 8 lecture hours Governing differential equation for a general laminate, angle ply and cross ply laminates - Failure criteria for composites.
Unit V: Sandwich Constructions, Fabrication Process 8lecture hours Basic design concepts of sandwich construction - Materials used for sandwich construction - Failure modes of sandwich panels - Various Open and closed mould processes - Manufacture of fibers - Types of resins and properties and applications – Netting analysis.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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