गोंय विद्यापीठ
ताळगांव पठार,
गोंय - ४०३ २०६
फोन : + ९१ - ८६६९६०९०४८

Goa University
Taleigao Plateau,Goa - 403 206
Tel : +91-8669609048
Email : registrar@unigoa.ac.in
Website : www.unigoa.ac.in

(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS -NEP/2026-27/225 Date: 20.07.2026

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2024/495 dated 10.09.2024,
GU/Acad –PG/BoS -NEP/2025/255 dated 18.07.2025

In continuation to the above referred Circulars, the syllabus for Semester V & VI of the **Bachelor of Engineering in Civil Engineering** Programme as approved by the Academic Council in its meeting held on 24th April, 12th & 13th May 2026 is attached.

The Dean, Faculty of Engineering and Principals of affiliated Colleges offering the **Bachelor of Engineering in Civil Engineering** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN V LAWANDE
Digitally signed by ASHWIN V LAWANDE
Date: 2026.07.20 16:28:02 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of Affiliated Engineering Colleges.

Copy to:

1. Chairperson, BoS in Civil Engineering, Goa University.
2. Controller of Examinations, Goa University.
3. Assistant Registrar Examinations (Technical and Allied), Goa University
4. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

CIVIL ENGINEERING (AY 2024-25)

SEMESTER - V							
Sr. No	**Course Category**	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**TCr**
1	**Major**	**CIV-300**	Transportation Engineering - I	3	0	0	3
		CIV-301	Transportation Engineering Laboratory - I	0	0	1	1
2	**Major**	**CIV-302**	Geotechnical Engineering - I	3	0	0	3
		CIV-303	Geotechnical Engineering Laboratory I	0	0	1	1
3	**Major**	**CIV-304**	Design of Concrete Structures - I	3	0	0	3
		CIV-305	Design of Concrete Structures Laboratory-I	0	0	1	1
4	**Major**	**CIV-306**	Water and Wastewater Technology	3	0	0	3
		CIV-307	Water and Wastewater Laboratory	0	0	1	1
5	**Prof. Electives**	**CIV-321**	Environmental Pollution and Control	3	0	0	3
		CIV-322	Environmental Pollution and Control Laboratory	0	0	1	1
		OR					
		CIV-323	Finite Element Analysis	3	0	0	3
		CIV-324	Finite Element Analysis Laboratory	0	0	1	1
		OR					
		CIV-325	Geo-Spatial Technology	3	0	0	3
		CIV-326	Geo-Spatial Technology Laboratory	0	0	1	1
			TOTAL	**15**	**0**	**5**	**20**

Approved by: Academic Council on 24th April, 12th & 13th May 2026

SEMESTER - VI							
Sr. No.	**Course Category**	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**TCr**
1	**Major**	**CIV-308**	Geotechnical Engineering - II	3	0	0	3
		CIV-309	Geotechnical Engineering Laboratory II	0	0	1	1
2	**Major**	**CIV-310**	Transportation Engineering - II	3	0	0	3
		CIV- 311	Transportation Engineering Laboratory - II	0	0	1	1
3	**Major**	**CIV-312**	Design of Concrete Structures - II	3	0	0	3
		CIV-313	Design of Concrete Structures Laboratory-II	0	0	1	1
4	**Major**	**CIV-314**	Design of Steel Structures	3	0	0	3
		CIV-315	Design of Steel Structures Laboratory	0	0	1	1
5	**Prof. Electives**	**CIV-327**	Solid Waste Management	3	0	0	3
		CIV-328	Solid Waste Management Laboratory	0	0	1	1
		OR					
		CIV-329	Advanced Structural Analysis	3	0	0	3
		CIV-330	Advanced Structural Analysis Laboratory	0	0	1	1
		OR					
		CIV-331	Ground Improvement Techniques	3	0	0	3
		CIV-332	Ground Improvement Techniques Laboratory	0	0	1	1
			TOTAL	**15**	**0**	**5**	**20**

SEMESTER – V

Major Courses

Name of the Programme	**: B.E. Civil Engineering**
Course Code	**: CIV-300**
Title of the Course	**: Transportation Engineering - I**
Number of Credits	**: 03**
Effective from AY	**: 2024-25**

Pre-requisites for the course:	Knowledge of fundamentals of Civil Engineering	
Course Objectives:	**The course will enable the students to:** 1. Understand the principles of highway planning, geometric design, and roadway development. 2. Understand and apply the properties of pavement materials and pavement design methods. 3. Evaluate pavement performance and maintenance requirements using standard procedures 4. Analyse traffic characteristics and traffic study data for highway design decisions.	
Content:		**No. of Hours**
UNIT 1	**Importance of Highway Engineering and Development of Roads in India:** Jayakar Committee recommendations; salient features of 20-Year Road Development Plans; Central Road Fund (CRF); Indian Roads Congress (IRC); Central Road Research Institute (CRRI); National Highway Act; role of MoRT&H. **Road types and classification;** road patterns; highway planning and surveys; preparation of master plan; saturation system of road planning; phasing of road development in India; Road Development Vision 2021; Rural Road Development Plan 2025; highway projects—new construction and realignment; preparation of Detailed Project Report (DPR). **Geometric Elements and Cross Sections:** Highway cross-section elements—camber, width of carriageway, shoulder width, formation width, right of way (ROW), and road margins; typical cross-sections for highways and rural roads; pavement surface characteristics; numerical problems.	**12**

UNIT 2	**Highway Geometric Design:** Sight Distance – types and significance; Design of Horizontal Alignment – Super elevation, Extra Widening and Transition Curves; Design of Vertical Alignment – Types of gradients, Grade compensation on curves; Hill Roads – Considerations in alignment, Geometric design standards, Hairpin Bends, Numerical problems **Highway Drainage:** Basic principles of a good drainage; Design of Surface drainage and Sub-surface drainage system; Hydrologic and Hydraulic Analysis; Cross water drainage system, Numerical problems.	**11**
UNIT 3	**Pavement Materials and Design:** Properties and requirements of subgrade soil, Aggregates, Bitumen – Tests for desirable properties; Types of surface and base courses; Modern materials and methods of construction – Construction of fly ash embankments, Polymer modified bitumen in road construction; Introduction to Flexible and Rigid pavements – Flexible and rigid pavement design as per IRC method; Interlocking Concrete Block Pavements.	**11**
UNIT 4	**Highway Maintenance:** Typical failures in flexible and rigid pavements; Repairs and maintenance of flexible and rigid pavements; Strengthening of existing pavements; Pavement evaluation – Benkelman Beam method; Evaluation of pavement surface condition. **Traffic Engineering & Control:** Traffic characteristics – Road user and vehicular; Traffic studies – Traffic volume studies, Speed study, Parking study, Accident study; Traffic control devices – Signs and signals; Intersections – Intersections at grade and grade-separated intersections; Highway lighting; Parking facilities.	**11**
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Khanna, S. K., Justo, C. E. G., and Veeraragavan, A., Highway Engineering, Revised 10th ed., Nemi Chand & Brothers, Roorkee, 2015, ISBN-13: 978-8185240930. 2. Kadiyali, L. R., and Lal, N. B., Principles and Practice of Highway Engineering, 5th ed., Khanna Publishers, New Delhi, 2013, ISBN-13: 978-8193328439. **Reference Books** 1. Venkatramaiah, C., Transportation Engineering, Volume I: Highway Engineering, Universities Press, Hyderabad, 2011, ISBN-13: 978-8173719592.	

	2. Srinivasa Kumar, R., Textbook of Highway Engineering, Universities Press, Hyderabad, 2016, ISBN-13: 978-8173719950. 3. IS and IRC/ MoRT&H codes.
Course Outcomes	**After going through this course, students will be able to:** **CO1** Describe the importance of highway engineering and road development **CO2** Apply principles of highway planning, surveys, geometric design, and drainage systems **CO3** Analyze traffic characteristics, pavement materials, pavement performance and drainage requirements **CO4** Design basic elements of highways and *evaluate* existing pavements

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-301**

Title of the Course : **Transportation Engineering Laboratory - I**

Number of Credits : **1**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of fundamentals of Civil Engineering	
Course Objectives:	**The course will enable the students to:** 1. Understand the properties and significance of aggregates and bitumen used in highway construction. 2. Apply standard laboratory testing procedures for evaluating aggregates and bituminous materials. 3. Develop skills in conducting strength, durability, and quality tests on highway materials. 4. Interpret test results for assessing the suitability of materials for pavement construction.	
Content:	Laboratory Practicals shall be performed on the topics listed below.	**No. of Hours**
Experiments	1. To determine the crushing strength of aggregates. 2. To determine the impact value of aggregates. 3. To conduct the Los Angeles abrasion test on aggregates. 4. To determine the flakiness index, elongation index, and angularity number of aggregates. 5. To determine binder content in asphaltic mix by bitumen extraction test. 6. To determine the following tests on bitumen: (i) Penetration value of bitumen. (ii) Ductility value of bitumen. (iii) Softening point of bitumen. 7. To determine the flash point and fire point of bitumen. 8. To design a job mix for road construction as per MoRT&H. 9. To evaluate the strength of subgrade soil for pavement design by CBR test 10. To design bituminous courses by Marshall mix design method	**30**
Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.	
References/ Readings:	**<u>Text Books</u>**	

	1. Khanna, S. K., Justo, C. E. G., and Veeraragavan, A., Highway Engineering, Revised 10th ed., Nemi Chand & Brothers, Roorkee, 2015, ISBN-13: 978-8185240930. 2. Kadiyali, L. R., and Lal, N. B., Principles and Practice of Highway Engineering, 5th ed., Khanna Publishers, New Delhi, 2012, ISBN-13: 978-8193328439. **Reference Books** 1. Venkatramaiah, C., Transportation Engineering, Volume I: Highway Engineering, Universities Press, Hyderabad, 2011, ISBN-13: 978-8173719592. 2. Srinivasa Kumar, R., Textbook of Highway Engineering, Universities Press, Hyderabad, 2016, ISBN-13: 978-8173719950. 3. IS and IRC/ MoRT&H codes.
Course Outcomes	**After going through this course, students will be able to:** **CO1** Understand the purpose and principles of aggregate and bitumen tests used in highway material evaluation. **CO2** Conduct standard laboratory tests on aggregates and bitumen **CO3** Analyze test data to determine the strength, durability, and quality of aggregates and bituminous materials. **CO4** Evaluate the suitability of tested materials for use in pavement layers as per relevant specifications/standards.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-302**

Title of the Course : **Geotechnical Engineering - I**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of applied mechanics	
Course Objectives:	**The course will enable the students to:** 1. Understand fundamental soil properties and classification. 2. Perform soil exploration and evaluate in-situ and laboratory test results. 3. Apply principles of effective stress, seepage, compaction, consolidation, and shear strength. 4. Analyze and design basic geotechnical engineering applications.	
Content:		**No. of Hours**
UNIT 1	**Origin and Classification of Soils:** Scope and importance of geotechnical engineering, Soil formation, soil structure and clay mineralogy, Phase relationships and basic definitions (void ratio, porosity, degree of saturation, unit weights), Clay–water interaction, adsorbed water, double layer theory (qualitative), Determination of index properties: water content, specific gravity, grain size distribution, Atterberg limits, Consistency indices and sensitivity of clays, Plasticity characteristics, Consistency and Atterberg limits, Classification of soils – IS classification system, field density tests (core cutter, sand replacement) **Soil Exploration and Sampling:** Importance and planning of site exploration, Methods of site exploration, Types of soil samples and samplers, Disturbed and undisturbed samples, Boring logs and soil reports, Standard Penetration Test (SPT), and Cone Penetration Test (CPT)	**13**
UNIT 2	**Permeability & Seepage:** Darcy's Law and its validity, Laboratory determination of permeability, Factors affecting permeability, One-dimensional and two-dimensional flow, Flow nets: construction and applications **Effective Stress and Stress Distribution:** Concept of total, neutral, and effective stresses, Principle of effective stress – importance and limitations, Capillarity, seepage forces, and quicksand condition.	**10**

UNIT 3	**Soil Compaction:** Principles of compaction, Proctor and Modified Proctor tests, Factors affecting compaction, Equipment used, Field compaction methods and control, Compaction curves and relationships with soil structure, Compaction curves for cohesive and cohesionless soil. **Consolidation:** Compressibility and consolidation concepts, Spring Analogy, Theory of consolidation (Terzaghi's one-dimensional theory), Determination of coefficient of consolidation and compressibility parameters, Preconsolidation pressure and over-consolidation ratio, Computation of consolidation settlement, Time rate of consolidation, Improvement techniques: Sand drains and prefabricated vertical drains**.**	**11**
UNIT 4	**Shear Strength of Soils**: Mohr's circle and failure envelope, Mohr–Coulomb failure criterion, Types of shear tests: direct shear, triaxial, unconfined compression, vane shear, Drained and undrained behaviour of sands and clays, Pore pressure parameters **Earth Pressure:** Earth pressure theories: Rankine and Coulomb; active, passive, and at-rest earth pressures; Mohr circle for active and passive cases. Pressure distribution on retaining walls, cohesive, cohesionless cases.	**11**
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Murthy, V. N. S., Soil Mechanics and Foundation Engineering, CBS Publishers & Distributors, New Delhi, 2010, ISBN-13: 978-8123909044. 2. Ranjan, G., and Rao, A. S. R., Basic and Applied Soil Mechanics, 2nd ed., New Age International Publishers, New Delhi, 2005, ISBN-13: 978-8122434876. 3. Das, B. M., Principles of Foundation Engineering, Cengage Learning India Pvt. Ltd., New Delhi, 2015, ISBN-13: 978-8131521685. 4. Gulhati, S. K., and Datta, M., Geotechnical Engineering, Tata McGraw-Hill Education, New Delhi, 2008, ISBN-13: 978-0074637124. **Reference Books** 1. Craig, R. F., Soil Mechanics, 8th ed., Chapman and Hall (CRC Press), London, 2012, ISBN-13: 978-0415272973. 2. Arora, K. R., Soil Mechanics and Foundation Engineering, Standard Publishers Distributors, New Delhi, 2017, ISBN-13: 978-8180141126. 3. Terzaghi, K., Peck, R. B., and Mesri, G., Soil Mechanics in Engineering Practice, 3rd ed., Wiley India Pvt. Ltd., New Delhi, 1996, ISBN-13: 978-0471086589.	

	4. Lambe, T. W., and Whitman, R. V., Soil Mechanics, Wiley, New York, 1969, ISBN-13: 978-0471511920. 5. IS codes.
Course Outcomes	**After going through this course, students will be able to:** **CO1** Explain soil origin, formation, classification, and determine basic index properties through standard tests. **CO2** Conduct soil exploration using sampling and in-situ tests (SPT, CPT) and interpret bore logs and investigation reports. **CO3** Analyze soil behaviour with respect to permeability, effective stress, compaction, consolidation, and shear strength to compute engineering parameters. **CO4** Evaluate and apply geotechnical principles to problems involving seepage, settlement, shear failure, and earth pressures for safe geotechnical design.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-303**

Title of the Course : **Geotechnical Engineering Laboratory - I**

Number of Credits : **1**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of applied mechanics	
Course Objectives:	**The course will enable the students to:** 1. Understand soil formation, classification, and basic engineering properties. 2. Apply laboratory and field methods for determining index and strength properties of soils. 3. Analyze soil behaviour related to permeability, compaction, consolidation, and shear strength. 4. Evaluate geotechnical data and apply principles for safe soil and foundation design.	
Content:	Laboratory Practicals shall be performed on the topics listed below.	**No. of Hours**
Experiments	1. To determine the natural moisture content and specific gravity of soil. 2. To determine the grain size distribution of soil using wet sieve analysis and hydrometer (or pipette) method. 3. To determine the Atterberg limits of soil, namely liquid limit, plastic limit, and shrinkage limit. 4. To determine the shear strength parameters of soil using the direct shear test. 5. To determine the in-situ density of soil using the core cutter and sand replacement methods. 6. To determine the moisture–density relationship of soil using the modified Proctor compaction test. 7. To determine the coefficient of permeability of soil using the constant head or falling head method. 8. To determine the undrained shear strength of cohesive soil using the unconfined compression test. 9. To determine the shear strength of soil using the vane shear test. 10. To determine the compression index of soil using the consolidation test.	**30**
Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.	

References/ Readings:	**Text Books** 1. Das, Braja M., Soil Mechanics Laboratory Manual, 8th ed., Oxford University Press, 2015, ISBN-13: 978-0190209667. 2. Mir, Bashir Ahmed, Manual of Geotechnical Laboratory Soil Testing, 1st ed., CRC Press, 2021, ISBN-13: 978-0367570613. 3. Arora, K. R., Geotechnical Engineering Laboratory Manual, Standard Publishers Distributors, New Delhi, ISBN-13: 978-8180141126. **Reference Books** 1. Murthy, V. N. S., Soil Mechanics Laboratory Manual, CBS Publishers & Distributors, New Delhi, ISBN-13: 978-8123913568. 2. Ranjan, G., and Rao, A. S. R., Basic and Applied Soil Mechanics, 2nd ed., New Age International Publishers, New Delhi, 2005, ISBN-13: 978-8122434876. 3. Das, B. M., Principles of Foundation Engineering, Cengage Learning India Pvt. Ltd., New Delhi, 2015, ISBN-13: 978-8131521685. 4. Gulhati, S. K., and Datta, M., Geotechnical Engineering, Tata McGraw-Hill Education, New Delhi, 2008, ISBN-13: 978-0074637124. 5. IS codes.
Course Outcomes	**After going through this course, students will be able to:** **CO1** Explain and determine basic soil properties through standard tests. **CO2** Conduct soil exploration and interpret bore logs and investigation reports. **CO3** Analyze soil behaviour and compute parameters for consolidation, and shear. **CO4** Evaluate geotechnical problems and apply principles for seepage, settlement, and earth pressure design.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-304**

Title of the Course : **Design of Concrete Structures - I**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Strength of Materials and Structural Analysis	
Course Objectives:	**The course will enable the students to:** 1. Understand the fundamental principles of the Working Stress Method and Limit State Method. 2. Apply the concepts of R.C.C design for analyzing and designing flexural members. 3. Analyze the load path mechanism in buildings and examine the structural behaviour of various members. 4. Evaluate and select appropriate design solutions and detailing for R.C.C structural elements.	
Content:		**No. of hours**
UNIT 1	**Working Stress** Method: Introduction, assumptions, Fundamentals, Moment of resistance of singly reinforced rectangular R.C. sections, under reinforced, Balanced and Over reinforced sections (No numerical shall be asked in exams based on working stress method) **Limit State Method**: Assumptions of limit state method, Strain and Stress variation diagram. Limit state of collapse, Limit state of serviceability and Limit state of durability. Characteristic strength, Characteristic load, Partial safety factors for material strengths and Loads. **Design of R.C Beams:** Concept of singly and doubly reinforced rectangular/ flanged sections, design for flexure and shear. Design and detailing of simply supported, cantilever and continuous beams.	**12**
UNIT 2	**Load Path in Buildings:** Load path mechanism of a framed structure. **Design of RCC Slabs:** Design and detailing of one-way slabs, two-way slabs and continuous slabs. **Design of Staircase**: Types of staircases, Design and detailing of dog-legged staircase (spanning longitudinally and transversely)	**11**

UNIT 3	**Design of Compression Members:** Introduction, Concepts of short and long columns, Design and detailing of compression members for axial loads, uniaxial bending and biaxial bending.	**11**
UNIT 4	**Design of Footings:** Design of isolated footings (square and rectangular) for axial load, axial load with uniaxial moments and axial load with biaxial moments.	**11**
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Punmia, B. C., Jain, A. K., and Jain, A. K., Limit State Design of Reinforced Concrete, 1st ed., Laxmi Publications Pvt. Ltd., New Delhi, 2012, ISBN-13: 978-8131802410. 2. Shah, V. L., and Karve, S. R., Illustrated Design of Reinforced Concrete Buildings, 12th ed., Standard Publications, New Delhi, 2023, ISBN-13: 978-8195012046. 3. Raju, N. K., Design of Reinforced Concrete Structures (IS 456:2000), 4th ed., CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2019, ISBN-13: 978-9385915369. **Reference Books** 1. Subramanian, N., Design of Reinforced Concrete Structures, 1st ed., Oxford University Press, New Delhi, 2013, ISBN-13: 978-0198086949. 2. Pillai, S. U., and Menon, D., Reinforced Concrete Design, 3rd ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012, ISBN-13: 978-0070141100. 3. Sinha, S. N., Reinforced Concrete Design, 2nd ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012, ISBN-13: 978-0070473324. 4. IS codes.	
Course Outcomes	**After going through this course, students will be able to:** **CO1** Explain the principles of the Working Stress Method and Limit State Method **CO2** Apply IS code provisions and R.C.C design concepts **CO3** Analyze load transfer mechanisms in buildings and assess the structural behaviour. **CO4** Evaluate alternative design solutions and prepare appropriate detailing.	

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-305**

Title of the Course : **Design of Concrete Structures Laboratory – I**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Strength of Materials and Analysis of Structures.	
Course Objectives:	**The course will enable the students to:** 1. Understand the fundamental principles, assumptions, and behaviour of R.C.C structural elements. 2. Apply Excel-based tools/ industry-standard structural design software. 3. Analyze structural behaviour and load distribution in R.C.C elements 4. Evaluate and prepare accurate reinforcement detailing for R.C.C elements.	
Content:	Laboratory Practicals shall be performed as listed below:	**No. of hours**
Practicals	1. To design RCC beam sections using MS Excel or any industry-standard software. 2. To prepare reinforcement detailing for RCC beam sections using manual methods or CAD drawings. 3. To design RCC slab sections using MS Excel or any industry-standard software. 4. To prepare reinforcement detailing for RCC slab sections using manual methods or CAD drawings. 5. To design RCC staircases using MS Excel or any industry-standard software. 6. To prepare reinforcement detailing for RCC staircases using manual methods or CAD drawings. 7. To design RCC column sections using MS Excel or any industry-standard software. 8. To prepare reinforcement detailing for RCC column sections using manual methods or CAD drawings. 9. To design RCC footing sections using MS Excel or any industry-standard software. 10. To prepare reinforcement detailing for RCC footing sections using manual methods or CAD drawings. **Note:** Use of appropriate software tools for analysis, modelling, data processing, or design is recommended wherever applicable.	**30**

Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.
References/ Readings:	**Text Books** 1. Shah, V. L., and Karve, S. R., Illustrated Design of Reinforced Concrete Buildings, 12th ed., Standard Publications, New Delhi, 2023, ISBN-13: 978-8195012046. 2. Raju, N. K., Design of Reinforced Concrete Structures (IS 456:2000), 4th ed., CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2019, ISBN-13: 978-9385915369. 3. Subramanian, N., Design of Reinforced Concrete Structures, 1st ed., Oxford University Press, New Delhi, 2013, ISBN-13: 978-0198086949. **Reference Books** 1. Punmia, B. C., Jain, A. K., and Jain, A. K., Limit State Design of Reinforced Concrete, 1st ed., Laxmi Publications Pvt. Ltd., New Delhi, 2012, ISBN-13: 978-8131802410. 2. Pillai, S. U., and Menon, D., Reinforced Concrete Design, 3rd ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012, ISBN-13: 978-0070141100. 3. Sinha, S. N., Reinforced Concrete Design, 2nd ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012, ISBN-13: 978-0070473324. 4. IS codes.
Course Outcomes	**After going through this course, student will be able to:** **CO1** Understand the fundamental principles, assumptions, and behaviour of RCC structural elements. **CO2** Apply Excel-based tools/ industry-standard structural design software **CO3** Analyze structural behaviour and load distribution in RCC elements. **CO4** Evaluate and prepare accurate reinforcement detailing for RCC elements.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-306**

Title of the Course : **Water and Wastewater Technology**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:	Environmental Science and Sustainability	
Course Objectives:	**The course will enable the students to:** 1. Understand sources, demand, and quality requirements of water and wastewater. 2. Explain basic water treatment processes and distribution systems. 3. Gain knowledge of wastewater collection and building sanitation. 4. Describe wastewater characteristics, treatment, disposal, and reuse.	
Content:		**No. of hours**
UNIT 1	**Water: Sources, Demand and Quality** Sources of water: surface and subsurface. Intake structures – purpose and basic types. Water demand: types, influencing factors, demand variations, design period, population forecasting, and estimation of water requirements. Water quality: basic physical, chemical, and biological characteristics; drinking water standards, Water quality Index	**12**
UNIT 2	**Water: Treatment and Distribution** Water treatment processes: aeration, sedimentation, coagulation and flocculation, filtration, and disinfection (chlorination). Water distribution systems: gravity, pumping, and combined systems; service reservoirs; basic pipe network layouts; pressure management, leakage control.	**11**
UNIT 3	**Wastewater Collection and Building Sanitation:** Introduction and definitions; wastewater characteristics; concepts of BOD and COD. Building drainage and sewerage systems; on-site sanitation systems—septic tank and soak pit.	**11**
UNIT 4	**Wastewater Treatment and Sludge Management** Preliminary treatment—screens, grit chambers, and equalization basins; primary treatment—primary settling tanks; secondary biological treatment—activated sludge process, Membrane Bio-reactors, rotating biological contactors, and stabilization ponds; anaerobic sludge digestion. Sludge	**11**

	handling—thickening, dewatering, and final disposal or safe reuse.	
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Textbooks** 1. Garg, S. K., Water Supply Engineering, 25th ed., Khanna Publishers, New Delhi, 2010, ISBN-13: 978-8174091201. 2. Garg, S. K., Sewage Disposal and Air Pollution Engineering, 27th ed., Khanna Publishers, New Delhi, 2012, ISBN-13: 978-8174092284. 3. Mihelcic, J. R., and Zimmerman, J. B., Environmental Engineering: Fundamentals, Sustainability, Design, Wiley, New York, 2010, ISBN-13: 978-0470165056. **Reference Books** 1. Peavy, H. S., and Row, L. A., Environmental Engineering, McGraw-Hill Education, New York, 1985, ISBN-13: 978-0070491342. 2. Hammer, M. J., and Hammer, M. J. Jr., Water and Wastewater Technology, 8th ed., Pearson Education, New Delhi, 2011, ISBN-13: 978-1292020173. 3. Metcalf & Eddy, Wastewater Engineering: Treatment and Resource Recovery, 5th ed., McGraw-Hill Education, New York, 2014, ISBN-13: 978-1259010798. 4. CPHEEO, Manual on Water Supply and Treatment, Ministry of Housing and Urban Affairs, Government of India, New Delhi. 5. IS codes.	
Course Outcomes	**After going through this course, students will be able to:** **CO1** Describe sources of water and wastewater, quality standards, and health impacts. **CO2** Apply methods to estimate water demand, forecast population growth, and interpret basic water quality parameters. **CO3** Explain the functions of key units in water treatment, distribution, sewerage, and sanitation systems. **CO4** Analyze and compare water and wastewater treatment processes for suitable applications.	

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-307**

Title of the Course : **Water and Wastewater Laboratory**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Environmental Science and Sustainability Laboratory	
Course Objectives:	**The course will enable the students to:** 1. Understand fundamental water quality parameters and their significance in environmental monitoring. 2. Apply standard laboratory procedures for analysing physical, chemical, and biological characteristics of water. 3. Analyze test results to assess pollution levels and treatment requirements. 4. Develop systematic laboratory skills for accurate measurement, data interpretation, and reporting.	
Content:	Laboratory Practicals shall be performed on the topics listed below.	**No. of Hours**
Experiments	1. To determine the pH and turbidity of given water and wastewater samples. 2. To determine the total solids (TS), total suspended solids (TSS), and total dissolved solids (TDS) present in a given water sample. 3. To determine the acidity and alkalinity of a given water sample. 4. To determine the total hardness of a given water sample using the EDTA titration method. 5. To determine the chloride and iron content present in a given water sample. 6. To determine the oil and grease content present in a given wastewater sample. 7. To determine the biochemical oxygen demand (BOD) of a given wastewater sample. 8. To determine the chemical oxygen demand (COD) of a given wastewater sample. 9. To determine the optimum dosage of coagulant for a given water sample using the jar test. 10. To detect the presence of E. coli in a given water sample to assess its bacteriological quality. 11. To study the components and treatment processes of a Water Treatment Plant (WTP) and Sewage Treatment Plant (STP)	**30**

	through a field visit and prepare a technical report based on observations.	
Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry-based learning, Constructive learning, Collaborative learning and problem solving.	
References/ Readings:	**Textbooks** 1. Kaur, K. Handbook of Water and Wastewater Analysis, Atlantic Publishers & Distributors, 2007, ISBN-13: 9788126906109 2. Khanna, D. R., & Bhutiani, R. (2008). Laboratory Manual of Water and Wastewater Analysis. Delhi, India: Daya Publishing House. ISBN-13: 9788170355281. **Reference Books** 1. Garg, S. K., Water Supply Engineering, 25th ed., Khanna Publishers, New Delhi, 2010, ISBN-13: 978-8174091201. 2. Garg, S. K., Sewage Disposal and Air Pollution Engineering, 27th ed., Khanna Publishers, New Delhi, 2012, ISBN-13: 978-8174092284. 3. Peavy, H. S., and Row, L. A., Environmental Engineering, McGraw-Hill Education, New York, 1985, ISBN-13: 978-0070491342. 4. Mihelcic, J. R., and Zimmerman, J. B., Environmental Engineering: Fundamentals, Sustainability, Design, Wiley, New York, 2010, ISBN-13: 978-0470165056 5. IS codes.	
Course Outcomes	After taking this course, students will be able to: **CO1:** Explain the significance of basic water and wastewater quality tests. **CO2:** Perform standard tests using appropriate instruments. **CO3:** Analyze and interpret test results for compliance with standards. **CO4:** Prepare concise laboratory records and reports.	

Professional Electives

Name of the Programme : B.E. Civil Engineering

Course Code : CIV-321

Title of the Course : Environmental Pollution and Control

Number of Credits : 03

Effective from AY : 2024-25

Pre-requisites for the course:	Environmental Science and Sustainability	
Course Objectives:	**The course will enable the students to:** 1. Understand the concept of air, noise, and groundwater pollution. 2. Identify various sources of pollution in the environment and its impact. 3. Apply basic pollution control measures and remediation technologies to environmental problems. 4. Assess the level of pollution and its impact on the environment.	
Content:		**No. of hours**
UNIT 1	**Fundamentals of Air Pollution:** Sources, types and impacts of air pollution; ambient air quality standards; atmospheric stability; temperature lapse rate; temperature inversion. Calculation of effective stack height and plume behaviour; measurement of SPM using HVS.	**12**
UNIT 2	**Air Pollution Control Technologies and Monitoring:** Control of particulate pollutants—cyclones, electrostatic precipitators (ESP), bag filters, and wet scrubbers; control of gaseous pollutants—absorption, adsorption, and catalytic converters.	**10**
UNIT 3	**Noise Pollution:** Introduction to Noise Pollution, sources of noise pollution; effects of noise on human health and environment; noise monitoring procedures and standards; and noise control and management methods.	**10**
UNIT 4	**Groundwater Pollution:** Sources of groundwater pollution, groundwater contamination pathways, monitoring and control using monitoring wells, and engineering protection measures—liners, geomembranes, cutoff walls. Remediation methods: pump-and-treat, air sparging, and permeable reactive barriers.	**13**
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	

References/ Readings:	**Text Books:** 1. Rao, C. S., Environmental Pollution Control Engineering, Wiley India, New Delhi, 2017, ISBN-13: 978-9386649898. 2. Peavy, H. S., Rowland, D. R., & Tchobanoglous, G., Environmental Engineering, McGraw-Hill Education, 1985, ISBN-13: 978-0070491341. 3. Cooper, C. D. & Alley, F. C., Air Pollution Control: A Design Approach, Waveland Press, 2011, ISBN-13: 978-1577667578. **Reference Books:** 1. Rao, C. S., Environmental Pollution Control Engineering, Wiley India, New Delhi, 2017, ISBN-13: 978-9386649898. 2. Rao, M. N. & Rao, H. V. N., Air Pollution, Tata McGraw-Hill Education, New Delhi, 2001, ISBN-13: 978-0074639589. 3. Todd, D. K. & Mays, L. W., Groundwater Hydrology, Wiley India, 2005, ISBN-13: 978-8126531226. 4. Peavy, H. S., Rowland, D. R., & Tchobanoglous, G., Environmental Engineering, McGraw-Hill Education, 1985, ISBN-13: 978-0070491341. 5. IS codes
Course Outcomes	**After going through this course, students will be able to:** **CO1** Explain the principles of air, noise, and groundwater pollution. **CO2** Distinguish major sources of environmental pollution and their associated impacts. **CO3** Implement basic pollution control and remediation techniques for environmental issues. **CO4** Evaluate pollution levels and their impact on the environment.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV -322**

Title of the Course : **Environmental Pollution and Control Laboratory**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:	Environmental Science and Sustainability	
Course Objectives:	**The course will enable the students to:** 1. Understand the sources, effects, and standards related to air, soil, and groundwater pollution. 2. Apply sampling and monitoring techniques for environmental pollutant measurement. 3. Analyze contaminant behavior in air, noise, and groundwater systems using engineering principles. 4. Evaluate pollution control and remediation technologies for environmental protection.	
Content:	Laboratory Practicals shall be performed on the topics as listed below:	**No. of Hours**
Experiments	1. To measure the settleable particulate matter present in ambient air at polluted or high-dust locations. 2. To determine ambient noise levels at traffic-dense or polluted zones and compare them with permissible standards. 3. To study stack emission sampling techniques using a demonstration setup and/or through an industry visit. 4. To determine the pH and electrical conductivity of groundwater samples. 5. To determine the dissolved oxygen (DO) content of groundwater samples. 6. To determine the biochemical oxygen demand (BOD) of a given groundwater sample. 7. To determine the chemical oxygen demand (COD) of a given groundwater sample. 8. To determine the total dissolved solids (TDS) present in groundwater samples. 9. To determine the hardness of groundwater samples. 10. To determine the chloride concentration in groundwater samples.	**30**

Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry-based learning, Constructive learning, Collaborative learning and problem solving.
References/ Readings:	**Text Books:** 1. Rao, C. S., Environmental Pollution Control Engineering, Wiley India, New Delhi, 2017, ISBN-13: 978-9386649898. 2. Rao, M. N. & Rao, H. V. N., Air Pollution, Tata McGraw-Hill Education, New Delhi, 2001, ISBN-13: 978-0074639589. 3. Todd, D. K. & Mays, L. W., Groundwater Hydrology, Wiley India, 2005, ISBN-13: 978-8126531226. **Reference Books:** 1. Boubel, R. W., Fox, D. L., Turner, D. B., & Stern, A. C., Fundamentals of Air Pollution, Academic Press (Elsevier), 2013, ISBN-13: 978-0123969602. 2. Peavy, H. S., Rowland, D. R., & Tchobanoglous, G., Environmental Engineering, McGraw-Hill Education, 1985, ISBN-13: 978-0070491341. 3. Wark, K., Warner, C. F., & Davis, W. T., Air Pollution: Its Origin and Control, Pearson Education, 1998, ISBN-13: 978-0205029991. 4. Cooper, C. D. & Alley, F. C., Air Pollution Control: A Design Approach, Waveland Press, 2011, ISBN-13: 978-1577667578Bies, D. A. & Hansen, C. H., Engineering Noise Control: Theory and Practice, CRC Press, 2009, ISBN-13: 978-0415470551. 5. Fetter, C. W., Applied Hydrogeology, Pearson Education, 2014, ISBN-13: 978-0134509582.
Course Outcomes	**After going through this course, students will be able to:** **CO1** Explain the causes, effects, and regulations related to air, soil, and groundwater pollution. **CO2** Apply appropriate sampling, monitoring, and testing methods for air, noise, and groundwater pollutants. **CO3** Analyze pollutant dispersion, soil contamination, and groundwater migration patterns. **CO4** Evaluate air pollution control devices and soil/groundwater remediation techniques.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-323**

Title of the Course : **Finite Element Analysis**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Engineering Mechanics	
Course Objectives:	**The course will enable the students to:** 1. Understand the basics of the Finite Element method. 2. Demonstrate the ability to invoke appropriate assumptions, select proper elements and develop FEM models. 3. Apply the mathematical and physical principles underlying the FEA to solve beam and truss problems. 4. Analyse various structural elements using the principles of FEA.	
Content:		**No. of hours**
UNIT 1	**Introduction to Finite Element method (FEM):** General description of the method, Steps involved, Advantages, Range of applications. Basic Equations from linear theory of elasticity; Equilibrium equations, Compatibility equations, Strain displacement equations. Generalized Hooke's law; Constitutive laws for plane stress and Plane strain problems, Potential energy approach, Rayleigh-Ritz method. **Matrix algebra** and Solution of simultaneous equations using Crout's reduction and Cholesky's decomposition methods.	**12**
UNIT 2	**Types of Elements, Discrete Systems:** Analysis of one-dimensional stress deformation problems; Generation of matrix displacement equations for spring element, 1-D bar element using direct and energy approach. Assembly of global stiffness matrix and Load vector, Treatment of boundary conditions and Solutions. **Co-ordinate System:** Global, Local and Natural co-ordinate. Convergence requirement on displacement field. **Shape functions** for linear, Quadratic and Cubic 1-D element.	**11**
UNIT 3	**Analysis of Plane Trusses:** Introduction, Plane trusses, Formulation of problem, Generation of element stiffness matrix, Assembly of global stiffness matrix and Load vector, Boundary conditions and Solution. Band width of a matrix. **Stiffness matrix for a beam element**. Hermite shape function. Applications to determinate and Indeterminate beams; Finite	**12**

	element formulation, Load vector, Boundary conditions, Shear force and Bending moment, Problem solution.	
UNIT 4	**Shape functions for Constant Strain Triangle (CST),** Linear Strain Triangle (LST) and 4noded rectangular element. 2-D stress deformation, Finite element formulation, Derivation of element equation, Problem solution for two dimensional stress deformation problems using CST. **Introduction to Isoparametric element** and its formulation; Jacobian matrix. Numerical integration; Guass Legendre quadrature techniqueStructural stability. **Dynamic Considerations in FEM:** Introduction, Formulation of element mass matrix; beam element.	**10**
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Reddy, J. N., An Introduction to the Finite Element Method, 3rd ed., McGraw-Hill Education, New York, 2006, ISBN-13: 978-0070607415. 2. Chandrupatla, T. R., and Belegundu, A. D., Introduction to Finite Elements in Engineering, 4th ed., Prentice Hall, New Jersey, 2011, ISBN-13: 978-0134830827. 3. Krishnamoorthy, C. S., Finite Element Analysis: Theory and Programming, 2nd ed., McGraw-Hill Education, New Delhi, 2007, ISBN-13: 978-0074622100. **Reference Books** 1. Bathe, K. J., Finite Element Procedures, Prentice Hall of India, New Delhi, 2006, ISBN-13: 978-0133173055. 2. Desai, C. S., and Abel, J. F., Introduction to the Finite Element Method: A Numerical Method for Engineering Analysis, CBS Publishers & Distributors, New Delhi, 2010, ISBN-13: 978-8123908953. 3. Rao, S. S., The Finite Element Method in Engineering, 5th ed., Butterworth-Heinemann, Oxford, 2017, ISBN-13: 978-1856176613. 4. Logan, D. L., A First Course in the Finite Element Method, 6th ed., Cengage Learning, Boston, 2017, ISBN-13: 978-1305887176.	
Course Outcomes	**After going through this course, student will be able to:** **CO1** Understand the basics of the Finite Element method. **CO2** Demonstrate the ability to invoke appropriate assumptions, select proper elements and develop FEM models. **CO3** Apply the mathematical and physical principles underlying the FEA to solve beam and truss problems. **CO4** Analyse various structural elements using the principles of FEA.	

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-324**

Title of the Course : **Finite Element Analysis Laboratory**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Strength of Materials	
Course Objectives:	**The course will enable the students to:** 1. Understand the fundamental concepts of finite element methods. 2. Apply commercial FEA software tools to build finite element models. 3. Analyse the behaviour of engineering components by interpreting stresses, deformations, reactions, etc. 4. Evaluate the accuracy and reliability of finite element solutions by comparison with analytical results.	
Content:	Laboratory Practicals shall be performed on the topics listed below.	**No. of hours**
Practicals	1. Solution of simultaneous equations using a numerical computing platform. 2. Solution of a 1-D bar element with varying cross-section using FEM and comparison with FEM software results. 3. Solution of a composite 1-D bar element using FEM and comparison with FEM software results. 4. Solution of beam elements (cantilever, simply supported, and fixed beams) using FEM and comparison with FEM software results. 5. Solution of a continuous beam with sinking support using FEM and comparison with FEM software results. 6. Solution of a truss using FEM and comparison with FEM software results. 7. Modelling and analysis of a truss subjected to temperature differential. 8. Modelling and analysis of a frame with pinned and fixed supports under varying load cases. 9. Modelling and analysis of a frame with unsymmetrical geometry under varying load cases. 10. Modelling and analysis of a slab with various mesh refinements. 11. Development of a simple code to solve a 1-D FEM problem. 12. Two-dimensional stress analysis of a plate with a hole using CST/LST elements.	**30**

	Note: Use of appropriate software tools for analysis, modelling, data processing, or design is recommended wherever applicable.	
Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.	
References/ Readings:	**Text Books** 1. Reddy, J. N., An Introduction to the Finite Element Method, 3rd ed., McGraw-Hill Education, New York, 2006, ISBN-13: 978-0070607415. 2. Chandrupatla, T. R., and Belegundu, A. D., Introduction to Finite Elements in Engineering, 4th ed., Prentice Hall, New Jersey, 2011, ISBN-13: 978-0134830827. 3. Bathe, K. J., Finite Element Procedures, Prentice-Hall of India, New Delhi, 2006, ISBN-13: 978-0133173055. **Reference Books** 1. Krishnamoorthy, C. S., Finite Element Analysis: Theory and Programming, 2nd ed., McGraw-Hill Education, New Delhi, 2007, ISBN-13: 978-0074622100. 2. Desai, C. S., and Abel, J. F., Introduction to the Finite Element Method, CBS Publishers & Distributors, New Delhi, 2010, ISBN-13: 978-8123908953. 3. Rao, S. S., The Finite Element Method in Engineering, 5th ed., Butterworth-Heinemann, Oxford, 2017, ISBN-13: 978-1856176613. 4. Logan, D. L., A First Course in the Finite Element Method, 6th ed., Cengage Learning, Boston, 2017, ISBN-13: 978-1305887176.	
Course Outcomes	**After going through this course, student will be able to:** **CO1** Understand the fundamental concepts of finite element methods. **CO2** Apply commercial FEA software tools to build finite element models. **CO3** Analyse the behaviour of engineering components by interpreting stresses, deformations, reactions, etc. **CO4** Evaluate the accuracy and reliability of finite element solutions by comparison with analytical results.	

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-325**

Title of the Course : **Geo-Spatial Technology**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Surveying and fundamentals of Civil Engineering	
Course Objectives:	**The course will enable the students to:** 1. Understand fundamental concepts, data models, and components of Geographic Information Systems. 2. Apply raster, vector, and terrain-based spatial analysis techniques using GIS software. 3. Analyze elevation, hydrological, and spatial datasets for engineering and environmental applications. 4. Interpret GIS outputs for decision-making in civil engineering applications.	
Content:		**No. of hours**
UNIT 1	**Introduction to Geographic Information Systems (GIS):** Essential components of GIS; types of vector data; concept of topology; raster data model and comparison with vector data; TIN data model and comparison with raster data; non-spatial (attribute) data and their types; vector and raster data compression techniques; georeferencing; preprocessing of spatial datasets; demonstrations using GIS software.	**11**
UNIT 2	**GIS Data Analysis and Management:** Spatial interpolation techniques; introduction to GIS analysis methods; multiple GIS analysis operations; attribute classification methods; spatial database systems and their types; concept of NoData in raster datasets; map projections; Digital Elevation Models (DEM) – concept and representation; demonstrations using GIS software.	**12**
UNIT 3	**Digital Elevation Models and Terrain Analysis:** Techniques for generation of DEMs; types of DEM resolutions; assessment of DEM quality; integration of DEMs with satellite data; DEM derivatives – slope and aspect; Triangulated Irregular Network (TIN) and its derivatives; shaded relief models; DEM-based surface hydrologic modelling; dam simulation; applications in groundwater hydrology.	**11**
UNIT 4	**Applications and Limitations of DEM and GIS:** Sources, limitations and future of DEMs; applications of DEMs in	**11**

	viewshed analysis and flood hazard mapping; applications in solar and wind energy potential estimation; errors in GIS; key elements of maps; limitations of GIS.	
Pedagogy:	The teaching–learning pedagogy will emphasize interactive learning, hands-on demonstrations using GIS software, reflective thinking, critical analysis, and problem-solving through real-world datasets.	
References/ Readings:	**Text Books** 1. Elangovan, K., GIS: Fundamentals, Applications and Implementations, New India Publishing Agency, India, 2020, ISBN-13: 978-9390175420 2. Chakraborty, D. & Sahoo, R. N., Fundamentals of Geographic Information System, Viva Books Originals, India, 2020, ISBN-13: 978-8130900414 3. Demers, M. N., Fundamentals of Geographic Information Systems, John Wiley & Sons Inc., New York, 2005, ISBN-13: 978-0470120675. **Reference Books** 1. Goodchild, M. F., Parks, B. O., and Steyaert, L. T., Environmental Modelling with GIS, Oxford University Press, New York, 1993, ISBN-13: 978-0195080072. 2. Chang, K.-T., Introduction to Geographic Information Systems, Tata McGraw-Hill Education, New Delhi, 2006, ISBN-13: 978-0070658986Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., Geographic Information Systems and Science, John Wiley & Sons, New York, 2005, ISBN-13: 978-0470870013. 3. Madhu, N., Sathikumar, R., and Satheesh Gobi, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson India, New Delhi, 2006, ISBN-13: 978-8131700563. 4. Thankappan, S., Geographical Information System, Lambert Academic Publishing, Saarbrücken, 2011, ISBN-13: 978-3845437698. 5. Kumar, P. G., Remote Sensing for the Beginner, Affiliated East–West Press Pvt. Ltd., New Delhi, ISBN-13: 978-8185936581.	
Course Outcomes	**After going through this course, student will be able to:** **CO1** Explain fundamental GIS concepts, data models, and spatial data handling techniques. **CO2** Apply raster, vector, and terrain-based spatial analysis methods using GIS software. **CO3** Analyze DEM and hydrological datasets for civil engineering applications. **CO4** Interpret GIS results for environmental assessment, hazard mapping, and infrastructure planning	

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-326**

Title of the Course : **Geo-Spatial Technology Laboratory**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Surveying and fundamentals of Civil Engineering	
Course Objectives:	**The course will enable the students to:** 1. Understand the fundamentals of satellite imagery, GIS data types, and the QGIS interface. 2. Apply digitization, georeferencing, and data styling techniques for creating spatial layers. 3. Analyze vector, raster, DEM, overlay, and buffer operations for spatial interpretation. 4. Create professional map layouts and perform spatial queries for geospatial decision-making.	
Content:	Laboratory Practicals shall be performed on the topics listed below.	**No. of Hours**
Practicals	1. To study QGIS software, basic GIS operations and import downloaded satellite imagery from Bhuvan and USGS portals 2. To digitize spatial features including point, line, and polygon layers from satellite imagery and scanned maps. 3. To create and manage attribute tables and understand different non-spatial data types. 4. To perform vector and raster data preprocessing, including handling No Data values. 5. To style vector and raster datasets using appropriate symbology and color ramps. 6. To georeference scanned maps using ground control points and appropriate transformation methods. 7. To perform spatial interpolation and generate continuous raster surfaces from point datasets. 8. To perform GIS spatial analysis including spatial queries, overlay analysis, buffer analysis, and proximity analysis. 9. To prepare professional map layouts including title, legend, scale bar, north arrow, grid, and export maps in standard formats. 10. GIS based Case-study of real world spatial problem	**30**

	Note: Use of appropriate software tools for analysis, modelling, data processing, or design is recommended wherever applicable.	
Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.	
References/ Readings:	**Text Books** 1. Demers, M. N., Fundamentals of Geographic Information Systems, John Wiley & Sons Inc., New York, 2005, ISBN-13: 978-0470120675. 2. Ormsby, T., Napoleon, E., Burke, R., Groessl, C., and Feaster, L., Getting to Know ArcGIS Desktop, ESRI Press, Redlands, California, 2004, ISBN-13: 978-1589480834. 3. Chang, K.-T., Introduction to Geographic Information Systems, Tata McGraw-Hill Education, New Delhi, 2006, ISBN-13: 978-0070658986. **Reference Books** 1. Goodchild, M. F., Parks, B. O., and Steyaert, L. T., Environmental Modelling with GIS, Oxford University Press, New York, 1993, ISBN-13: 978-0195080072. 2. Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., Geographic Information Systems and Science, John Wiley & Sons, New York, 2005, ISBN-13: 978-0470870013. 3. Madhu, N., Sathikumar, R., and Satheesh Gobi, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson India, New Delhi, 2006, ISBN-13: 978-8131700563. 4. Thankappan, S., Geographical Information System, Lambert Academic Publishing, Saarbrücken, 2011, ISBN-13: 978-3845437698. 5. Kumar, P. G., Remote Sensing for the Beginner, Affiliated East–West Press Pvt. Ltd., New Delhi, ISBN-13: 978-8185936581.	
Course Outcomes	**After going through this course, students will be able to:** **CO1** Understand satellite imagery sources, GIS data formats, and QGIS functionalities. **CO2** Perform digitization, georeferencing, and styling of vector and raster layers. **CO3** Conduct overlay analysis, buffer analysis, DEM visualization, and spatial queries. **CO4** Design and export professional map layouts with essential cartographic elements.	

SEMESTER – VI

Major Courses

Name of the Programme	**: B.E. Civil Engineering**
Course Code	**: CIV-308**
Title of the Course	**: Geotechnical Engineering - II**
Number of Credits	**: 03**
Effective from AY	**: 2024-25**

Pre-requisites for the course:	Knowledge of Geotechnical Engineering I	
Course Objectives:	**The course will enable the students to:** 1. Understand the behaviour of soils under various loading conditions. 2. Explain the principles of shallow and deep foundation design. 3. Analyze and design earth retaining structures and slopes. 4. Provide an overview of ground improvement techniques.	
Content:		**No. of hours**
UNIT 1	**Stress Distribution in Soil Mass:** Assumptions in elastic soil mass. Boussinesq's theory for point load, line load, and uniformly loaded circular area. Westergaard's theory and comparison with Boussinesq. Stress distribution below rectangular loaded areas (2:1 method approximation and analytical methods). Stress isobars and stress bulbs. Use of Influence Charts. Purpose and construction of Newmark's influence chart. Procedure for determining stress beneath irregularly shaped loaded areas, Numerical examples using influence factors, Stress beneath embankments and footings. **Stability of Slope:** Types and causes of slope failures. Infinite and finite slopes (cohesionless and cohesive soils). Taylor's stability charts. Methods of analysis: Swedish circle (Fellenius), Bishop's simplified method, Culmann's method, Slope stabilization techniques. Infinite slope analysis for seepage conditions.	**11**
UNIT 2	**Shallow Foundations:** Bearing capacity theories: Terzaghi, Meyerhof, Hansen, Vesic, IS, Plate load test. Contact pressure distribution below foundations, Modes of shear failure, concepts with typical failure patterns. Effect of water table and shape/depth factors, footing on slope. Skempton's bearing capacity for clays, Effect of eccentric or inclined loading,	**11**

	Settlement analysis: immediate, consolidation, and differential settlements. Design of isolated, combined, and raft footings, Field measurement techniques (Plate load tests, SPT, CPT, DCPT), Allowable total and differential settlement limits, Correction for rigidity and shape factors in consolidation settlement.	
UNIT 3	**Deep Foundations – Piles:** Load transfer mechanisms (end bearing, skin friction), negative skin friction, uplift resistance; pile load capacity (static and dynamic formulae); pile group efficiency, group settlement, spacing effects; pile load testing and interpretation; laterally loaded piles – sources of lateral loads, applications. **Deep Foundations – Caissons:** Comparison with piles and pier foundations; Introduction to types, components, sinking, bottom plugging; design features, launching and sinking techniques. Design aspects – bearing capacity (end bearing, skin friction), embedment depth, Introduction to check for lateral stability. **Composite Foundations:** Introduction to Combined Pile Raft Foundation (CPRF).	**13**
UNIT 4	**Sheet Piles and Ground Anchors:** Concept and applications (e.g., reinforced earth walls, slopes and excavation supports), types – tension piles, tieback anchors and micro-anchors; load transfer mechanism and pull-out resistance; design considerations – load capacity, factor of safety and allowable displacement; construction and testing of anchor piles. **Introduction to Ground Improvement Techniques:** Mechanical stabilization, lime/cement stabilization, grouting, geosynthetics, sand drains and stone columns.	**10**
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Ranjan, G., and Rao, A. S. R., Basic and Applied Soil Mechanics, 4th ed., New Age International Publishers, New Delhi, 2023, ISBN-13: 978-8122440393. 2. Das, B. M., Principles of Foundation Engineering, 9th ed., Cengage Learning, Boston, 2018, ISBN-13: 978-1337705028. 3. Murthy, V. N. S., Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, Marcel Dekker Inc., New York, 2002, ISBN-13: 978-0824708733. **Reference Books**	

	1. Punmia, B. C., Jain, A. K., and Jain, A. K., Soil Mechanics and Foundations, 18th ed., Laxmi Publications Pvt. Ltd., New Delhi, 2024, ISBN-13: 978-8170087915. 2. Bowles, J. E., Foundation Analysis and Design, 5th ed., McGraw-Hill Education, New York, 1997, ISBN-13: 978-0071188449. 3. Terzaghi, K., Peck, R. B., and Mesri, G., Soil Mechanics in Engineering Practice, 3rd ed., Wiley India Pvt. Ltd., New Delhi, 1996, ISBN-13: 978-0471086581. 4. Arora, K. R., Soil Mechanics and Foundation Engineering, 7th ed., Standard Publishers Distributors, New Delhi, 2017, ISBN-13: 978-8180141126. 5. Raj, P., Soil Mechanics and Foundation Engineering, Pearson Education, New Delhi, 2012, ISBN-13: 978-8131707796. 6. IS codes.
Course Outcomes	**After going through this course, student will be able to:** **CO1** Interpret shear strength parameters of soils and their influence on engineering behaviour under various loading conditions. **CO2** Evaluate the stability of natural and man-made slopes using analytical and graphical methods. **CO3** Design earth retaining structures by applying appropriate earth pressure theories and considering practical constraints. **CO4** Assess the bearing capacity and settlement of shallow and deep foundations for different soil conditions. Ground improvement and soil stabilization techniques for problematic soil sites.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-309**

Title of the Course : **Geotechnical Engineering Laboratory - II**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:	Basics of Geotechnical Engineering - I	
Course Objectives:	**The course will enable the students to:** 1. Understand and determine key engineering properties of soil 2. Apply standard geotechnical testing procedures as per IS codes for tests 3. Analyze soil behavior under varying loading, drainage, and stress conditions 4. Interpret test data to estimate bearing capacity and foundation performance for safe and economical geotechnical design.	
Content:	Laboratory Practicals shall be performed on the topics as listed below:	**No. of Hours**
	1. To determine the shear strength parameters of soil using the Triaxial Compression Test under Consolidated Drained (CD) conditions. 2. To determine the shear strength parameters of cohesive soil using the Consolidated Undrained (CU) triaxial test with pore water pressure measurement. 3. To determine Skempton's pore pressure parameters (A and B) based on the results obtained from the CU triaxial test. 4. To analyze the effect of confining pressure on the shear strength of soil. 5. To determine the relative density of granular soil and assess its compactness (loose, medium, or dense state). 6. To determine the consolidation characteristics of soil, including coefficient of consolidation, compression index, and pre-consolidation pressure, using the Oedometer Test. 7. To determine the ultimate bearing capacity and load–settlement behaviour of soil through a Plate Load Test. 8. To determine the safe bearing capacity of soil based on the shear strength parameters obtained from laboratory tests. 9. To determine the in-situ resistance of soil and assess its allowable bearing pressure using the Standard Penetration Test (SPT).	**30**

	10. To develop technical reporting skills and interpret experimental results for practical geotechnical engineering applications. Note: Use of appropriate software tools for analysis, modelling, data processing, or design is recommended wherever applicable.	
Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.	
References/ Readings:	**Text Books** 1. Murthy, V. N. S., Soil Mechanics and Foundation Engineering Laboratory Manual, CBS Publishers & Distributors, New Delhi, 2017, ISBN-13: 978-8123918610. 2. Arora, K. R., Soil Mechanics and Foundation Engineering Laboratory Manual, Standard Publishers Distributors, New Delhi, 2011, ISBN-13: 978-8185224145. **Reference Books** 1. Punmia, B. C., Jain, A. K., and Jain, A. K., Soil Mechanics and Foundations, 18th ed., Laxmi Publications Pvt. Ltd., New Delhi, 2024, ISBN-13: 978-8170087915. 2. Ranjan, G., and Rao, A. S. R., Basic and Applied Soil Mechanics, 4th ed., New Age International Publishers, New Delhi, 2023, ISBN-13: 978-8122440393. 3. Das, B. M., Principles of Foundation Engineering, 9th ed., Cengage Learning, Boston, 2018, ISBN-13: 978-1337705028. 4. Murthy, V. N. S., Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, Marcel Dekker Inc., New York, 2002, ISBN-13: 978-0824708733. 5. Bowles, J. E., Foundation Analysis and Design, 5th ed., McGraw-Hill Education, New York, 1997, ISBN-13: 978-0071188449. 6. Arora, K. R., Soil Mechanics and Foundation Engineering, 7th ed., Standard Publishers Distributors, New Delhi, 2017, ISBN-13: 978-8180141126. 7. Raj, P., Soil Mechanics and Foundation Engineering, Pearson Education, New Delhi, 2012, ISBN-13: 978-8131707796. 8. IS codes.	
Course Outcomes	**After going through this course, student will be able to:** **CO1** Conduct consolidation and triaxial CD tests to evaluate compressibility and shear strength parameters of soil for design applications. **CO2** Analyze and interpret results from laboratory and field tests to determine soil behavior, settlement characteristics, and	

	foundation performance. **CO3** Apply obtained soil parameters for safe design recommendations for shallow and deep foundations in practical engineering problems. **CO4** Analyze, interpret, and present laboratory test data in accordance with relevant IS codes.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-310**

Title of the Course : **Transportation Engineering – II**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Transportation Engg - I	
Course Objectives:	**The course will enable the students to:** 1. Provide foundational knowledge of railway, airport, dock, and harbour engineering systems. 2. Develop design skills for geometric elements and layouts of rail, air, and water transport infrastructure. 3. Strengthen analytical ability to assess efficiency, safety, and operational performance of transportation facilities. 4. Create awareness of sustainability and modern practices in planning, construction, and maintenance of transport systems.	
Content:		**No. of Hours**
UNIT 1	**Introduction to Railway Engineering:** Selection of routes, permanent way and its requirements, gauges and types, BG track in cutting, embankment and electrified tracks, **Components of a Track:** Requirements of a good track, track specifications on Indian Railways, forces acting on the track, ballast; types of rails and its defects coning of wheels and tilting of rails.; sleepers; subgrade and formation – functions, materials and slopes; causes of track failures and remedial measures; track fittings and fasteners. Introduction to Points and Crossings Introduction to metro railway and high-speed rail (HSR).	**11**
UNIT 2	**Geometric Design of a Railway Track:** Necessity, components, Safe speed on curves, Cant deficiency-negative cant-safe speed based on various criteria, Transition curve, Gradient and types, grade compensation, Superelevation. **Bridge Engineering:** Bridge Components: Substructure (piers, abutments, wing walls) and Superstructure (deck slab, girders, bearings). Classification and Selection: Selection of bridge site, IRC Types of bridges and culverts. Loads and Stresses: Dead load, live load (IRC and Railway loads), impact factors, and wind/seismic loads.	**11**

	Foundation Engineering: Shallow, pile, and well foundations for bridges. Construction and Maintenance: Maintenance, inspection, and rehabilitation of bridges. .	
UNIT 3	**Introduction to Airport Engineering:** Layout of an airport with component parts and functions, Site selection for airport, Aircraft characteristics affecting the design and planning of airport, Airport classification, Runway orientation using wind rose. Air Traffic Control **Runway-** Basic runway length-Corrections and examples, Runway geometrics, Runway safety and Modern Technology in Air Transport **Taxiway**-Factors affecting the layout - geometrics of taxiway- **Visual aids-** Airport marking, Airport lighting, Instrument Landing System	**12**
UNIT 4	**Harbours And Docks:** Harbour classifications, Factors considered in site selection, Harbour Layout with components, Design elements in planning of Harbours, Breakwater-Types, Wharf and Quays, Jetties and Piers, Dry dock and wet docks, Slipways, Navigational aids, Mooring accessories, fenders, Dolphins, Maintenance of Harbours **Tunnels:** Advantages and disadvantages, Size and shape of tunnels, Surveying-Transferring centre line, and gradient from surface to inside the tunnel working face, Tunnelling in rocks-methods, Tunnelling methods in soils-Needle beam, Liner plate, Tunnel lining-types, Tunnel ventilation,	**11**
Instructions	Assignments shall be given in accordance with the prescribed course content.	
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Saxena, S. C., and Arora, S. P., Railway Engineering, Dhanpat Rai Publications Pvt. Ltd., New Delhi, 2010, ISBN-13: 978-8189928834. 2. Khanna, S. K., Arora, M. G., and Jain, S. S., Airport Planning and Design, Nem Chand & Brothers, Roorkee, 1999, ISBN-13: 978-8185240688. 3. Chandra, S., and Agarwal, M. M., Railway Engineering, Oxford University Press, New York, 2013, ISBN-13: 978-0198083534. 4. Bindra S P, Principles and Practice of Bridge Engineering, Danpat Rai & sons, New Delhi, 2012, ISBN-13: 978-8189928841. **Reference Books**	

	1. Gupta, B. L., and Gupta, A., Roads, Railways, Bridges, Tunnels and Harbours Dock Engineering, Standard Publishers Distributors, New Delhi, 1978, ISBN-13: 978-8180140099. 2. Subramanian, K. P., Transportation Engineering, Scitech Publications (India) Pvt. Ltd., Chennai, 2010, ISBN-13: 978-8183716451. 3. Victor D. J. Essentials of Bridge Engineering, CBS Publishers & distributors, New Delhi, 2017, ISBN-13:978-9388178280
Course Outcomes	**The student will be able to:** **CO1** Explain the components and geometric design principles of railway tracks, airports, docks, and harbours. **CO2** Apply design standards and procedures to solve problems related to track alignment, runway orientation, and harbour layout. **CO3** Analyze the performance, safety, and efficiency of rail, air, and water transport systems under varying conditions. **CO4** Design integrated and sustainable transportation infrastructure solutions

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-311**

Title of the Course : **Transportation Engineering Laboratory - II**

Number of Credits : **1**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Transportation Engg - I	
Course Objectives:	**The course will enable the students to:** 1. Understand the principles of transportation infrastructure design, including railway tracks, airports, harbours, and tunnels. 2. Apply industry-standard software tools for designing and analyzing transportation infrastructure projects. 3. Develop skills in planning, designing, and optimizing transportation infrastructure projects. 4. Evaluate the performance of transportation infrastructure systems.	
Content:	Laboratory Practicals shall be performed on the topics listed below.	**No. of Hours**
Experiments	1. To determine the gradation and strength properties of ballast material used in railway tracks. 2. To plot Wind Rose diagram for the given wind data and determine the optimal runway orientation. 3. To design a railway track alignment for a plain or hilly terrain, including various geometric design elements . 4. To design a flexible pavement for a runway at a major airport. 5. To design a tunnel alignment for a metro project. 6. To design a harbour layout for a major port clearly specifying docks, breakwaters, jetties Dolphins. 7. To design an Airport Layout for an International Airport with Runways, Apron, and Taxiways etc. (Any Industry standard or educational free software to be use for Expt No 3 to 7) 8. To present a case study on the design and construction of any one of the following : (i) Railways (ii) Harbour (iii) Airport (iv)Tunnel	**30**
Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.	

References/ Readings:	**Text Books** 1. Saxena, S. C., and Arora, S. P., Railway Engineering, Dhanpat Rai Publications Pvt. Ltd., New Delhi, 2010, ISBN-13: 978-8189928834. 2. Khanna, S. K., Arora, M. G., and Jain, S. S., Airport Planning and Design, Nem Chand & Brothers, Roorkee, 1999, ISBN-13: 978-8185240688. 3. Chandra, S., and Agarwal, M. M., Railway Engineering, Oxford University Press, New York, 2013, ISBN-13: 978-0198083534. 4. Bindra S P, Principles and Practice of Bridge Engineering, Danpat Rai & sons, New Delhi, 2012, ISBN-13: 978-8189928841. **Reference Books** 1. Gupta, B. L., and Gupta, A., Roads, Railways, Bridges, Tunnels and Harbours Dock Engineering, Standard Publishers Distributors, New Delhi, 1978, ISBN-13: 978-8180140099. 2. Subramanian, K. P., Transportation Engineering, Scitech Publications (India) Pvt. Ltd., Chennai, 2010, ISBN-13: 978-8183716451. 3. Victor D. J. Essentials of Bridge Engineering, CBS Publishers & distributors, New Delhi, 2017, ISBN-13:978-9388178280
Course Outcomes	**After going through this course, students will be able to:** **CO1** Understand the performance of transportation infrastructure systems **CO2** Develop skills in using industry-standard software tools for transportation infrastructure design and analysis. **CO3** Analyze case studies on transportation infrastructure projects and apply lessons learned to real-world problems. **CO4** Communicate effectively transportation infrastructure designs and results through reports and presentations.

Name of the Programme	**: B.E. Civil Engineering**
Course Code	**: CIV-312**
Title of the Course	**: Design of Concrete Structures - II**
Number of Credits	**: 03**
Effective from AY	**: 2024-25**

Pre-requisites for the course:	Design principles of Reinforced Concrete Structures	
Course Objectives:	**The course will enable the students to:** 1. Develop an understanding of the behaviour and design principles of reinforced concrete structural elements. 2. Enable students to analyse and design liquid-retaining structures as per codal provisions. 3. Familiarise students with additional methods of structural analysis, including moment redistribution, plastic hinge concepts and yield line theory for slab design. 4. Introduce the fundamental concepts of prestressed concrete and design of simply supported prestressed members.	
Content:		**No. of hours**
UNIT 1	**Yield Line Analysis:** Introduction, Basic concepts, Location of yield lines for standard cases for uniformly distributed and Point loads. Methods of analysis - virtual and equilibrium. Numerical examples on analysis and design of simple slab using yield line method **Design of Water Tanks:** General design principles, Introduction to rectangular water tanks resting on ground, Underground and Overhead tanks. Design of circular and rectangular tanks resting on ground, underground tanks. General design consideration for Intze tank	**12**
UNIT 2	**Design of Combined Footings:** Design Rectangular and Trapezoidal combined footing. **Redistribution of Moments:** Concepts, Plastic hinge, Analysis of single span and continuous beams.	**12**
UNIT 3	**Retaining walls:** Stability analysis of retaining wall, Design of cantilever retaining wall and design principles of counter fort retaining wall.	**10**
UNIT 4	**Pre-Stressed Concrete:** Concept of pre-stressing, Materials used, Analysis of sections, Methods of pre-stressing, Load balancing concept. Losses of pre-stress. Design of simply supported pre-stressed member. Numericals on losses and	**11**

	stress/load concept. Design concept of precast segmental structural elements	
Instructions	Assignments shall be given in accordance with the prescribed course content.	
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Punmia, B. C., Jain, Ashok Kumar, and Jain, Arun Kumar, "RCC Design: Reinforced Concrete Structures", 10th Edition, Laxmi Publications (P.) Ltd., New Delhi, January 2015. ISBN: 9788131809426 2. Dr. V. L. Shah and Dr. S. R. Karve, "Illustrated Design of Reinforced Concrete Buildings", 12th Edition, Standard Publications, New Delhi, 2023. ISBN: 9788195012046 3. N. Krishna Raju, "Design of Reinforced Concrete Structures (IS:456-2000)", 4th Edition, CBS Publishers Pvt. Ltd., New Delhi, 2019. ISBN: 9789385915369 **Reference Books** 1. N. Subramanian, "Design of Reinforced Concrete Structures", 1st Edition, Oxford University Press, New Delhi, 2013. ISBN: 9780198086949 2. Pillai S. U. and Menon D., "Reinforced Concrete Design", 4th Edition, McGraw Hill Education (India) Private Limited, Noida, U.P., October 2021. ISBN: 9789354601026 3. Darwin D., Dolan C. W. and Nilson A. H., "Design of Concrete Structures", 15th Edition, McGraw Hill Education (India) Private Limited, Noida, U.P., July 2017. ISBN: 9789352601981 4. Sinha S. N., "Reinforced Concrete Design", 2nd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012. ISBN: 9780070473324 5. IS codes	
Course Outcomes	**After going through this course, student will be able to:** **CO1** Explain and apply the behaviour and design principles of reinforced concrete elements such as water tanks, retaining walls, and combined footings. **CO2** Analyse and design rectangular, circular, underground, overhead, and Intze water tanks as per codal requirements. **CO3** Interpret and use moment redistribution, plastic hinge concepts, portal frame analysis, and yield line theory for analysing structural components and slabs. **CO4** Apply prestressed concrete concepts, evaluate losses of prestress, and design simply supported prestressed members.	

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-313**

Title of the Course : **Design of Concrete Structures Laboratory- II**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:	Design principles of Reinforced Concrete Structures	
Course Objectives:	**The course will enable the students to:** 1. Analyse and design reinforced and prestressed concrete structures 2. Develop the ability to prepare accurate reinforcement detailing 3. Strengthen understanding of advanced structural behaviour 4. Solve problems by integrating analysis, design, and detailing for real-world structural systems.	
Content:	Laboratory Practicals shall be performed on the topics listed below.:	**No. of hours**
Practical	1. To analyse and design Underground tank sections using Excel or any industry-standard software 2. To prepare reinforcement detailing for the Underground tank sections manually OR CAD drawings. 3. To analyze and design of Intze tank using Excel or any industry-standard software 4. To design combined footings using Excel or any industry-standard software 5. To prepare reinforcement detailing for combined footings manually OR CAD drawings. 6. To design retaining walls using Excel or any industry-standard software 7. To prepare reinforcement detailing for retaining walls manually OR CAD drawings. 8. To prepare an Excel spreadsheet OR numerical examples for standard cases of Redistribution of moments. 9. To prepare an Excel spreadsheet OR numerical examples for standard cases of Yield Line failure theories of slabs. 10. To analyse and design of Prestressed concrete structure using Excel or any industry standard software Note: Use of appropriate software tools for analysis, modelling, data processing, or design is recommended wherever applicable.	**30**

Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.
References/ Readings:	**Text Books** 1. Punmia, B. C., Jain, Ashok Kumar, and Jain, Arun Kumar, "RCC Design: Reinforced Concrete Structures", 10th Edition, Laxmi Publications (P.) Ltd., New Delhi, January 2015. ISBN: 9788131809426 2. Dr. V. L. Shah and Dr. S. R. Karve, "Illustrated Design of Reinforced Concrete Buildings", 12th Edition, Standard Publications, New Delhi, 2023. ISBN: 9788195012046 3. N. Krishna Raju, "Design of Reinforced Concrete Structures (IS:456-2000)", 4th Edition, CBS Publishers Pvt. Ltd., New Delhi, 2019. ISBN: 9789385915369 **Reference Books** 1. N. Subramanian, "Design of Reinforced Concrete Structures", 1st Edition, Oxford University Press, New Delhi, 2013. ISBN: 9780198086949 2. Pillai S. U. and Menon D., "Reinforced Concrete Design", 4th Edition, McGraw Hill Education (India) Private Limited, Noida, U.P., October 2021. ISBN: 9789354601026 3. Darwin D., Dolan C. W. and Nilson A. H., "Design of Concrete Structures", 15th Edition, McGraw Hill Education (India) Private Limited, Noida, U.P., July 2017. ISBN: 9789352601981 4. Sinha S. N., "Reinforced Concrete Design", 2nd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012. ISBN: 9780070473324 5. IS codes
Course Outcomes	**After going through this course, student will be able to:** **CO1** Apply modern tools with structural engineering principles to analyse and design underground tanks, Intze tanks, retaining walls, combined footings, and prestressed concrete members. **CO2** Create accurate and code-compliant reinforcement detailing drawings for tank structures, footings, and retaining walls using manual drafting or CAD tools. **CO3** Analyze structural behaviour such as moment redistribution and yield-line failure mechanisms using numerical methods and spreadsheet-based computations. **CO4** Evaluate the safety and adequacy of designed structural components and draw conclusions.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-314**

Title of the Course : **Design of Steel Structures**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of fundamentals of Mechanics and Structural Analysis.	
Course Objectives:	**The course will enable the students to:** 1. Understand the mechanical behaviour, properties, and design principles of structural steel. 2. Apply relevant design codes and standards to design steel structural components and their connections for various loading conditions. 3. Analyze steel structural systems—including beams, columns, trusses, and frames. 4. Evaluate the safety, efficiency, and economy of steel structural designs	
Content:		**No. of hours**
UNIT 1	**Introduction**: Merits and demerits of steel, cold formed sections, Rolled steel sections, loads and loading combinations , permissible stresses, partial safety factors, design methods. **Bolted Connections**: Introduction, Advantages/ Disadvantages, Types of bolts, types of bolted connections, design of bolted shear connections, Bolts subjected to tension, bolted connections subjected to combined shear and moment and shear and tension. **Welded Connections:** Introduction, types of welds, types of welded joints, permissible stresses, design of fillet welds for axial loads and eccentric loads, unstiffened seat connections, butt welds, design of axiaily and eccentrically loaded butt welds.	**11**
UNIT 2	**Design of Tension Members**: Introduction, permissible stresses, Net sectional areas, Design of axially loaded tension members, design of tension members subjected to both axial tension and bending. **Trusses** types of trusses, components, Wind load calculation for trusses. Basic principles of design **Plastic bending of beams**, Plastic hinge, Shape factor.	**12**
UNIT 3	**Design of Compression Members:** Introduction, effective length of columns, Slenderness ratio, design of axially loaded compression members, Beam Column, design of eccentrically	**11**

	loaded compression members, column splicing, and design of angle struts. Design of Built - up Compression Members with Lacings and Battens. **Design of Column Bases**: Introduction, design of slab base and gusseted base, column bases subjected to moments.	
UNIT 4	**Design of Beams**: Introduction, permissible stresses in bending, shear, bearing, deflection, web crippling, web buckling, lateral stability of beams, design of laterally supported beams, design of laterally unsupported beams. **Built - Up Beams**: Design of plated built-up beams, check for bending stress, shear stress, deflection. Design concept of pre-engineered buildings (PEB)	**11**
Instructions	Assignments shall be given in accordance with the prescribed course content.	
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Shiyekar, M. R., Limit State Design in Structural Steel, 3rd ed., PHI Learning Pvt. Ltd., New Delhi, 2017, ISBN-13: 978-8120353503. 2. Bhavikatti, S. S., Design of Steel Structures by Limit State Method as per IS 800:2007, 5th ed., I.K. International Publishing House Pvt. Ltd., New Delhi, 2017, ISBN-13: 978-9385909559. 3. Duggal, S. K., Limit State Design of Steel Structures, 3rd ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2019, ISBN-13: 978-9353164874. **Reference Books** 1. Gambhir, M. L., Fundamentals of Structural Steel Design, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013, ISBN-13: 978-0070681163. 2. Merritt, F. S., and Brockenbrough, R. L., Structural Steel Designer's Handbook, 5th ed., McGraw-Hill, New York, 1999, ISBN-13: 978-0070419940. 3. Institute for Steel Development and Growth (INSDAG), Design Manual for Designing Steel Structures According to IS 800:2007, INSDAG, Kolkata. 4. Duggal, S. K., Steel Tables, McGraw Hill Education (India) Pvt. Ltd., New Delhi, latest edition. 5. IS 800:2007, General Construction in Steel – Code of Practice, Bureau of Indian Standards, New Delhi. 6. IS 875 (Part 3):2015, Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures – Wind Loads, Bureau of Indian Standards, New Delhi.	

Course Outcomes	**After going through this course, student will be able to:** **CO1** Understand the mechanical behaviour, properties, and design principles of structural steel members. **CO2** Apply relevant design codes and standards to design steel structural components and their connections for various loading conditions. **CO3** Analyze steel structural systems—including beams, columns, trusses, and frames. **CO4** Evaluate the safety, efficiency, and economy of steel structural designs.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-315**

Title of the Course : **Design of Steel Structures Laboratory**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of fundamentals of Mechanics and Structural Analysis.	
Course Objectives:	**The course will enable the students to:** 1. Understand the fundamental concepts of steel connection behavior and detailing. 2. Apply codal provisions to design and detail bolted shear connections, weld groups under eccentric loading, and tension/compression members. 3. Analyze structural components such as roof trusses, columns, and beams by evaluating load effects, wind forces, and stability requirements. 4. Evaluate the adequacy, safety, and efficiency of designed steel members and connections.	
Content:	Laboratory Practicals shall be performed on the topics listed below.:	**No. of hours**
Practicals	1. To draft and detail various types of bolted connections. 2. To design and detail a bolted shear connection. 3. To design weld groups subjected to eccentric loading. 4. To draft and interpret different types of welded joints. 5. To calculate wind loads acting on a roof truss. 6. To design a tension member. 7. To design an axially loaded compression member. 8. To design a laterally supported beam. 9. To design a built-up compression member with lacing or batten systems. 10. To design a slab base and a gusseted base for a column. 11. To model, analyse, and design a two-storey steel-framed structure. Note: Use of appropriate software tools for analysis, modelling, data processing, or design is recommended wherever applicable.	**30**
Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.	

References/ Readings:	**Text Books** 1. Shiyekar, M. R., Limit State Design in Structural Steel, 3rd ed., PHI Learning Pvt. Ltd., New Delhi, 2017, ISBN-13: 978-8120353503. 2. Bhavikatti, S. S., Design of Steel Structures by Limit State Method as per IS 800:2007, 5th ed., I.K. International Publishing House Pvt. Ltd., New Delhi, 2017, ISBN-13: 978-9385909559. 3. Duggal, S. K., Limit State Design of Steel Structures, 3rd ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2019, ISBN-13: 978-9353164874. **Reference Books** 1. Gambhir, M. L., Fundamentals of Structural Steel Design, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013, ISBN-13: 978-0070681163. 2. Merritt, F. S., and Brockenbrough, R. L., Structural Steel Designer's Handbook, 5th ed., McGraw-Hill, New York, 1999, ISBN-13: 978-0070419940. 3. Institute for Steel Development and Growth (INSDAG), Design Manual for Designing Steel Structures According to IS 800:2007, INSDAG, Kolkata. 4. Duggal, S. K., Steel Tables, McGraw Hill Education (India) Pvt. Ltd., New Delhi, latest edition. 5. IS 800:2007, General Construction in Steel – Code of Practice, Bureau of Indian Standards, New Delhi. 6. IS 875 (Part 3):2015, Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures – Wind Loads, Bureau of Indian Standards, New Delhi.
Course Outcomes	**After going through this course, student will be able to:** **CO1** Understand the fundamental concepts of steel connection behavior and detailing. **CO2** Apply codal provisions to design and detail bolted shear connections, weld groups under eccentric loading, and tension/compression members. **CO3** Analyze structural components. **CO4** Evaluate the adequacy, safety, and efficiency of designed steel members and connections.

Professional Electives

Name of the Programme : B.E. Civil Engineering

Course Code : CIV-327

Title of the Course : Solid Waste Management

Number of Credits : 03

Effective from AY : 2024-25

Pre-requisites for the course:	Basics of Environmental Science & Sustainability	
Course Objectives:	**The course will enable the students to:** 1. To understand the sources, characteristics, and impacts of municipal solid waste. 2. To learn the key principles of integrated solid waste management, including handling, treatment, and regulatory requirements. 3. To understand the essential components, design aspects, and environmental controls of sanitary landfill systems. 4. To gain knowledge of construction and demolition (C&D) waste, its processing technologies, and reuse applications as per national guidelines.	
Content:		**No. of hours**
UNIT 1	**Municipal Solid Waste:** Definition, sources, types, generation rates, and composition. Physical and chemical characteristics of MSW. Impacts of open dumping. Role of informal sector (ragpickers, NGOs) in MSW management.	**11**
UNIT 2	**Integrated Solid Waste Management (ISWM):** Waste management hierarchy; key stages of MSW handling: storage, collection, transportation, transfer stations. Reuse and recycling methods, including Material Recovery Facilities (MRFs). MSW treatment: composting, anaerobic digestion, incineration, pyrolysis. MSW Rules and Regulations.	**12**
UNIT 3	**MSW Disposal:** concept and importance. Landfill site selection. Basic landfill components. Liner and cover systems. Leachate collection and treatment. Landfill gas collection and control. Waste compaction and daily cover. Drainage, operation, monitoring, closure, and post-closure care.	**11**

UNIT 4	**Construction and Demolition (C&D) Waste:** Construction and demolition waste: meaning, sources, types, and composition. Environmental problems due to improper disposal. C&D waste processing: crushing, screening, grading, and production of recycled aggregates and blocks. Use of recycled C&D materials in roads, concrete, and backfilling. C&D Waste Management Rules, 2016.	**11**
Instructions	Assignments shall be given in accordance with the prescribed course content.	
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Ahuja, T. S., Solid Waste Management, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2014, ISBN-13: 978-8123922694. 2. Garg, S. K., Environmental Engineering, Vol. II, Khanna Publishers, New Delhi, 2015, ISBN-13: 978-8174090781. 3. Tchobanoglous, G., Theisen, H., and Vigil, S., Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw-Hill Education, New York, 1993, ISBN-13: 978-0070632370. **References** 1. Datta, M., Waste Disposal in Engineered Landfills, Narosa Publishing House, New Delhi, 1997, ISBN-13: 978-8173190437Mazumder, D., Solid Waste Management, PHI Learning Pvt. Ltd., New Delhi, 2010, ISBN-13: 978-8120353026. 2. Reddy, K. R., Municipal Solid Waste Management: Processing, Energy Recovery, Global Examples, IK International Publishing House Pvt. Ltd., New Delhi, 2011, ISBN-13: 978-9385909122. 3. Dutta, R. S., Municipal and Industrial Solid Waste Management, SBS Publishers & Distributors Pvt. Ltd., New Delhi, 2011, ISBN-13: 978-9380090207. 4. Chatterjee, S., Waste Management in Construction Industry, PHI Learning Pvt. Ltd., New Delhi, 2011, ISBN-13: 978-8120348596.	
Course Outcomes	**After going through this course, students will be able to:** **CO1** Describe the sources, characteristics, and impacts of municipal solid waste. **CO2** Explain the key elements of integrated solid waste management and basic MSW treatment methods. **CO3** Analyze sanitary landfill components and evaluate essential disposal and monitoring practices. **CO4** Describe C&D waste sources, processing methods, and applications of recycled materials as per regulatory requirements.	

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-328**

Title of the Course : **Solid Waste Management Laboratory**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:	Basics of Environmental Science & Sustainability	
Course Objectives:	**The course will enable the students to:** 1. Understand basic characterization methods for municipal solid waste and leachate. 2. Learn fundamental laboratory tests for evaluating the properties of recycled aggregates obtained from C&D waste. 3. Develop hands-on skills in testing aggregate quality parameters needed for reuse in civil engineering works. 4. Assess the suitability of recycled aggregates for use in concrete and pavement applications.	
Content:	Laboratory Practicals shall be performed on topics as listed below:	**No. of Hours**
	1. To determine the moisture content of wet waste (organic fraction) by oven-drying. 2. To determine the bulk density of MSW and interpret its impact on storage/transport. 3. To measure the pH and electrical conductivity of a leachate sample. 4. To perform sieve analysis on recycled aggregates obtained from C&D waste. 5. To determine the specific gravity and water absorption of recycled aggregates. 6. To determine the bulk density (loose and compacted) of recycled aggregates. 7. To determine the Aggregate Impact Value and Aggregate Crushing Value of recycled aggregates. 8. To conduct the Los Angeles Abrasion Test on recycled aggregates. 9. To determine the flakiness and elongation index of recycled aggregates. 10. To carry out a case study visit to a municipal solid waste processing facility or C&D waste recycling plant and prepare a technical report.	**30**

Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, inquiry-based learning, Constructive learning, Collaborative learning and problem-solving.
References/ Readings:	**Text Books** 1. Ahuja, T. S., Solid Waste Management, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2014, ISBN-13: 978-8123922694. 2. Garg, S. K., Environmental Engineering, Vol. II, Khanna Publishers, New Delhi, 2015, ISBN-13: 978-8174090781. 3. Tchobanoglous, G., Theisen, H., and Vigil, S., Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw-Hill Education, New York, 1993, ISBN-13: 978-0070632370. **References** 1. Datta, M., Waste Disposal in Engineered Landfills, Narosa Publishing House, New Delhi, 1997, ISBN-13: 978-8173190437Mazumder, D., Solid Waste Management, PHI Learning Pvt. Ltd., New Delhi, 2010, ISBN-13: 978-8120353026. 2. Reddy, K. R., Municipal Solid Waste Management: Processing, Energy Recovery, Global Examples, IK International Publishing House Pvt. Ltd., New Delhi, 2011, ISBN-13: 978-9385909122. 3. Dutta, R. S., Municipal and Industrial Solid Waste Management, SBS Publishers & Distributors Pvt. Ltd., New Delhi, 2011, ISBN-13: 978-9380090207. 4. Chatterjee, S., Waste Management in Construction Industry, PHI Learning Pvt. Ltd., New Delhi, 2011, ISBN-13: 978-8120348596.
Course Outcomes	**After going through this course, students will be able to:** **CO1** Identify and classify components of municipal solid waste and interpret basic leachate characteristics. **CO2** Identify and classify components of municipal solid waste and interpret basic leachate characteristics. **CO3** Determine key physical properties of recycled aggregates. **CO4** Assess the suitability of recycled aggregates for construction applications through basic mix proportioning and observation.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-329**

Title of the Course : **Advanced Structural Analysis**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Strength of Materials and Analysis of Structures.	
Course Objectives:	**The course will enable the students to:** 1. Understand the fundamental principles of structural behaviour. 2. Apply matrix-based analytical methods to determine the response of determinate and indeterminate structural systems. 3. Analyse practical structural systems by developing appropriate idealizations, constructing computational models and interpreting results 4. Evaluate the behaviour and performance of structures.	
Content:		**No. of Hours**
UNIT 1	**Review of basic Structural Analysis:** Static indeterminacy and Kinematic indeterminacy, Degree of freedom, Analysis of determinate structures (trusses, beams, frames), Analysis of indeterminate structures (Force-based and Displacement-based methods). **Matrix concepts and Basics of Matrix analysis of structures:** Matrix, vector, basic matrix operations, rank, solution of linear simultaneous equations, eigenvalues and eigenvectors, coordinate systems, displacement and force transformation matrices, element and structure stiffness matrices, element and structure flexibility matrices, equivalent joint loads, stiffness and flexibility approaches.	**12**
UNIT 2	**Matrix analysis of structures with axial elements:** Stiffness and flexibility matrices for one dimensional axial element, plane truss. Analysis by conventional stiffness and flexibility methods.	**11**
UNIT 3	**Matrix analysis of beams:** Stiffness and flexibility matrices for beam element, Analysis of continuous beams with different boundary conditions using Flexibility and Stiffness matrix methods. **Matrix analysis of grids:** Torsional stiffness of grid element and advantage of torsion release; Stiffness matrix of a grid element.	**11**

UNIT 4	**Matrix analysis of frames:** Stiffness matrix for plane frame element, Analysis of Plane Frames with different boundary conditions using Stiffness matrix method. **Structural Modelling and Computer Software Applications:** Structural Modelling Principles: Idealization, DOFs, element types, boundary conditions, modelling assumptions. Practical modelling of (i) Buildings (G+3), (ii) Bridges, using standard FEM software.	**11**
Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.	
References/ Readings:	**Text Books** 1. Menon, D., Advanced Structural Analysis, 1st ed., Narosa Publishing House, New Delhi, 2009, ISBN-13: 978-8173199394. 2. Nagarajan, A., and Praveen, G. N., Matrix Methods of Structural Analysis, 1st ed., PHI Learning Pvt. Ltd., New Delhi, 2018, ISBN-13: 978-0367571269. 3. Natarajan, C., and Revathi, P., Matrix Methods of Structural Analysis, 1st ed., PHI Learning Pvt. Ltd., New Delhi, 2019, ISBN-13: 978-8120349001. **Reference Books** 1. Pandit, G. S., and Gupta, S. P., Structural Analysis: A Matrix Approach, 2nd ed., Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2010, ISBN-13: 978-0074518182. 2. Wang, C. K., Intermediate Structural Analysis, McGraw-Hill Education, New Delhi, 2012, ISBN-13: 978-0070702769. 3. Kassimali, A., Matrix Analysis of Structures, 2nd ed., Cengage Learning, New Delhi, 2012, ISBN-13: 978-0357448304. 4. McGuire, W., Gallagher, R. H., and Ziemian, R. D., Matrix Structural Analysis, 2nd ed., Wiley India, New Delhi, 2017, ISBN-13: 978-0471352693. 5. IS codes.	
Course Outcomes	**After going through this course, student will be able to:** **CO1** Understand the principles of structural behaviour. **CO2** Apply matrix-based stiffness and flexibility methods to compute forces, displacements, and reactions. **CO3** Analyse structural systems by formulating appropriate idealizations, constructing computational models, and interpreting results. **CO4** Evaluate the performance and response of structural systems by examining analytical and computational outcomes.	

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-330**

Title of the Course : **Advanced Structural Analysis Laboratory**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:	Knowledge of Strength of Materials and Analysis of Structures.	
Course Objectives:	**The course will enable the students to:** 1. Understand the computational foundations of stiffness and flexibility methods implemented in structural analysis software. 2. Apply matrix-based modelling and analysis techniques using FEM software and scientific computing tools. 3. Analyse building and bridge structures by developing digital models and interpreting numerical outputs. 4. Evaluate structural responses by validating computational results, checking modelling assumptions, and identifying numerical or modelling errors.	
Content:	Laboratory Practicals shall be performed on the topics listed below.	**No. of Hours**
Practicals	1. To formulate the stiffness matrix for a two-dimensional truss element. 2. To implement the flexibility method for the analysis of simple beams. 3. To analyse grid structures using the stiffness method. 4. To analyse a single-bay, multi-storey plane frame. 5. To model and analyse a (G+3) building structure using structural analysis software. 6. To study rigid and flexible diaphragm modelling in building structures. 7. To analyse a simply supported bridge deck using the grillage method. 8. To assemble the global stiffness matrix for a frame structure. 9. To perform eigenvalue analysis of a frame structure. 10. To perform finite element analysis of a two-dimensional beam or truss system. **Note:** Use of appropriate software tools for analysis, modelling, data processing, or design is recommended wherever applicable.	**30**

Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.
References/ Readings:	**Text Books** 1. Menon, D., Advanced Structural Analysis, 1st ed., Narosa Publishing House, New Delhi, 2009, ISBN-13: 978-8173199394. 2. Nagarajan, A., and Praveen, G. N., Matrix Methods of Structural Analysis, 1st ed., PHI Learning Pvt. Ltd., New Delhi, 2018, ISBN-13: 978-0367571269. 3. Natarajan, C., and Revathi, P., Matrix Methods of Structural Analysis, 1st ed., PHI Learning Pvt. Ltd., New Delhi, 2019, ISBN-13: 978-8120349001. **Reference Books** 1. Pandit, G. S., and Gupta, S. P., Structural Analysis: A Matrix Approach, 2nd ed., Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2010, ISBN-13: 978-0074518182. 2. Wang, C. K., Intermediate Structural Analysis, McGraw-Hill Education, New Delhi, 2012, ISBN-13: 978-0070702769. 3. Kassimali, A., Matrix Analysis of Structures, 2nd ed., Cengage Learning, New Delhi, 2012, ISBN-13: 978-0357448304. 4. McGuire, W., Gallagher, R. H., and Ziemian, R. D., Matrix Structural Analysis, 2nd ed., Wiley India, New Delhi, 2017, ISBN-13: 978-0471352693. 5. IS codes.
Course Outcomes	**After going through this course, student will be able to:** **CO1** Understand the mathematical basis of matrix methods and their role in computer-aided structural analysis. **CO2** Apply FEM software and programming tools (Python/MATLAB) to analyse truss, beam, grid, and frame systems. **CO3** Analyse multistorey buildings and bridge structures through computational modelling and extraction of global and element-level responses. **CO4** Evaluate analysis results by verifying numerical outputs, comparing with hand calculations, and assessing the suitability of modelling assumptions.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-331**

Title of the Course : **Ground Improvement Techniques**

Number of Credits : **03**

Effective from AY : **2024-25**

Pre-requisites for the course:		
Course Objectives:	**The course will enable the students to:** 1. Understand problematic soils, their geological formation, field indicators, and engineering properties. 2. Analyze the need for ground improvement and classify suitable improvement techniques for different soil conditions. 3. Apply principles of soil treatment, compaction, stabilization, and reinforcement for improving weak soils. 4. Evaluate and select appropriate ground improvement methods with quality control and monitoring practices.	
Content:		**No. of hours**
UNIT 1	**Problematic Soils :** Soft clays, loose sands, collapsible soils, expansive soils, lateritic soils, black cotton soils, Geological formation and engineering problems, Identification & field indicators **Engineering Properties of Weak & Compressible Deposits:** Compressibility, shear strength, permeability, sensitivity, Effect of soil structure, fabric, mineralogy **Need & Role of Ground Improvement:** Need for ground improvement, Applications in foundations, embankments, pavements, Limitations & feasibility **Classification of Ground Improvement Techniques:** Mechanical, Hydraulic, Physical, Chemical, Thermal, Electrical & Electro-kinetic, Biological / Emerging trends **Principles of Soil Treatment:** Densification, Reinforcement, Drainage, Consolidation, Soil modification vs stabilization	**12**
UNIT 2	**Principles of Soil Compaction:** Compaction mechanism, moisture–density relationships, Standard & Modified Proctor tests, Field compaction control: Sand cone, core cutter, nuclear gauge, Compaction specifications **Shallow Mechanical Stabilization:** Rolling, ramming, vibration, kneading, Selection of equipment for different soils, Effect on engineering properties	**11**

	Improvement of Loose Sands (Shallow): Shallow compaction techniques, Densification requirements **Admixture Stabilization (Shallow):** Cement stabilization, Lime stabilization, Bitumen/emulsion stabilization, Industrial wastes (fly ash, slag, GGBS), Basic design guidelines, mixing & construction practices **Geosynthetics for Shallow Reinforcement:** Types of reinforcement (geotextiles, geogrids, geocells), Mechanisms: confinement, separation, filtration, drainage, Simple design of reinforced earth walls	
UNIT 3	**Deep Densification Techniques:** Dynamic compaction, Vibro-flotation, Compaction piles, Sand compaction piles. **Deep Chemical & Physical Modification:** Deep Soil Mixing (DSM), Lime columns / cement columns, Jet grouting (types: single, double, triple fluid), Principles, construction steps, applicability, limitations, Microbially Induced Carbonate Precipitation (MICP) **Consolidation Acceleration in Soft Clays:** Preloading and surcharge design, Drainage methods: Sand drains, Prefabricated vertical drains (PVDs), Radial consolidation theory, Vacuum consolidation, Effect of smear zone **Ground Improvement by Alternate Methods:** Dewatering techniques (well points, deep wells, vacuum, electro-osmosis), Electro-kinetic stabilization, Ground freezing, Vitrification & thermal methods, Microbial geotechnology (bio-cementation) **Grouting Techniques (Deep & Shallow):** Types of grouts: cement, chemical, bituminous, polymer Injection methods: permeation, compaction grouting, jet grouting, Grouting in difficult conditions, Advantages, limitations, applications **Columnar Systems:** Stone columns: mechanism, installation, applications, Micro-piles	**13**
UNIT 4	**Slope Stabilization (In-situ Techniques):** Soil nailing, Rock anchors, pre-stressed ground anchors, Drainage & surface protection, Simple design concepts for nailed slopes **Liquefaction & Its Mitigation:** Evaluation of liquefaction potential, Ground improvement techniques for mitigating liquefaction **Quality Control, Monitoring & Instrumentation:** Importance of QC/QA in ground improvement Instrumentation: settlement plates, piezometers, inclinometers, load cells, Field verification: SPT, CPT, plate load tests, permeability tests, Monitoring data interpretation, Safety & precaution measures	**09**
Instructions	Assignments shall be given in accordance with the prescribed course content.	

Pedagogy:	The teaching–learning pedagogy will emphasize on interactive learning, reflective thinking, critical analysis, and problem-solving.
References/ Readings:	**Text Books** 1. Gulhati, S. K., and Datta, M., Geotechnical Engineering, Tata McGraw-Hill Education, New Delhi, 2008, ISBN-13: 978-0070588295. 2. Raj, P. Purushothama, Ground Improvement Techniques, 3rd ed., Laxmi Publications Pvt. Ltd., New Delhi, 2015, ISBN-13: 978-8131805947. 3. Shukla, S. K., Fundamentals of Ground Improvement Engineering, CRC Press (Taylor & Francis Group), Boca Raton, 2015, ISBN-13: 978-1482252187. **Reference Books** 1. Moseley, M. P., and Kirsch, K., Ground Improvement, 2nd ed., Spon Press (Taylor & Francis Group), London, 2004, ISBN-13: 978-0415274555. 2. Bell, F. G., Engineering Treatment of Soils, E & FN Spon (Taylor & Francis Group), London, 1993, ISBN-13: 978-0419177500. 3. Hausmann, M. R., Engineering Principles of Ground Modification, McGraw-Hill Inc., New York, 1990, ISBN-13: 978-0070272798.
Course Outcomes	**After going through this course, student will be able to:** **CO1** Identify and classify problematic soils and evaluate their engineering behaviour and the need for ground improvement. **CO2** Apply and compare shallow ground improvement techniques for improving soil performance. **CO3** Explain various deep ground improvement methods and evaluate their suitability for different soil conditions. **CO4** Assess slope stabilization methods, liquefaction mitigation strategies, and quality control/monitoring measures using field instrumentation.

Name of the Programme : **B.E. Civil Engineering**

Course Code : **CIV-332**

Title of the Course : **Ground Improvement Techniques Laboratory**

Number of Credits : **01**

Effective from AY : **2024-25**

Pre-requisites for the course:		
Course Objectives:	**The course will enable the students to:** 1. To understand and evaluate soil properties, compaction characteristics, and subgrade performance. 2. To study and implement soil stabilization techniques and assess their effects on soil behavior. 3. To design and analyze ground improvement systems for enhancing soil strength and stability. 4. To assess geotechnical hazards such as liquefaction and consolidation.	
Content:	Laboratory Practicals shall be performed on the topics listed below.:	**No. of hours**
	1. To evaluate the densification potential of soil by determining its Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) using the Proctor compaction test. 2. To assess the efficiency of field compaction for ground improvement using in-situ density determination methods such as the Sand Cone or Core Cutter test. 3. To examine the improvement in subgrade performance by determining the California Bearing Ratio (CBR) of compacted soil specimens. 4. To study the effect of lime stabilization on expansive soil by evaluating changes in Atterberg limits and Free Swell Index. 5. To investigate the effectiveness of industrial waste materials (Fly Ash / GGBS) in soil stabilization by conducting compaction and CBR tests. 6. To determine the influence of cement or lime stabilization on soil behavior through compaction characteristics and CBR strength evaluation. 7. To design a preloading system with vertical drains for accelerating the consolidation of soft clay deposits. 8. To design stone column ground improvement systems for enhancing the load-bearing capacity of soft soils.	**30**

	9. To design a reinforced earth retaining wall using geogrid reinforcement for improved stability and performance. 10. To evaluate the liquefaction potential of soil deposits using Standard Penetration Test (SPT) data. 11. Case study of sites with various ground improvement techniques such as PVD's, stone columns, stabilisation etc Note: Use of appropriate software tools for analysis, modelling, data processing, or design is recommended wherever applicable.	
Pedagogy:	The teaching–learning pedagogy will emphasize on Instructional learning, Inquiry based learning, Constructive learning, Collaborative learning and problem solving.	
References/ Readings:	**Text Books** 1. Gulhati, S. K., and Datta, M., Geotechnical Engineering, Tata McGraw-Hill Education, New Delhi, 2008, ISBN-13: 978-0070588295. 2. Raj, P. Purushothama, Ground Improvement Techniques, 3rd ed., Laxmi Publications Pvt. Ltd., New Delhi, 2015, ISBN-13: 978-8131805947. 3. Shukla, S. K., Fundamentals of Ground Improvement Engineering, CRC Press (Taylor & Francis Group), Boca Raton, 2015, ISBN-13: 978-1482252187. **Reference Books** 1. Moseley, M. P., and Kirsch, K., Ground Improvement, 2nd ed., Spon Press (Taylor & Francis Group), London, 2004, ISBN-13: 978-0415274555. 2. Bell, F. G., Engineering Treatment of Soils, E & FN Spon (Taylor & Francis Group), London, 1993, ISBN-13: 978-0419177500. 3. Hausmann, M. R., Engineering Principles of Ground Modification, McGraw-Hill Inc., New York, 1990, ISBN-13: 978-0070272798.	
Course Outcomes	**After going through this course, student will be able to:** **CO1** Analyze soil properties and compaction characteristics using laboratory and field tests. **CO2** Apply appropriate soil stabilization techniques and evaluate their effectiveness on improving soil behavior. **CO3** Design and assess ground improvement systems to enhance load-bearing capacity and stability. **CO4** Identify and evaluate geotechnical hazards and propose effective engineering solutions.	