SHIV NADAR

INSTITUTION OF EMINENCE DEEMED TO BE UNIVERSITY

DELHI NCR

BTech Civil Engineering

Priorities for our new curriculum

Our curriculum transformation is guided by four strategic priorities that reflect the evolving demands of engineering education and industry needs. These foundational principles ensure our graduates emerge as innovative, adaptable professionals ready to lead in a rapidly changing technological landscape.

- **Hands-On Learning**
- **Interdisciplinary Systems**
- **Critical Thinking**
- **Emerging Technologies**

Proposed Curriculum (2025 onwards)

Total credits	**163**
Credit breakup	
Core	79
Electives	24
Experiential Learning	8
CCC/UWE	40
Project	12

Specializations offered – (Applicable for 2025 batch onwards)

- **Specialization 1** - Sustainable Infrastructure Systems
- **Specialization 2** - Water, Environment and Climate
- **Specialization 2** - Urban Network Systems

Program Structure | Civil Engineering

Semester 1 (20 credits)				
Course Code	**Title**	**Credits**	**Category**	**Prerequisites**
Not Assigned	Fields, Waves & Quanta	5	Core	NA
Not Assigned	Multivariate Calculus	4	Core	NA
Not Assigned	Problem solving using Programming	4	Core	NA
Not Assigned	The Electron's Path: Fundamentals of EEE	3	Core	NA
Not Assigned	Nature's Code: Chemistry & Biology	2	Core	NA
Not Assigned	Introduction to Engineering: Ideas to Impact	2	Experiential Learning	NA

Semester 2 (18 credits)				
Course Code	**Title**	**Credits**	**Category**	**Prerequisites**
Not Assigned	Environmental & Sustainability (CCC)	4	CCC	NA
Not Assigned	Linear Systems and Transforms	4	Core	NA
Not Assigned	Forces in Action	3	Core	NA
Not Assigned	Connected Intelligence: Sensors and IoT	3	Core	NA
Not Assigned	The Matter of Materials	2	Core	NA
Not Assigned	Design to Reality: CAD & 3D Printing	2	Experiential Learning	NA

Semester 3 (24 credits)				
Course Code	**Title**	**Credits**	**Category**	**Prerequisites**
	CCC/UWE	8	CCC/UWE	
CED214	Building Information Modelling	2	Core	
CED215	Mechanics of Solids	4	Core	
CED216	Mechanics of Fluid	4	Core	
CED324	Programming for Data Analytics	3	Core	
CED222	Elements of Surveying	3	Core	

Semester 4 (24 credits)				
Course Code	**Title**	**Credits**	**Category**	**Prerequisites**
	CCC/UWE	7	CCC/UWE	
CED203	Engineering Hydrology	2	Core	
CED207	Hydraulic Engineering	3	Core	
CED219	Concrete Technology	3	Core	
CED220	Structural Analysis	3	Core	

CED310	Introduction to Remote Sensing and GIS	3	Core	
CED325	Geotechnical Engineering	3	Core	

Semester 5 (24 credits)				
Course Code	**Title**	**Credits**	**Category**	**Prerequisites**
	CCC/UWE	6	CCC/UWE	
CED304	Transportation Engineering	4	Core	
CED305	Design of RCC Structures	3	Core	
CED306	Foundation Analysis and Design	3	Core	
CED326	Water Resource Engineering	2	Core	
CEDxxx	Major Elective I	3	Elective	
CEDxxx	Major Elective II	3	Elective	

Semester 6 (24 credits)				
Course Code	**Title**	**Credits**	**Category**	**Prerequisites**
	CCC/UWE	7	CCC/UWE	
CED308	Environmental Engineering	4	Core	
CEDxxx	Major Elective III	3	Elective	
CEDxxx	Major Elective –IV	3	Elective	
	Integrated Design Practicum	4	Experiential Learning	
CEDxxx	Project-I	3	Project	

Semester 7 (20 credits)				
Course Code	**Title**	**Credits**	**Category**	**Prerequisites**
	CCC/UWE	5	CCC/UWE	
CEDxxx	Major Elective –V	3	Elective	
CEDxxx	Major Elective –VI	3	Elective	
CEDxxx	Major Elective –VII	3	Elective	
CED444	Project-II	6	Project	

Semester 8 (9 credits)				
Course Code	**Title**	**Credits**	**Category**	**Prerequisites**
	CCC/UWE	3	CCC/UWE	
CEDxxx	Major Elective –VIII	3	Elective	
CED419	Project III	3	Project	

List of Courses

List of courses in Experiential Learning category

Course code	Title	Credits	Semester	Prerequisites
	Introduction to Engineering	2	1	
	Practicum: CAD and 3D Printing	2	2	
	Integrated Design Practicum	4	6	
	Total:	8		

List of courses in Core category

Course code	Title	Credits	Semester	Prerequisites
	Engineering Physics	5	1	
	Engineering Mathematics I	4	1	
	Introduction to Programming	4	1	
	Basics of Electrical & Electronics Engineering	3	1	
	Materials for Engineers	2	1	
	Engineering Mathematics II	4	2	
	Engineering Mechanics	3	2	
	Sensors and IoT Applications	3	2	
	Engineering Chemistry & Biology	2	2	
CED214	Building Information Modelling	2	3	
CED215	Mechanics of Solids	4	3	
CED216	Mechanics of Fluid	4	3	
CED…	Programming for Data Analytics	3	3	
CED222	Elements of Surveying	3	3	
CED203	Engineering Hydrology	2	4	
CED207	Hydraulic Engineering	3	4	
CED219	Concrete Technology	3	4	
CED220	Structural Analysis	3	4	
CED…	Introduction to Remote Sensing and GIS	3	4	
CED…	Geotechnical Engineering	3	4	
CED304	Transportation Engineering	4	5	
CED305	Design of RCC Structures	3	5	
CED306	Foundation Analysis and Design	3	5	
CED326	Water Resource Engineering	2	5	
CED308	Environmental Engineering	4	6	
	Total:	79		

List of electives:

Course code	Title	Credits	Prerequisites
CED…	Risk and Reliability Analysis	3	
CED…	System Analysis in Civil Engineering	3	
CED…	Transportation Engineering – II	3	
CED…	Watershed Management	3	
CED…	Environmental Management in Industries	3	
CED…	Machine Learning for Civil Engineering	3	
CED…	Data Analytics for Civil Engineering	3	
CED…	Digital Design and Construction through BIM	3	
CED401	Design of Steel Structures	3	
CED402	Statistics in Engineering	3	
CED403	Pavement Design	3	
CED404	Photogrammetry and GPS	3	
CED405	Air Quality Science and Engineering	3	
CED406	Analysis of Tall Building	3	
CED407	Transportation Systems	3	
CED408	Spatial Analysis and Digital Image Processing	3	
CED409	Geotechnical Earthquake Engineering	3	
CED411	Earthquake Engineering	3	
CED413	Biological Process in Environmental Engineering	3	
CED420	Building Physics	3	
CED421	Public Transport Systems	3	
CED424	Estimation, Costing, and Project Management	3	
CED426	Transport Infrastructure	3	
CED431	Hydropower Engineering	3	
CED432	Mechanics of Geomaterials	3	
CED433	Physio-chemical Processes Environmental Engineering	3	
NA	Introduction to Finite Element Analysis	3	
NA	Bridge Design	3	
NA	Advanced RCC Design	3	
NA	Urban Drainage System	3	
NA	Introduction to Climate Science	3	
NA	Urban Drainage System	3	

Areas of Specialization

The students enrolled in B. Tech. Civil Engineering (4 year) would have an option to specialize in one the following emerging areas-

1. Specialization 1 - Sustainable Infrastructure Systems
2. Specialization 2 - Water, Environment and Climate
3. Specialization 3 - Urban Network Systems

Minimum Requirement for Specialization:
Suggested CGPA - 6.5
The student must complete minimum of 12 credits from the list of elective courses from the chosen specialization bucket. At the time of graduation (end of 8th semester before convocation), students who have completed the specialization requirement may apply for a specialization in CED to UG advisor for further processing. A student can apply for a specialization in only one of the mentioned areas.

List of Elective courses in specialization buckets - *Sustainable Infrastructure System*

Course code	Title	Credits	Prerequisites
CED401	Design of Steel Structures	3	
CED406	Analysis of Tall Building	3	
CED409	Geotechnical Earthquake Engineering	3	
CED411	Earthquake Engineering	3	
CED420	Building Physics	3	
CED432	Mechanics of Geomaterials	3	
NA	Introduction to Finite Element Analysis	3	
NA	Bridge Design	3	
NA	Advance RCC Design	3	

List of Elective courses in specialization buckets - Water, Environment and Climate

Course code	Title	Credits	Prerequisites
CED…	Watershed Management	3	
CED…	Environmental Management in Industries	3	
CED404	Photogrammetry and GPS	3	
CED405	Air Quality Science and Engineering	3	
CED408	Spatial Analysis and Digital Image Processing	3	
CED413	Biological Process in Environmental Engineering	3	
CED431	Hydropower Engineering	3	
NA	Urban Drainage System	3	
NA	Introduction to Climate Science	3	
CED433	Physio-Chemical processes in Environmental engg.	3	

List of Elective courses in specialization buckets - Urban Network Systems

Course code	Title	Credits	Prerequisites
CED…	Transportation Engineering – II	3	
CED403	Pavement Design	3	
CED404	Photogrammetry and GPS	3	
CED407	Transportation Systems	3	
CED421	Public Transport Systems	3	
CED426	Transport Infrastructure	3	
NA	Urban Drainage System	3	

Areas of Interdisciplinary Specialization

The students enrolled in B. Tech. Civil Engineering (4 year) would have an option to specialize in one the following interdisciplinary areas-

1. Computational Mechanics

Minimum Requirement for Specialization:

Suggested CGPA - 12

The student must complete minimum of 12 credits from the list of elective courses from the chosen specialization bucket. At the time of graduation (end of 8th semester before convocation), students who have completed the specialization requirement may apply for a specialization in CED to UG advisor for further processing. A student can apply for a specialization in only one of the mentioned areas.

List of Elective courses in specialization buckets - Computational Mechanics

Prerequisites – Fundamental knowledge of the following courses:

- Engineering Mechanics, Strength of Materials/Mechanics of Solids, and Mechanics of Fluids

Course code	Title	Compulsory (Yes/No)	Offering Department
	Modelling and Simulation for Engineering System	Yes	CHED
	Finite Element Method/ Computational Fluid Dynamics	Yes	CED/MED
	Fracture Mechanics	No	CED
	Continuum Mechanics	No	CED
	Molecular Simulation	No	CHED
	Advance Mechanics of Composite	No	CHED/MED
	Optimization Method for Engineering Process & Design	No	CHED
	Multi-Phase Flow	No	MED
More relevant courses may be added by other SoE departments			

Course Description
Core Courses

Add contents in the Course Proposal Form template provided by Dean's office below for each course

Course title: Mechanics of Solids

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	**Department of Civil Engineering**
3. Course Code	**CED215**
4. Course Title	**Mechanics of Solids**
5. Credits (L:T:P)	**3:0:1**
6. Contact Hours (L:T:P)	**3:0:2**
7. Prerequisites	**CED101; Engineering Mechanics**
8. Major Core for	**Civil Engineering**
9. Major Elective for	

PART B: OBJECTIVES AND PRACTICE

Course Summary:

The objective of this course is to provide in depth knowledge of mechanics of deformable bodies to the students. This course gives the students an opportunity to learn important concepts as stress, strain, mechanical behaviour of engineering materials, constitutive relationships, and strain energy; which are required to analyse and design the structural systems. It also provides the knowledge to use these concepts to determine deflection of beams and analyse buckling of columns. Apart from these, it serves the purpose to prepare a good foundation for taking up advanced courses in structural analysis and design of structures in the subsequent semesters.

1. Course aims

The main aims of this course are:

1. To understand the inter relationship between different type of loads, deformations, stresses and strains
2. Apply the concepts to analyse the behaviour of materials and structural components

2. Learning outcomes

On successful completion of the course, students will be able to achieve the following:

L01: Analyse and design the basic structural elements under tension, compression, shear, bending and torsion.

L02: Analyse the stress and strain fields in the deformable bodies under axial load, torsion, and bending. L03:

Understand failure of components due to buckling, shear, crushing and yielding.

L04: Draw Shear force and Bending moment diagrams for determinate beams. L05:

Analyze state of stress and strain under multi-axial loading.

L06: Determine deflection of beam under bending.

3. Curriculum content:

Module 1: Introduction to Mechanics of Deformable Bodies

A Short Review of Methods of Statics, Forces and Moments Transmitted by Slender Members: Differential Equilibrium Relationships, Singularity Functions and Three Dimensional Problems, Normal Stress and

Strain, Shear Stress and Strain, Bearing Stress in Connections, Stress on an Oblique Plane under Axial Loading Conditions, Stress under General Loading Condition, Allowable Stresses and Allowable Loads, Design for Axial Loads and Direct Shear, Statically Determinate Structures, Statically Indeterminate Structures

Module 2: Concept of Stress and Strain

Traction Vector, Stress Tensor, Plane Stress, Equilibrium of a Differential Element in Plane Stress, Stress Components Associated with Arbitrarily Oriented Faces in Plane Stress, Mohr's Circle Representation of Plane Stress, Mohr's Circle Representation of a General State of Stress, Analysis of Deformation, Definition of Strain Components, Relation Between Strain and Displacement in Plain Strain, Strain Components Associated with Arbitrary Sets of Axes, Mohr's Circle Representation of Plane Strain, Mohr's Circle Representation of General State of Strain, Measurement of Strains

Module 3: Constitutive Relationships

The Tensile Test, Idealizations of Stress-Strain Curves, Elastic Stress-Strain Relations, Thermal Strain, Complete Equation of Elasticity, Strain Energy in an Elastic Body, Stress Concentration, Anisotropic Elasticity, Criteria for Initial Yielding, Behaviour Beyond Initial Yielding, Introduction to Fracture and Fatigue, Plasticity and Creep

Module 4: Torsion

Torsional Deformations of a Circular Bar, Circular Bars of Linearly Elastic Materials, Non- uniform Torsion, Stresses and Strains in Pure Shear, Transmission of Power by Circular Shafts, Statically Indeterminate Torsional Members, Strain Energy in Torsion and Pure Shear, Thin-Walled Tubes.

Module 5: Stress Due to Bending

Bending Deformations of a Symmetrical Beam, Pure Bending and Non uniform Bending, Curvature of a Beam, Longitudinal Strains in Beams, Normal Stresses in Beams (Linearly Elastic Materials), Design of Beams for Bending Stresses, Non prismatic Beams, Shear Stresses in Beams of Rectangular Cross Section, Shear Stresses in Beams of Circular Cross Section, Shear Stresses in the Webs of Beams with Flanges, Built-Up Beams and Shear Flow, Beams with Axial Loads, Stress Concentrations in Bending, Bending of Unsymmetrical Beams, The Shear-Center Concept

Module 6: Deflections of Beams

Differential Equations of the Deflection Curve, Deflections by Integration of the Bending- Moment Equation, Deflections by Integration of the Shear-Force and Load Equations, Method of Superposition, Moment-Area Method, Nonprismatic Beams, Strain Energy in Bending, Castigliano's Theorem, Types of Statically Indeterminate Beams, Analysis by the Differential Equations of the Deflection Curve, Method of Superposition, Temperature Effects

Module 7: Stability of Equilibrium: Buckling of Column

Buckling and Stability, Columns with Pinned Ends, Columns with Other Support Conditions Columns with Eccentric Axial Loads, The Secant Formula for Columns, Elastic and Inelastic Column Behaviour, Inelastic Buckling, Design Formulas for Columns

LAB EXPERIMENTS:

The list of the experiments are:

1. *Verification of Varignon's theorem*- verification of varignon's principal of moments
2. *Tensile test of mild steel rod* - To find yield strength, ultimate strength, breaking strength, and Young's modulus (E).
3. *Compression test* - To find the compressive strength of a material, and identify failure patterns.
4. *Shear strength test* - To find the shear strength of specimens, and identify failure patterns.
5. *Torsion test* - To find the modulus of rigidity
6. *Spring test* - To find the stiffness and modulus of rigidity of a spring
7. *Impact test* - To find the impact strength of steel (Izod and Charpy)
8. *Hardness test* - To find the Brinell's and Rockwell's hardness number
9. *Deflection test on beams*- To find deflection due to loads acting at different locations and due to varying amounts of load and boundary conditions.
10. *Column Buckling Test*- To find buckling load of compression member under various boundary conditions

4. Bibliography

5. F. P. Beer and E. R. Johnston, Mechanics of Materials, Tata McGraw Hill

6. R.C. Hibbeler, Mechanics of materials, Tenth edition in SI units, Pearson Education

7. James M. Gere and Barry J. Goodno, Mechanics of Materials, 7th Edition, Cengage Learning

8. Stephan H. Crandall and Norman C. Dahl, An Introduction to The Mechanics of Solids,McGraw Hill

Course title : Computational Methods

PART A: COURSE IDENTIFIERS

1. School	School of Engineering
2. Department	Civil Engineering
3. Course Code	CED217
4. Course Title	Computational Methods
5. Credits (L:T:P)	2:0:1
6. Contact Hours (L:T:P)	2:0:1
7. Prerequisites	MAT103 & MAT104
8. Major Core for	Civil Engineering
9. Major Elective for	

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

This is the first course on computational methods to teach mathematical modelling and numerical analysis. It covers approximation and error, computational methods for linear algebra, solution of nonlinear equations, and numerical differentiation and integration. In addition to this, Python programming language is also part of this course which will be used for implementing the algorithm in the computer programming.

11. Course Aims

The objective of this course is to provide an introduction of computational methods to the students. This course gives the students an opportunity to learn mathematical modelling of physical systems and to learn various algorithms to solve the engineering problems using computers. It also serves the purpose to prepare a good foundation for taking up advanced courses in computational methods, such as, finite element method, computational fluid dynamics, Optimization Methods, etc., in the subsequent semesters.

12. Learning Outcomes

Upon successful completion of the course, student should be able

- to understand the role of mathematical modelling in engineering application
- to understand the deeper concepts of commonly used algorithms in computational methods
- to write the computer program and to implement the algorithms to solve various engineering problems

13. Curriculum Content

Module 1: **Introduction**

Mathematical Modelling and Engineering Problem Solving, Approximations and round-off errors, Significant figures, Accuracy and precision, Errors, Round-Off errors, Error propagation and condition number of a problem, condition number of an algorithm, Truncation errors and the Taylor series.

Module 2: **System of Linear Equations**

Introduction, The Guass elimination method, Pivoting, Ill conditioned equations, Refinement of the solution obtained by Guass elimination, The Guass-Seidel iterative method, An algorithm to implement the Guass-Seidel method, Comparison of direct and iterative methods

Module 3: **Solving Non-Linear Equations**

Introduction, solving equation using an iterative method, the method of successive bisection, The method of false position, Newton-Raphson iterative method, The secant method, The method of successive approximations, Comparison of iterative methods, Solving polynomial equations, Solving simultaneous nonlinear equations

Module 4: **Differentiation and Integration**

Introduction, Numerical differentiation, Numerical integration, Simpson's rule, Truncation Error in integration formulae, Algorithms for integration of tabulated function, Algorithms for integrating a known function, Gaussian quadrature formulae, Comparison of integration formulae

LAB EXPERIMENTS:

The list of the experiments are:

1. Getting Started with Python
2. Data Types in Python
3. Numpy for Multidimensional Array
4. Decision and Iteration in Python
5. Function
6. Writing Program for Gauss Elimination and LU Decomposition
7. Writing Program for Solving Nonlinear Equations

Writing Program for Numerical Differentiation and Integration

14. Bibliography

1. V. Rajaraman (2018), Computer Oriented Numerical Methods, 4th Edition, Prentice Hall

2. Steven C. Chapra and Raymond P Canale (2015), Numerical Methods for Engineers, 7th Ed, McGraw Hill

3. Jaan Kiusalaas (2010), Numerical Methods in Engineering with Python, 2nd Ed, Cambridge University Press

Course title : Concrete Technology

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	**Civil Engineering**
3. Course Code	**CED 219**
4. Course Title	**Concrete Technology**
5. Credits (L:T:P)	**2-0-1**
6. Contact Hours (L:T:P)	
7. Prerequisites	**Not Applicable**
8. Major Core for	**Civil Engineering**
9. Major Elective for	**Open to All**

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

This course explores the materials science of concrete and attempts to bring about the understanding of concrete behaviour from a fundamental perspective. It will cover the basic composition, properties and applications of common building materials. This course will primarily emphasize on how manufacturing processes and material chemistry affect the properties and the characteristics of cement concrete and its future performance. It will help the students to gain knowledge on materials testing and performance evaluation for concrete buildings and other building materials

11. Course Aims

The main aims of this course are:

- Clearly understand the relevant concrete technology for civil infrastructure development
- Perform suitable tests on a range of concrete design mixes using Portland cement and local aggregates
- Apply knowledge of the principal properties of the components of normal Portland cement concrete and special concrete mixes

Identify the chemical or physical process of concrete structures durability concerns and design their service life.

12. Learning Outcomes

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

- Gain knowledge about the properties of cement, concrete and special concretes.
- Perform the process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible.
- Distinguish basic principles of the experimental methods and techniques in concrete materials, their advantages and limitations.
- Perform experimental tests using devices related to the laboratory and "in-situ" tests.
- Describe the performance of concrete materials and elements using different test methods.

13. Curriculum Content

1. Concrete Materials

Introduction basic building material and systems. Types of material, Brick & Brick masonry, Lime, and Other miscellaneous materials ***Cement*** *: cement production, composition, and*

properties; cement chemistry; Types of cements; special cements. ***Aggregates:*** *mineralogy; properties, types of aggregates tests and standards. Brief idea about laboratory tests meant for cement and aggregate.*

2. Chemical and mineral admixtures:

Admixtures *- structure properties, and effects on concrete properties. Introduction to supplementary cementing materials and pozzolans. Fly ash, blast furnace slag, silica fume, and metakaolin - their production, properties and effects on concrete properties. Other mineral additives - reactive and inert, water reducers, air entrainers, set controllers.*

3. Concrete Mix Design

Mix Design - factors influencing mix proportion - Mix design by ACI method and I.S. code. method - Design of high strength concrete.

4. Properties of fresh and hardened concrete

Workability, Factors affecting workability, type of tests. Water cement ratio, gain of strength with age, effect of maximum size of aggregate, relationship between compressive and tensile, strength, high strength concrete, high performance concrete. Elasticity, shrinkage and creep of concrete.

5. Durability of concrete

Introduction to durability; relation between durability and permeability. Chemical attack of concrete; corrosion of steel rebars; other durability issues.

6. Special concrete

Lightweight concrete. high density concrete, hot weather and cold weather concreting, polymer concrete.

LAB EXPERIMENTS:

The list of the experiments are:

CEMENT

- Fineness of cement
- Specific surface area of cement grain
- Normal consistency of cement
- Initial setting time and final setting time of cement.
- Specific gravity test of cement
- Soundness of cement
- Compressive strength of cement mortar
- Tensile strength of cement mortar

AGGREGATE

- Fineness modulus of fine and coarse Aggregate
- Specific gravity and bulk modulus of Aggregates
- Shape test of aggregate (Flakiness index, elongation index)
- Water absorption coefficient for both coarse and fine aggregate
- Aggregate abrasion value test for coarse aggregate
- Aggregate impact value test for coarse aggregate
- Aggregate crushing value test for coarse aggregate

FRESH CONCRETE

Design of concrete for nominal and design mix (IS Code) Workability test on concrete by

- Compaction factor
- Slump
- Vee-bee
- Flow table test

HARDENED CONCRETE

- Compressive strength of concrete cube
- Tensile strength of concrete cylinder
- Flexural strength of concrete beam

. NON-DESTRUCTIVE TESTING ON CONCRETE

- Rebound Hammer test

Pulse Velocity test

14. Bibliography

Textbooks

1. Concrete Technology: M. L. Gambhir
2. Properties of concrete: A.M. Neville
3. P. Kumar Mehta, Paulo J. M. Monteiro (2006). Concrete: microstructure, properties, and materials. New York, NY: McGraw-Hill ; London, cop. 2006.

Reference Books:

1. Concrete Technology: M. S. Shetty

Course handouts: include class PPT with explanatory notes and relevant IS Codes.

Course title : Structural Analysis

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	**Civil Engineering**
3. Course Code	**CED220**
4. Course Title	**Structural Analysis**
5. Credits (L:T:P)	**3:0:0**
6. Contact Hours (L:T:P)	**3:0:0**
7. Prerequisites	**Strength of Materials**
8. Major Core for	**Civil Engineering, Second year**
9. Major Elective for	**Civil Engineering**

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

The primary objective of this course is to teach the students the methods of analyzing the indeterminate structures using force-based method, moment distribution method, slope deflection method and matrix stiffness method. By the end of this course, the students learn to calculate the support reactions, internal forces / stresses and deflections for indeterminate structures such as continuous beams, frames and two hinges arc.

11. Course Aims

i. To introduce the second year Civil Engineering students to application of fundamentals of structural analysis to Indeterminate structures.
ii. To introduce the second year Civil Engineering students to different methods of solving the indeterminate beams and frames.
iii. To introduce the second year Civil Engineering students to the concepts of Influence lines and its applications.

12. Learning Outcomes

On successful completion of the course, students will be able to:

1. Understand analysis of statically indeterminate structures and its application to various structures.
2. Understand different methods and their advantages to analyze the indeterminate structures.
3. Application of Influence lines to study the deformation behavior of structural elements.

Analyze the structural systems using matrix methods.

13. Curriculum Content

Module 1: Introduction

Degree of indeterminacy and stability of structures; Drawing the influence lines using direct equilibrium; Influence lines for beams, girders and trusses.

Module 2: Analysis (displacement) of Statically Indeterminate Beams

Energy methods, Theorem of Three moments, Two hinged arches (Reaction, horizontal thrust, Effect of yielding of supports, Temperature change),

Module 3: Analysis of Statically Indeterminate Structures

Moment distribution method: Introduction, method development, solution of continuous beam, effect of settlement and rotation of support, frames with or without lateral sway.

Slope deflection method: Introduction, development of slope deflection equations; Application to continuous beams and frames with and without lateral sway.

Method of Consistent deformation (Force method): Continuous beams, Non-sway frames, Sway frames.

Module 4: Matrix Stiffness Method

Introduction, member stiffness matrix; Transformation, compatibility and equilibrium, assemblage of structural stiffness matrix; Imposing support conditions; Banded property of structural stiffness matrix

14. Bibliography

A. Kassimali, Structural analysis, Cengage Learning, Inc.

R. C. Hibbeler, Structural Analysis, Pearson Publications.

C. S. Reddy, Basic Structural Analysis, Tata McGraw Hill Publications.

Course title : Elements of Surveying

PART A: COURSE IDENTIFIERS

1. School	School of Engineering
2. Department	Civil Engineering
3. Course Code	CED222
4. Course Title	Elements of Surveying
5. Credits (L:T:P)	2:0:1
6. Contact Hours (L:T:P)	2:0:2
7. Prerequisites	Basic Science & Maths
8. Major Core for	Civil Engineering
9. Major Elective for	SoE

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

This course enables students to understand various theoretical and practical aspects on viz. chain, compass, plane table, leveling and contouring, Area and volume calculation, Theodolite, and Electronic devices in Surveying.

11. Course Aims

The main aims of this course are:

- To determine the relative position of any objects or points on the earth.
- To describe surveying which deals with measuring linear distances and angles (horizontal and vertical) on the ground
- To prepare a map or plan to represent an area on a horizontal plane.
- To define control points and boundaries of an area, for example, a cadastral survey

12. Learning Outcomes

On successful completion of the course, students will be able to achieve the following:

- application of surveying techniques
- calculate the length or area on the map in the real value.
- recognize measuring instruments used in basic and telescopic sight (theodolites, Total Station etc.)
- carry out a sense of team work through the tasks of applications that students learn

13. Curriculum Content

Module 1: *Overviews and Introduction (Basics of Surveying)*

Overview of elements of surveying; brief ideas of technical terminologies and survey equipment; Fundamental concepts; Classification of surveys; Plane surveying, Geodetic surveying; Principles and operations of surveying; Surveying measurements; Mapping and conventional signs.

Module 2: *Linear Measurement (Chain and Tape Surveying):*

Road, road user and vehicle characteristics, factors affecting design standards, cross-section elements, Stopping and overtaking sight distances, Road alignment, site selection, plan evaluation, Horizontal alignment, vertical alignment, design of summit and valley curves.

Module 3: ***Compass Surveying:***
Prismatic compass; Surveyor's compass; Bearing: whole circle (W.C.B) and reduced bearing (R.B); Local attraction and its adjustments; Traversing; Errors in compass surveying and precautions

Module 4: ***Plane Table Surveying:***
Plane Table Instruments and Accessories; Merits and demerits; Methods (Radiation, Intersection, Resection, and Traversing); Orientation; Two and three point problems; Errors in plane tabling.

Module 5: ***Theodolite Surveying****:*

Study of theodolite, Temporary and permanent adjustments; Measurement of horizontal angles (repetition and reiteration methods); Measurement of vertical angles; Sources of errors; Overview on Optical and Electronic theodolites.

Module 6: ***Traverse Surveying****:*
Traverse Surveying; Tacheometric surveying; Stadia method, Movable hair method; Trigonometric leveling and various methods.

Module 7: *Levelling:*
Principle and definition; Levelling instruments; Dumpy level; Auto and Digital level; Booking and reducing levels (Collimation, Rise and Fall); Curvature and refraction corrections; Bubble tube and its sensitiveness; Difficulties in Levelling.

Module 8: *Contouring:*
Contour survey; Definition, Characteristics of contours; Methods of contouring; Interpolations; Uses of contour maps.

Module 9: ***Area and Volume Surveying****:*

Areas and Volume computation; Trapezoidal rule; Simpson's rule; Other relevant methods for area and volume computation.

LAB EXPERIMENTS:

The list of the experiments are:

1. Map reading and understanding scales in Surveying
2. To calculate the distance between two points/place by pacing and subsequently computing the area of the field
3. To survey an open field by chain survey in order to calculate the area covered of the open field or the targeted region
4. To survey an area by chain survey across obstacles and determination of the obstructed lengths
5. To determine distance between two inaccessible points using Prismatic Compass.
6. To plot a given area or region of interest by Radiation and Intersection method of Plane Table Survey
7. To measure horizontal angle with a Vernier Theodolite
8. To determine elevation of various points with Auto level by collimation (H.I.) method and rise and fall method

To determine reduced levels (R.L) of various points and draw contour lines by radial line (Tacheometric) method

14. Bibliography

TEXT BOOKS

1. Bannister, A., 2006/2011. Surveying. Pearson Education India.
2. Punmia, B.C., Jain, A.K. and Jain, A.K., 2005. Surveying, Vols. I II and III. Laxmi Publication.
3. Kanetkar T.P., "Surveying and Levelling", Vols. I and II, United Book Corporation, Pune (1994)

REFERENCE BOOKS

1. Duggal, S. K. "Surveying" Vol 1, Tata, McGraw Hill (2004)
2. Roy, S.K. Fundamentals of Surveying, PHI.
3. K. R., Arora. "Surveying" Vol I and II, Standard Book House (1993)

Course title : Transportation Engineering - I

PART A: COURSE IDENTIFIERS

1. School	School of Engineering
2. Department	Civil Engineering
3. Course Code	CED304
4. Course Title	Transportation Engineering - I
5. Credits (L:T:P)	3:0:1
6. Contact Hours (L:T:P)	3:0:2
7. Prerequisites	Basic Science & Maths
8. Major Core for	Civil Engineering
9. Major Elective for	SoE

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

Students will learn about all aspects of highway design, including alignment, super-elevation, stopping sight distance analysis, visibility checks, pavement design, grade separation, and interchanges.

11. Course Aims

The main aims of this course are:

- To provide a coherent development to the students for the courses in sector of Engineering like Transportation & Traffic Engineering etc.
- To present the foundations of many basic Engineering tools and concepts related Highway Engineering.
- To give an experience in the implementation of Engineering concepts which are applied in field of Transportation Engineering
- To involve the application of scientific and technological principles of planning, analysis, design and management to highway engineering.

12. Learning Outcomes

On successful completion of the course, students will be able to achieve the following:

- Learn about the planning and alignment of highways.
- The highway's geometric design
- Learn about pavement types such as rigid and flexible pavements.
- Study the properties, testing methods, and materials used in highway construction
- Understanding pavement management system, evaluating pavement distress, and maintaining pavements.
- Learn about the Grade separation interchanges

13. Curriculum Content

Module 1: Introduction

Breadth and scope of Transportation Engineering, modes of transportation and their comparison, effect of transportation systems on economy, impact on environment; Road transport Characteristics, Classification of roads, Road development plans in India, network patterns.

Module 2: Roadway Geometry
Road, road user and vehicle characteristics, factors affecting design standards, cross-section elements, Stopping and overtaking sight distances, Road alignment, site selection, plan evaluation, Horizontal alignment, vertical alignment, design of summit and valley curves.

Module 3: Traffic Engineering
Traffic Studies, Origin-Destination studies, speed and delay studies, accident analysis, volume studies, passenger car equivalent, etc.; Traffic control Devices, marking, Signs, Signals, Regulations; Speed-flow-density relationship, Greenshields model, signal timing estimation, capacity and Level-of-Service analysis.

Module 4: Materials
Sub-grade soil, classification, group index, sub-grade soil stabilization; Aggregate, physical properties, mechanical properties, test on aggregates; Bituminous material, classification, tests on bitumen.

Module 5: Pavement Design
Necessity of pavement, types of pavements & characteristics, design parameters, wheel loads and axle loads, tyre pressure, load repetitions, ESWL; rigid and flexible pavement design, stresses in rigid pavement.

LAB EXPERIMENTS:

Lab Session - Lab Work based on various testing methods for materials such as soil, aggregates, and bitumen as well as exercises based on traffic engineering concepts.

The list of the experiments are:

1. To determine the abrasion value of given aggregate sample by conducting Los Angeles abrasion Test
2. To determine the aggregate impact value of given aggregate as per I.S-2386 Part IV
3. To determine crushing strength of a given aggregate
4. To determine the flakiness Index and Elongation Index of a given aggregate sample.
5. To determine the absorption and specific gravity of aggregates
6. To determine the California bearing ratio by conducting a load penetration test
7. To determine the ductility value of a given sample of bitumen.
8. To determine the flash and fire point of a given bituminous material.
9. To determine the hardness of given VG binder by Penetration test
10. To determine the hardness of given Cutback Emulsion by Viscosity test To determine the softening point of given bitumen sample.

14. Bibliography

Text Book:

1. S. K. Khanna and C. E. G. Justo, "*Highway Engineering",* 9th Edition, Nem Chand and Brothers (2011).

Reference Books:

1. L. R. Kadiyali and N.B. Lal, "*Principles and Practices of Highway Engineering",*Khanna Publishers (2005)
2. L. R. Kadiyali, "*Traffic Engineering and Transport Planning",*Khanna Publishers (2011).
3. Paul H. Wright and Karen K. Dixon, "*Highway Engineering",7*th Edition, Wiley India (2012).
4. Yang H. Huang, "*Pavement Analysis and Design*", Pearson Education India.
5. Ajay K. Duggal and Vijay P. Puri, "*Laboratory Manual in Highway Engineering*", New Age International.

Course title : Reinforced Concrete Design

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	Civil
3. Course Code	CED305
4. Course Title	Reinforced concrete design
5. Credits (L:T:P)	3:0:0
6. Contact Hours (L:T:P)	3:0:0
7. Prerequisites	Concrete Technologies, Strength of materials
8. Major Core for	Civil Engineering
9. Major Elective for	

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

This course will cover the basic reinforced concrete design, including topics such as flexural , shear, torsional design of beams slabs, columns, staircase etc. accordance with IS guidelines and limit state of serviceability.

11. Course Aims

In this course, the student will be learned the design of basic structural elements governed by bending, shear, axial forces or combination and are considered as building blocks of the whole structure. The design will be done as per IS 456:2000.

12. Learning Outcomes

(A list of what students will know or be able to do because of successfully completing the course. Should be expressed as knowledge, skills, or attitudes.)

On successful completion of the course, students will be able to:

·To give an experience in the implementation of designing concepts (WSM/LSM) which are applied in field of structural engineering

·To involve the application of scientific and technological principles of design of buildings according to limit state method of design

·To present the foundations of many basic engineering concepts related designing of structures

- To understand the various design concepts and analyze and design structural elements such as beams, slabs, columns, and footing under flexure, shear, torsion, and compression.

13. Curriculum Content

(Syllabus, Lab work, Project, Term paper, Group work, etc.)

1. Unit-1

Introduction to RC structure, Constituents of concrete mix, Grade of concrete, Behavior of hardened concrete under uniaxial compression, tension, and combined stresses, Creep, shrinkage and temperature effects, Durability, Properties of reinforcing steel

2. Unit-2

Design philosophy, Working stress method and Limit states method

3. Unit-3

Limit State Method - Analysis at ultimate loads of singly and doubly reinforced rectangular and flanged sections, Design of beams, Design for bond: Development length, Splicing, Curtailment, Code requirements and Deflection control. Design of one-way & two-way rectangular slabs

4. Unit-4

Design for Shear and Torsion
Design for shear with shear reinforcement and Design for torsion with shear reinforcement

5. Unit-5

Design of compression member
Effective length, Short column under axial compression with and without uniaxial/biaxial moment
Slender columns

6. Unit-6

Design of staircase and column footing

14. Bibliography

Design Standards: (Download these from http://10.66.0.6/bis/)

- IS 456 : 2000 Indian Standard PLAIN AND REINFORCED CONCRETE, BIS, New Delhi
- SP 16 : 1980 Design Aids for Reinforced Concrete to IS 456 : 1978, BIS, New Delhi
- SP 24 (S and T) : 1983 Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced Concrete, BIS, New Delhi

BOOKS

- Design of Reinforced Concrete Structures (IS:456-2000) 3 Edition, N. Krishna Raju, CBS Publisher (2013)
- Reinforced Concrete Design 3 Edition, S. Pillai, Devdas Menon, Tata Mcgraw Hill Education Private Limited (2011)
- Limit State Design of Reinforced Concrete 2 Edition, P. C. Varghese, Phi Learning
- Reinforced Concrete Design, 3e (PB), Kenneth Leet, McGraw Hill 2015 edition

Course title : Foundation Analysis and Design

PART A: COURSE IDENTIFIERS

1. School	School of Engineering
2. Department	Civil Engineering
3. Course Code	CED306
4. Course Title	Foundation Analysis and Design
5. Credits (L:T:P)	3:0:0
6. Contact Hours (L:T:P)	3:0:0
7. Prerequisites	Geotechnical Engineering
8. Major Core for	Civil Engineering
9. Major Elective for	

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

This course provides a comprehensive introduction to soil mechanics, focusing on understanding soil properties, behaviour, and applications in geotechnical engineering. It is structured to cover fundamental concepts, including soil formation, classification, compaction, permeability, stress analysis, and shear strength, along with hands-on laboratory experiments. This course builds a strong foundation in geotechnical engineering principles, preparing students to apply soil mechanics concepts in real-world scenarios, from foundational soil assessments to complex stress and stability analysis in civil engineering projects.

11. Course Aims

These objectives aim to comprehensively understand foundation engineering principles and their practical applications in different scenarios.

- Define fundamental concepts of foundation engineering and soil mechanics.
- Relate theoretical concepts to real-world engineering problems
- Understand and appreciate ethical considerations in foundation engineering
- Design suitable foundations and develop the ability to communicate technical concepts
- Work effectively in multidisciplinary teams in the context of foundation engineering

Recognize the responsibility of engineers to ensure safety and sustainability

12. Learning Outcomes

On successful completion of the course, students will be able to achieve the following:

- Specify a basic site investigation strategy to identify soil deposits and determine the depth, thickness, and areal extent of such deposits within the ground
- Understand the applications and limitations of a wide range of methods available for profiling the ground, and interpreting their findings
- Appreciate the effects of sampling on the quality of soil samples taken for laboratory testing and the implications of these effects for the interpretation of such test data
- Understand the rationale behind testing soils in situ to obtain their constitutive properties, and appreciate the part it plays in laboratory testing and the use of empirical correlations in establishing a reliable ground model
- Understand the principle of operation of four common in-situ testing devices, their applicability, and the constitutive properties that can be reliably obtained from them
- Process the test data from these methods with the help of a computer and use this to derive key strength and stiffness properties

- Determine the stability of unsupported trenches, including those supported by slurry, and design these works within a limit state design framework
- Determine the stability of slopes, vertical cuttings, and embankments, and design these works within a limit state design framework
- Determine the stability of tunnels and the ground settlements caused by tunneling works, and use this information to conduct a preliminary design of tunneling works within a limit state design framework
- Understand the working principles behind shallow foundations
- Solve simple foundation capacity problems using Terzaghi's bearing capacity equation and/or limit analysis techniques
- Calculate the stresses induced beneath shallow foundations and the resultant foundation settlement using elastic solutions and consolidation theory
- Understand the philosophy behind limit state design codes
- Design a shallow foundation within a limit-state design framework either analytically (based on fundamental ground properties) or directly from in-situ test data
- Understand the working principles behind deep foundations, how they are constructed/installed, and the advantages they offer over shallow foundations
- Design a pile within a limit-state design framework, analytically (based on fundamental ground properties), directly from in-situ test data or the results of a pile load test
- Understand how piles and shallow foundations may be used as elements of larger foundation systems, including pile groups, rafts, piled rafts, and deep basements, and be able to design such systems
- Design shallow and deep foundation elements that are subjected to combined loading (vertical, horizontal, moment) within a limit-state design framework
- Use limit analysis and limit equilibrium techniques to determine the limiting lateral earth pressures acting on retaining structures
- Determine in-situ lateral stresses based on fundamental soil properties and understand how limiting earth pressures are mobilized from these values by relative soil–structure movement
- Determine the lateral stresses induced on a retaining structure due to external loads and construction procedures
- Design a gravity retaining structure, an embedded wall, a braced excavation, or a reinforced soil retaining structure within a limit-state design framework
- Select characteristic values of engineering parameters from laboratory or in-situ data that are suitable for use in engineering design
- Understand the principle of operation of field instrumentation used to measure the response of geotechnical constructions, and be able to select appropriate instrumentation for verifying design assumptions
- Understand how the Observational Method may be used in geotechnical construction

Apply the limit state techniques to the analysis and design of real geotechnical constructions in practice, to begin to develop engineering judgment

13. Curriculum Content

Module 1: Site Investigation – Reconnaissance, Preliminary and detailed investigation, and Investigation for foundations. Subsoil Exploration: Necessity and planning for subsoil exploration, Methods - direct (test pits and trenches), indirect (sounding, penetration tests, and geophysical methods).

Soil sampling – Types of samples, Standard penetration test, Static and dynamic cone penetration test, In-situ vane shear test, Rock coring, Soil exploration report.

Module 2: Lateral Earth Pressure and Retaining Structures – Concept of earth pressure, Earth pressure at rest, active and passive earth pressure for both cohesionless and cohesive soils, Earth pressure theories: Rankine's theory, Coulomb's Wedge theory, Graphical methods: Rebhan's and Culmann's graphical solutions, Stability conditions for retaining walls.

Module 3: Bearing Capacity – Definitions, Types of failures: General and local shear failure, Terzaghi's Analysis, Brinch-Hansen analysis, Meyerhof's analysis, Vesics's bearing capacity equation, Effect of water table on bearing capacity, IS code method for computing bearing capacity, Field Methods: Plate load test and its limitations, Standard penetration test.
Module 4: Stress Distribution – Normal and shear stresses on a plane, Boussinesq's solution for a point load, line load, Strip load, Uniformly loaded circular and rectangular areas, Isobar and pressure bulb concept, Stress distribution on horizontal and vertical planes, Newmark's chart and its application, contact pressure.
Shallow Foundations – Types of foundations: Spread footing, Combined and strap footing, Mat or raft footing, Settlement of footings.
Module 5: Deep Foundations – Difference between shallow and deep foundations, Types of deep foundations.
Pile Foundations - Types of piles, Pile driving, Load carrying capacity of piles-static and dynamic formulae, Pile load test and its limitations, Correlation with penetration tests, Group action in piles, Settlement and efficiency of pile groups in clay, negative skin friction, Under-reamed pile foundation. Basics of well foundation - Types, Component parts, and the forces acting on a well foundation.
Module 6: Stability analysis of slopes – Types and causes of slope failures, Practical applications. Stability analysis of infinite slopes with or without water pressures. Stability analysis of finite and infinite slopes: concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, Friction circle method; Method of slices, Bishop's method, Janbu's method. Effect of seepage, submerged and sudden draw down conditions; Design of slopes in cutting

14. Bibliography

- B. M. Das, Principles of Foundation Engineering, Cengage Learning, 2019.
- B. M. Das, Shallow Foundations: Bearing Capacity and Settlement, CRC Press, 1999.
- V. N. S. Murthy, Advanced Foundation Engineering, CBS Publishers & Distributors, 2010.
- 5. P. C. Varghese, Foundation Engineering, PHI Learning Pvt. Ltd., 2009.
- J. E. Bowles, Foundation Analysis and Design, McGraw Hill, 1996.
- B. C. Chattopadhyay and J. Maity, Foundation Engineering, Prentice-Hall, 2015.
- M. J. Tomlinson, Foundation Design and Construction, Prentice-Hall, 2001.
- M. J. Tomlinson, Pile Design and Construction Practice, Taylor & Francis, 2008.
- J. Knappett and R.F. Craig, Craig's Soil Mechanics (8th Edition), CRC Press, 2012.
- Braja M. Das and Khaled Sobhan, Principles of geotechnical engineering, Cengage Learning, 2021
- B. B. K. Huat, Arun Prasad, A. Asadi and S. Kazemian, Soil Mechanics and Foundation Engineering, Cengage Learning, 2016.
- K. R. Arora, Soil Mechanics and Foundation Engineering: Geotechnical Engineering, Standard Publishers Distributors, 1992.
- B. Bodó and C. Jones, Introduction to Soil Mechanics, Wiley-Blackwell, 2013.

Course title : Introduction to Remote Sensing and GIS

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	Civil Engineering
3. Course Code	CED310
4. Course Title	**Introduction to Remote Sensing and GIS**
5. Credits (L:T:P)	2:0:1
6. Contact Hours (L:T:P)	2:0:2
7. Prerequisites	NA
8. Major Core for	Civil Engineering
9. Major Elective for	UWE

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

Remote sensing and geographic information system (GIS) are the emerging technologies that find applications in various domains. The course will focus on satellite remote sensing, the popular satellite missions, data products and types of sensor used for data acquisition in remote sensing. The course will also cover applications of remote sensing and GIS.

11. Course Aims

- To provide an introduction to the basics of remote sensing and geographic information system (GIS)
- To discuss different types of sensors used for remote sensing based data acquisition
- To discuss satellite remote sensing, popular satellite missions and data products
- To discuss the basics of image processing and image classification
- To understand the applications of remote sensing and GIS

12. Learning Outcomes

- Developing an understanding of the basic concepts of remote sensing and GIS.
- Acquainting with the popular satellite data products and learning how to procure and use satellite images and spatial data.
- Learning the applications of remote sensing and GIS
- Familiarizing with and learning the basics of some popular software packages used in remote sensing and GIS applications.

13. Curriculum Content

Module 1: Introduction to Remote Sensing

Definition and process of remote sensing, History of remote sensing, Electromagnetic spectrum and atmospheric windows, Electromagnetic radiation (EMR) principles, Interaction of EMR with earth atmosphere: scattering, absorption and refraction, Spectral reflectance and signatures, Reflectance characteristics of earth cover types, Classification of remote sensing

Module 2: Satellite and Sensors

Satellite characteristics, Satellite imagery, Image resolutions, Multispectral scanning, Active and passive sensors, Optical sensors, Thermal scanners, Microwave remote sensing, Introduction to drone remote sensing

Module 3: Satellite Missions and Image Analysis

Satellite Missions: Landsat series, Sentinel series, MODIS, SPOT series, IRS (Indian) satellite series, Elements of image interpretation, Image corrections, Image classification: Supervised and unsupervised classification

Module 4: Applications of Remote Sensing

Land use and land cover mapping, Applications of remote sensing in hydrology and water resources, Applications in agriculture, Applications in environmental studies, Other applications.

Module 5: Geographical Information System (GIS)

Introduction to GIS, Applications of GIS in various domains, Geographic information and spatial data types, GIS database (types, structures) and data model, Raster data formats, Vector data and shape files, Attribute data, Topology, Coordinate reference systems, Metadata, Data acquisition, GPS, Digitization of maps and images, Data preparation, Spatial data analysis, Issues in spatial data quality, Mapping, GIS software packages.

14. Bibliography

- Floyd F. Sabins (1996). **Remote Sensing: Principles and Interpretation**, W. H. Freeman and Company, San Francisco, USA.
- Otto Huisman and Rolf A. de By (2009). **Principles of Geographic Information Systems**, The International Institute of Geo-Information Science and Earth Observation, The Netherlands.
- P.A. Burrough and R.A. McDonnell (1998). **Principles of Geographic Information Systems**, Oxford University Press, Oxford.

Course title : Water Resources Engineering

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	Civil Engineering
3. Course Code	CED326
4. Course Title	Water Resources Engineering
5. Credits (L:T:P)	2:0:0
6. Contact Hours (L:T:P)	2:0:0
7. Prerequisites	Engineering Hydrology, Hydraulic Engineering
8. Major Core for	Civil Engineering
9. Major Elective for	NA

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

In order to manage the precious natural resource water, understanding of water resources is very important. This course will cover the principles of water resources engineering, availability & usage of water resources, water resources engineering structures and their design. The course will also summarize the problems and techniques used for the management of water resources.

11. Course Aims

- To understand the importance and availability of available water resources
- To understand irrigation water requirements of the crops
- To know the design criteria for canal and canal structures
- To understand design concept of diversion head works
- To understand the different types of dams and hydraulic structures
- To understand the about storage capacity of reservoirs

12. Learning Outcomes

- Knowledge of available water resources, particularly in Indian perspective
- Estimation the crop water requirements and amount of irrigation to be supplied
- Understanding of canal layout & alignment and canal structures
- Design the various hydraulic structures such as irrigation canal, canal structures, diversion headworks and cross-drainage works
- Understand different types of hydraulic structure such as dams, spillway etc

13. Curriculum Content

Module 1: Principles of Water Resources Engineering: Distribution of water resources on earth, Freshwater, Consumption of water resources, Surface and ground water resources, Concept of watershed, Water resources of India: status and availability of water resources in India, National policy for water resources development, Major river systems in India, Water resources boards and institutes in India

Module 2: Crop Water Requirements and Irrigation: Soil water content and total available water, Crop water requirements and evapotranspiration (ET): Methods of ET estimation, Necessity of irrigation, Methods of irrigation, Duty and delta, Estimating irrigation demand, Irrigation efficiencies, Major irrigation projects in India

Module 3: Canals: Canal, classification and layout, Canal lining, Longitudinal and cross-sections of canal, Design of irrigation canals by Kennedy's and Lacey's theories, Estimation of canal discharge **Module 4: Canal structures:** Canal falls, Design principles of Sarda fall, Cross and head regulators, Canal escape, Sediment control structures, Cross drainage works: aqueduct, super passage and level crossing.

Module 5: Hydraulic Structures for Flow Diversion and Storage: Barrages and weirs, Design of weirs on permeable foundation, Bligh's creep theory, Khosla's theory, Dams and types, Concrete and gravity dams, Selection of type and site of dam, Reservoirs, Zones of storage of a reservoir, Spillways: types of spillways

14. Bibliography

Text Books

- Irrigation and Water Power Engineering by Punmia, B. C., Lal, P. B. B, Jain, A. K., Jain, A. K., Laxmi Publications
- Irrigation Engineering and Hydraulic Structures by Garg, S. K., Khanna Publishers
- Irrigation, Water Power and Water Resources Engineering by Arora, K. R, Standard Publisher Distributors

Reference Books

- Elements of Water Resources Engineering by Duggal, K. N. and Soni, J. P., New Age International
- Irrigation and Water Resources Engineering by Aswa, G. L., New Age International
- Water Resources Engineering: Principles and Practice by Murthy, Satya N. Challa, New Age International
- Irrigation Water Resources and Water Power Engineering by Modi, P. N, Standard Book House

Course Description

Elective Courses

Course title : Transportation Engineering - II

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	**Civil Engineering**
3. Course Code	**CED309**
4. Course Title	**Transportation Engineering - II**
5. Credits (L:T:P)	**3:0:0**
6. Contact Hours (L:T:P)	**3:0:0**
7. Prerequisites	**Basic Science & Maths**
8. Major Core for	**Civil Engineering**
9. Major Elective for	**SoE**

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

Students will learn about the basics and design of various components of railway engineering, the types and functions of track, junctions and railway stations, the aircraft characteristics, planning and components of airport, the types and components of docks and harbors, and about various urban transportation systems and Intelligent Transportation Systems.

11. Course Aims

The main aims of this course are:

- To Study the basics of railways, docks, harbour and airports.
- To expose students to the planning, design, construction and maintenance of railways
- To learn various marine structures and navigation aids at port.
- Understand various ground and airside structures including terminal building.
- To teach students about the planning, management, and design of urban transportation systems

12. Learning Outcomes

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

- carry out the surveys for railways, airports and harbours
- perform geometric design for the three modes
- demonstrate the fundamentals of Urban Transportation Systems
- perform Urban planning using four-step model

13. Curriculum Content

Module 1: Railway Planning

Location surveys and alignment - Permanent way - Gauges - Components - Functions and requirements - Geometric design
Track Junctions-Points and crossings - types and functions - design and layout - simple problems - Railway stations and yards. Signaling and interlocking - control systems of train movements.

Module 2: Railway Construction and Maintenance

Earthwork – Stabilization of track on poor soil — Tunneling Methods, drainage and ventilation — Calculation of Materials required for track laying - Construction and maintenance of tracks –Modern methods of construction & maintenance - Railway stations and yards and passenger amenities-Urban rail – Infrastructure for Metro, Mono and underground railways.

Module 3: Airport Engineering

Aircraft characteristics - Airport obstructions and zoning - Runway - taxiways and aprons- Terminal area planning, criteria for airport site selection and ICAO stipulations, Typical airport layouts, Case studies, Parking and circulation area.

Module 4: Docks and Harbours

Definition of Basic Terms: Harbor, Port, Satellite Port, Docks, Waves and Tides – Planning and Design of Harbours: Requirements, Classification, Location and Design Principles – Harbour Layout and Terminal Facilities – Coastal Structures: Piers, Break waters, Wharves, Jetties, Quays, Spring Fenders, Dolphins and Floating Landing Stage – Inland Water Transport – Wave action on Coastal Structures and Coastal Protection Works – Environmental concern of Port Operations

Module 5: Urban transportation systems

Travel Demand; Four Step Model; Bus transit - Mass Rapid Transit System - Light Rail Transit. Intelligent Transportation Systems (ITS)

14. Bibliography

1. Saxena and Arora. *Railway Engineering*. Dhanpat Rai Publications.
2. Saxena, S.C. *Airport Engineering : planning and design*
3. Rangwala, S.C. *Airport Engineering.* Charotar Publishing House
4. Srinivasan, R. *Harbour, Dock and Tunnel Engineering.* Charotar Publishing House

Course title : Advanced design of RCC structure

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	**Civil Engineering**
3. Course Code	**CED 312**
4. Course Title	**Advanced design of RCC structure**
5. Credits (L:T:P)	**3-0-0**
6. Contact Hours (L:T:P)	
7. Prerequisites	**Not Applicable**
8. Major Core for	**Civil Engineering**
9. Major Elective for	**NA**

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

Students will learn advanced topics related to the behaviour and design of reinforced concrete. Introduce the student to key advanced reinforced concrete concepts and topics as well as further develop the student's critical thinking skills.

11. Course Aims

Advanced Reinforced concrete design will help the students to grasp the basic concept of concrete structural design. This course will also enable the students to carry out design of engineering structures in accordance to Indian standard code. Designing of structures other than buildings such as water tanks and others special structures are presented in this course. This course also highlight the various steps in carrying out the analysis of frame structures.

12. Learning Outcomes

Upon successful completion of this course, students will be able to:

- analyze and design continuous and deep beams
- analyze and design of multi-storey frame structures
- design of water tanks and flat slab
- design of prestress concrete structure

13. Curriculum Content

Unit-1: General Design:

Compare and contrast different methods used for the design of structural concrete; describe the influence of concrete materials and geometry configurations on concrete design; explain fundamental behavior of structural concrete and principles behind select code provisions. Introduction plastic analysis, yield line method and strip method.

Unit-2: Design in flexure

Elements of flat slabs, Codal procedure for design of flat slabs, Behavior of flat slab in shear, One way and two way shear, Opening in flat slabs, Effect of pattern loading in flat slabs. Deep Beams: General features, Parameter influencing design, Flexural bending and shear stresses in deep beams. Design provisions of IS-456, Checking for local failures, Detailing of reinforcement in deep beams. Deformation of cracked and uncracked system

.

Unit-3 Structural designing of RC members

Detailed design procedure for Beam Column Joints, elevated water tank, shear wall, slender columns, portal frames and multi-storey building frames

Unit-4: Prestressesd Concrete

Introduction to prestressed concrete: Methods and systems of prestressing, materials and codes, need for high strength steel and concrete, losses in prestress, anchorages, analysis and design of sections for flexure, shear, bond, bearing and torsion, cable layouts, prestressed concrete continuous beams.

14. Bibliography

- P.C Varghese "Advanced Reinforced Concrete Design" -. Prentice Hall of India –2004.
- N. Krishna Raju "Advanced Reinforced Concrete Design", 2nd edition, CBS Publishers and Distributors.- 2018.
- M.L.Gambhir, "Design of Reinforced Concrete Structures, PHI Pvt. Ltd, New Delhi, 2008
- IS456, SP16, SP34

Course title : Design of Steel Structures

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	**Department of Civil Engineering**
3. Course Code	**CED401**
4. Course Title	**Design of Steel Structures**
5. Credits (L:T:P)	**3:0:0**
6. Contact Hours (L:T:P)	**3:0:0**
7. Prerequisites	**CED215: Mechanics of Solids** **CED220: Structural Analysis**
8. Major Core for	
9. Major Elective for	**Civil Engineering**

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

For centuries, low-carbon structural steel has been used as the primary construction material for residential and commercial buildings, bridges, towers, stadiums, etc. In general, hot rolled sections of various shapes (I-section, channels, angles, hollow sections, etc.) are used to fabricate primary and secondary loading bearing members, such as ties, struts, beams, columns, etc., in these structures. The main objective of this Course is to introduce students to the design these steel structural members by applying the concepts of limit state method through the guidelines provided in Indian standard IS800 – 2007. The design of bolted and welded connections used in these steel structures is also discussed as a part of this course.

11. Course Aims

The main aims of this course are:

1. Design steel members based on IS 800-2007 based on limit state method.
2. Correlate the specifications and guidelines given in codal provisions with the stress-strain and structural analysis.

12. Learning Outcomes

On successful completion of the course, students will be able to achieve the following:

L01: Understand and apply the concepts of limit state design towards the designing of steel structures. **L02:** Understand and apply the guidelines provided in IS800 – 2007, IS808 – 1989 and SP6 – Part 1 for designing of various structural steel members.

L03: Design steel members under tension loading and the related connection design.

L04: Design structural members under compression.

L05: Design steel beams and other bending elements.

13. Curriculum Content

Module 1: Introduction

Properties of Structural Steel; Difference between the properties of hot-rolled and cold-rolled structural sections; Introduction to limit state design method.

Module 2: Design of Steel Connections

Type of connections; Basic applications of bolted and welded connections; Strength, efficiency and design of bolted joints; Advantages and disadvantages of welded connections, Design of fillet and butt welds, Design of eccentric connections.

Module 3: T**ension Members**

Concept of gross and net sectional area; Permissible stresses; Design of axially loaded tension member, Design of member subjected to axial tension and bending.

Module 4: Compression Members

Modes of failure of a column; Euler's Theory of elastic buckling; Effective length and slenderness ratio; Design of compression members; Design of built-up compression members.

Module 5: Plastic analysis of structure

Basics of plastic analysis; Concept of plastic hinge; Shape factor, Elastic and plastic section modulus; Calculation of collapse load.

Module 6: Beams

Design of flexural members with and without lateral support; Web Crippling, Web Buckling; Built-up beams, Plate girders.

14. Bibliography

1. Limit state design in structural steel: M.R. Shiyekar.
2. Design of steel structure: N. Subramaniam.
3. Limit state design of steel structures: S.K. Duggal.

Software

- STAADPro Connect V22, Bentley Systems.
- 3dExperience, Dassault Systémes

Course title : Analysis of Tall structure

PART A: COURSE IDENTIFIERS

1. School	School of Engineering
2. Department	Civil Engineering
3. Course Code	CED 406
4. Course Title	Analysis of Tall structure
5. Credits (L:T:P)	3-0-0
6. Contact Hours (L:T:P)	
7. Prerequisites	Structural analysis
8. Major Core for	Civil Engineering
9. Major Elective for	Mechanical Engineering

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

Analysis, design and stability of tall buildings are covered in this course. At the end of this course, the student will have an understanding of the behaviour of tall buildings subjected to different loading especially lateral loading such as wind and earthquake.

11. Course Aims

The course aims at the development of ability for analysis of high-rise buildings. It offers the student with an opportunity to gain real life design experience, and to develop the ability to identify and solve tall civil engineering structures i.e. towers, chimneys and shear walls along with codes of practice and computer software

12. Learning Outcomes

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

- Implement design philosophies for the development of high rise structures
- To apply all types loads on tall buildings according IS code
- Analyze the behavior of tall buildings subjected to lateral loading.
- Perform stability analysis using various methods for tall buildings

13. Curriculum Content

Module-1 General Introduction

Structural system of tall buildings, Important structural analysis and design aspects of tall buildings, Progressive Collapse,

Moudle-2 Loads and load combinations

Gravity loading Methods and lively hood reduction- Impact loading - Construction loads – Wind loading – Static and dynamic approach – Analytical and experimental method – Earthquake loading Approach Analytical method, Wind Tunnel Experimental methods. Equivalent lateral Load analysis, Combination of Loads, Matrix and Approximate methods.

Moudle-3 Interaction system

High Rise behaviour- Rigid frames , Braced frames , Infilled frames , Shear walls , Coupled shear walls , Walls frames , Tubular cores Interaction of frames, shear - wall frames, Twist of frames. Tubular Buildings. Sequential loading, creep and shrinkage effects on tall buildings. Pounding, P-Δ Effect, Ductility, Redundancy, Hysteresis

Module-4 Analysis Procedure

Analysis method of 2D frame under lateral load: Cantilever and Portal frame method, Analysis of member forces- Drift and twist, three dimensional analysis - Section shapes, Properties and resisting capacity (computer based), Design of differential movement – Creep and shrinkage effects- Temperature effects, Codal aspects, Gust Factor, Building drift and Separation,

Overall buckling analysis of frames.

Module-5 Stability analysis

Stability of High Rise Structures: Buckling of Frame, Shear mode, Flexural mode, Combined shear and flexural modes, Bucking of wall-frame,

14. Bibliography

1. Bungale s. Taranath (2021), structural analysis and design of tall buildings: steel and composite construction
2. Bryan stafford smith and alex coull (2011), tall building structures: analysis and design.
3. Bungale s. Taranath (2010), reinforced concrete design of tall buildings
4. D) johann eisele and ellen kloft; (2003), high-rise manual: typology and design, construction and technology

Course title : Public Transport System

PART A: COURSE IDENTIFIERS

1. School	School of Engineering
2. Department	Civil Engineering
3. Course Code	CED421
4. Course Title	Public Transport System
5. Credits (L:T:P)	3:0:0
6. Contact Hours (L:T:P)	3:0:0
7. Prerequisites	Transportation Engineering - I
8. Major Core for	Civil Engineering
9. Major Elective for	SoE

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

This course will describe the evolution and role of urban public transportation modes, systems, and services, focusing on bus and rail. Technological characteristics and their impacts on capacity, service quality, and cost will be described. Current practices and new methods for data collection and analysis, performance monitoring, route design, frequency determination, and vehicle and crew scheduling will also be discussed. In addition, the effect of pricing policy and service quality on ridership and methods for estimating costs associated with proposed service changes will be presented together with means to improve operations through real time intervention.

11. Course Aims

The main aims of this course are:

- To identify the sustainability principles in transportation
- To Introduce the concept of Travel Demand Management (TDM)
- To disseminate the techniques of urban public transit planning, operations and management
- To imbibe the concepts of non-motorized urban transport
- To demonstrate the applications in intelligent transportation systems (ITS)

12. Learning Outcomes

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

- have a clear conceptual understanding of key challenges of public transport systems design and operations
- comprehend the interactions between the different components of public transport design and operations, i.e. service quality, passenger demand, infrastructure, transit operations and evaluation
- be familiar with the current challenges of public transport systems in South Africa and have a critical understanding of their implications for the competitiveness of public transport be equipped to do basic calculations on transit line capacity, scheduling and network design

13. Curriculum Content

Module 1: Transit System :

Capacity, Work and Utilization; Factors influencing Transit Travel; Scheduling of Service

Module 2: Estimation of Transit Demand:

Transit Line Capacity; Elements of line capacity; Capacity Computations; Relationship between capacity and other performance elements

Module 3: Route planning techniques:

Transit Stops; Sensitivity of Transit speeds to elements of Cycle time; Stops and Stopping Regimes; Skip-stop operation

Module 4: Bus Scheduling:

Scheduling of Single track lines, circle lines and Trunk lines; Transit System Modeling; Optimization of Rolling Stock; Analysis of Delay propagation on a transit line; Transit Lines and Networks; Network operating efficiency

Module 5: Transit Corridor identification and planning:

Geometry of transit lines; Line alignments; Types of transit lines and their characteristics; Timed transfer system Scheduling

Module 6:Integration of Public Transportation Modes:

Transit network types and their characteristics; Rail transit network types and their characteristics; Analysis of Metro networks and geometric forms; Classification of metro network measures and indicators; Network Topology; Planning of Rail Transit Station Locations; Application of theoretical Analysis to Rapid Transit station planning; Attraction of passengers

14. Bibliography

Text Book:

1. Vukan R. Vuchic, "*Urban Public Transportation: Systems and Technology",* 1st Edition, Prentice-Hall; 1st edition (1981).

Reference Books:

2. Vukan R. Vuchic, "*Urban Transit : operations, planning and economics*", New.Jersey. : J. Wiley & Sons, ©2005
3. Ceder, Avishai and Haifa, Israel, "*Public transit planning and operation : theory, modelling and practice*", London ; Burlington, MA : Elsevier , ©2007

Course title : Transportation Planning

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	**Civil Engineering**
3. Course Code	**CED652**
4. Course Title	**Transportation Planning**
5. Credits (L:T:P)	**3:0:0**
6. Contact Hours (L:T:P)	**3:0:0**
7. Prerequisites	**Transportation Engineering - I**
8. Major Core for	**Civil Engineering**
9. Major Elective for	**SoE**

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

This course covers a range of topics including how to plan for smart cities, including urban demographics, how to plan for transport infrastructure and freight, traditional and advanced models of urban transport systems, such as activity based models and shared mobility and traditional theories and models of urban transport systems. Transportation planning is the process of designing and evaluating transportation systems to improve access to goods, services, and activities. It involves considering factors such as mobility, non-motorized travel, and land-use patterns.

11. Course Aims

The main aims of this course are:

- to improve **transport economic efficiency for business users and transport providers**;
- to improve **transport interchange**;
- to integrate transport policy with **land-use policy**; and
- to improve **access to the transport system**.

12. Learning Outcomes

On completion of the course, the students will be able to demonstrate knowledge and understanding of the:

- transportation planning and design process
- concept of smart cities and its functions;
- concept of sustainable mobility and the way it affects the transformation of the transport sector;
- the transport data collection methods with regard to transport surveys, big data and transport planning and analysis techniques

13. Curriculum Content

Module 1: Overview of urban transportation

Urbanization and Transport, Key issues in urban transportation, Challenges in urban transportation, Travel demand modelling overview, Travel Demand Management (TDM), Vehicular Level of service (LOS) overview

Module 2: Public Transportation Planning

Introduction to public transportation, Basic operating elements of public transportation, Bus Transportation, Transit marketing, Rail transportation, Intermediate Public Transportation, Measuring performance of transit systems, Advanced operation concepts of public transportation, Station Capacity, Transit Stop Location

Module 3: Non-Motorised Transportation (NMT) Planning

Basic NMT Characteristics, Pedestrian Data Collection and Flow Characteristics, PTS Case Studies Pedestrian flow characteristics on facilities, Pedestrian Level of Service (PLOS) based on Flow models, Design of Pedestrian Infrastructure, Design of Cycling Infrastructure

Module 4: Intelligent Transportation Systems (ITS)

Introduction to Intelligent Transportation Systems (ITS), ITS components, applications and communication, ITS Architecture, Public Bicycle Sharing (PBS) System with ITS, Electronic Toll Collection (ETC), Park and Ride (P&R) Facility Planning

Module 5: Multimodal Transportation Planning

Multimodal Transportation (MMT) environment, Multimodal Level of Service (MMLOS), Design of multimodal transfer facilities

Module 6: Landuse Transportation Planning

Data Collection and Survey Techniques: Sampling Theory, Data-Collection Techniques, App-based Data-Collection, Stated Preference and Revealed Preference survey, Existing Landuse-Transportation Models and Frameworks: Lowry Model, Four-stage Model, MePlan, UrbanSim, ILUTE, Practical applications in India and abroad

14. Bibliography

1. Travel Demand Management and Road User Pricing: Success, Failure and Feasibility, edited by Gerd Sammer & Wafaa Saleh (2009), AshGate
2. The Implementation and Effectiveness of Transport Demand Management Measures -An International Perspective, edited by Stephen Ison, Tom Rye, (2008), Ashgate
3. Sustainable Transport: Planning for Walking and Cycling in Urban Environments, edited by Rodney Tolley (2003) Woodhead Publishing Ltd.
4. Fruin, J.J. Pedestrian Planning and Design, McGraw Hill Publication, 1987
5. Hudson, M. The Bicycle Planning, Open Books, 1982
6. Fundamentals of Intelligent Transportation Systems Planning, by Mashrur A. Chowdhury, Adel Wadid Sadek, (2003) Artech House, Inc. Boston
7. http://local.iteris.com/itsarch/index.htm
8. Perspectives on Intelligent Transportation Systems (ITS), by Joseph M. Sussman, (2008) MIT, Springer.
9. Ceder, A., 2016. Public Transit Planning and Operation: Modeling, Practice and Behavior, 2nd Ed., CRC Press

Course title : Irrigation Water Management

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	Civil Engineering
3. Course Code	CED329
4. Course Title	**Irrigation Water Management**
5. Credits (L:T:P)	3:0:0
6. Contact Hours (L:T:P)	3:0:0
7. Prerequisites	Water Resources Engineering
8. Major Core for	NA
9. Major Elective for	Civil Engineering

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

Irrigation water contributes to more than 50% of the total freshwater usage globally. To manage the available water resources, understanding of irrigation water management is indispensable. This course covers the concepts of irrigation, and the methods used for the estimation of crop & irrigation water requirements. The course also covers the emerging tools and techniques used for the management of irrigation water.

11. Course Aims

The main aims of this course are:

- To cover the availability of freshwater and its usage.
- To understand the irrigation, methods of irrigation as well as estimation of crop and irrigation water requirements.
- To understand the experimental techniques used for devising water-efficient irrigation schedules.
- To cover the emerging tools and technologies used for irrigation water management.

12. Learning Outcomes

On successful completion of the course, students will be able to achieve the following:

1. Understanding of the soil-water-plant-atmosphere continuum and relationships.
2. Estimation of point and spatial estimates of evapotranspiration and crop water requirements.
3. Basic understanding of the crop field experimentation in controlled conditions for the management of irrigation water.
4. Learning about the emerging tools and techniques for irrigation water management.

13. Curriculum Content

Module 1: Basic Concepts of Irrigation

Water resources availability and consumption, Necessity and methods of irrigation, Drip irrigation, Soil-water-plant-atmosphere relationships, Soil water content and total available water, Methods and equipment for observing soil water content

Module 2: Evapotranspiration and Irrigation Water Requirements

Evapotranspiration (ET) and crop water requirements, Methods to determine/estimate ET: Water balance and lysimeters, field water balance; Energy balance and remote sensing based-methods, Use of ET equations: FAO-56 Penman-Monteith method and crop coefficients, Estimation of irrigation water requirements

Module 3: Irrigation Scheduling and Water Saving Strategies

Irrigation scheduling and criteria, Deficit irrigation and regulated deficit irrigation, Field demonstration of crop experiments based on irrigation schedules, Deficit irrigation, crop water stress and crop yield, Water use efficiency and water saving.

Module 4: Emerging Tools and Techniques for Irrigation Water Management

Applications of remote sensing for irrigation water management: Mapping crop water use and crop water stress, Crop type mapping, Crop monitoring, Estimation of soil moisture by remote sensing methods, Drone remote sensing for irrigation water management; Smart irrigation systems

14. Bibliography

Books

- Michael, A.M. 2006. Irrigation: Theory and Practice, Vikas Publishing House Pvt. Ltd., New Delhi.
- Majumdar, D.K. 2013. Irrigation Water Management: Principles and Practices. PHI Learning Pvt. Ltd., Delhi.

Book Chapter

- Shankar et al., 2017. Optimum use of irrigation water. In: Sustainable Water Resource Management, American Society of Civil Engineers (ASCE), Reston, USA.

Course title : Pavement Design

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	**Civil Engineering**
3. Course Code	**CEDxxx**
4. Course Title	**Pavement Design**
5. Credits (L:T:P)	**3:0:0**
6. Contact Hours (L:T:P)	**3:0:0**
7. Prerequisites	**Transportation Engineering-I**
8. Major Core for	**Civil Engineering**
9. Major Elective for	**SoE**

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

Students will learn about all aspects of the various factors affecting design and performance of pavements, types of stresses and causes, design the thickness of flexible pavements under different exposure conditions and materials.

11. Course Aims

The main aims of this course are to:

- Identify and categorize the factors affecting design and performance of pavements.
- Explain the basic methods and concepts used to analyse flexible and rigid pavements.
- Explain different design methods for flexible and rigid pavement design.
- Explain Structural and functional requirements of flexible and rigid pavements.

12. Learning Outcomes

On successful completion of the course, students will be able to achieve the following:

- Compute the stresses and deflections in flexible pavement layers under the action of wheel loads.
- Design the thickness of flexible pavements by different methods under different exposure conditions and materials.
- Design the thickness of concrete pavements and joints associated with CC pavements in addition to the computation of stresses in CC pavements.
- Factors affecting design and performance of pavements. Types of stresses and causes.

13. Curriculum Content

Module 1: Introduction

Factors Affecting Pavement Design, Variables Considered in Pavement Design, Types of Pavements, and Functions of Individual Layers, Classification of Axle Types, Tire Pressure, Contact Pressure, EAL and ESWL Concept, Lane Distributions & Vehicle Damage Factors, Effect of Transient & Moving Loads.

Module 2: Stresses And Deflections In Flexible Pavements:

Stresses and deflections in homogeneous masses. Burmister's two-layer theory, three layer and multilayer theories, Problems on above.

Module 3: Flexible Pavement:
Design Methods Principle, design steps, advantages and applications of different pavement design methods – Group Index, CBR, McLeod, Kansas Triaxial test, IRC, AASHTO and Asphalt Institute methods

Module 4: Stresses In Rigid Pavements:
Factors affecting design and performance of pavements. Types of stresses and causes, factors influencing the stresses, general considerations in rigid pavement analysis, EWL, wheel load stresses, warping stresses, frictional stresses, combined stresses. Problems on above.

Module 5: Rigid Pavement Design:
Types of joints in cement concrete pavements and their functions, joint spacing, design of CC pavement for roads and runways, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements. Design of low volume CC roads. Problems on above

14. Bibliography

Reference Books:

1. Yoder, E.J., and Witczak, Principles of Pavement Design', 2nd ed. John Wiley and Sons,1975
2. Yang H Huang, Design of Functional Pavements', McGraw Hill BookCo.
3. Khanna and Justo, „Test Book of Highway Engineering „Nemchand brothers,Roorke-2004.
4. Huang, 'Pavement Analysis', Elsevier Publications
5. Pavement and Surfacing for Highway & Airports, Micheal Sargious, Applied Science Publishers Limited.
6. Concrete Pavements, AF Stock, Elsevier, Applied Science Publishers.

Course title : Transport Infrastructure

PART A: COURSE IDENTIFIERS

1. School	**School of Engineering**
2. Department	**Civil Engineering**
3. Course Code	**CEDxxx**
4. Course Title	**Transport Infrastructure**
5. Credits (L:T:P)	**3:0:0**
6. Contact Hours (L:T:P)	**3:0:0**
7. Prerequisites	**Transportation Engineering-I**
8. Major Core for	**-**
9. Major Elective for	**Civil Engineering**

PART B: OBJECTIVES AND PRACTICE

10. Course Summary

This course introduces a range of approaches about transport infrastructures, with particular emphasis on the interaction between transport systems and users. It proposes a variety of theoretical and methodological approaches for developing mobility alternatives able to adapt to foster sustainable development. That is, the course introduces the basic theoretical knowledge about design, construction and maintenance of transport infrastructures, considering the main principles of safety and environmental sustainability.

11. Course Aims

The main aims of this course are to discuss:

- the need of Infrastructure Management in planning and maintaining the Infrastructures
- the performance of Infrastructures, causes of failure, rating methods
- the need of application of methods of prioritization and application of innovative methods.
- the impacts of transportation related components on environment

12. Learning Outcomes

On successful completion of the course, students will be able to:

- Identify the factors influencing performance of Infrastructure
- Carry out structural and functional evaluation of infrastructure
- Explain the use of models for Infrastructure management
- To assess the impacts of various development on environment
- To describe the environmental imbalances, indicators and explain the concept of EIA

13. Curriculum Content

Module 1: Introduction

The Challenge of Managing Infrastructure- Infrastructure and Society-Definition- Infrastructure Assets-Life Cycle Analysis-Infrastructure Crisis-Infrastructure Management- An integrated approach.

- Experimental learning: In-situ evaluation of management in infrastructure

Module 2: Infrastructure Management

Framework for Infrastructure Management: Background-Key Issues, Application of system Methodology-Development of IMS- Life cycle analysis Concept. Planning, Needs, Assessment and Performance Indicators: Planning-Examples on planning- Life Cycle Management-Infrastructure Service life- Needs Assessments- Performance.

- Experimental learning: Planning the life cycle analysis of infrastructure

Module 3: Evaluation Technologies

Database Management: Information Management-Database Development and Management-Needs-Analysis and Modelling Techniques-Security-Quality Control and assurance Issues. In-service Monitoring and Evaluation Data: -Needs- In service evaluation of Physical assets-Technologies for Evaluation- Methods- Issues- Examples-Road and Airport Pavements-Railroad Tracks-Bridges-Buildings

- Experimental learning: In-situ quality control checks for the road pavements

Module 4: Environmental Impacts

Environmental Issues in Industrial Development: On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Greenhouse effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining and Energy development.

Module 5: Sustainable Built Environment

Sustainable design and construction, Environmental impact assessment, Circular economy, Life-cycle cost analyais, Green buildings, Sustainable smart cities.

14. Bibliography

Reference Books:

1. Infrastructure Management: Design, Construction, Maintenance, Rehabilitation, Renovation, .W. Ronald Hudson, Ralph Haas and Waheed Uddin, McGraw Hill Co., 1997.
2. Infrastructure Engineering and Management Neil S. Grigg, John Wiley and Sons.
3. Modern Pavement Management,W. Ronald Hudson, Ralph Haas and Zeniswki, McGraw Hill and Co.
4. Jain, R.K., Urban, L.V., Stracy, G.S., (1991), "Environmental Impact Analysis", Van Nostrand Reinhold Co., New York
5. Rau, J.G. and Wooten, D.C., (1996), "Environmental Impact Assessment", McGraw Hill Pub.Co., New York