Department of Civil Engineering

(Detailed Autonomous Syllabus)

Course Name: Transportation Engineering
Course Code: CE-401
(Semester IV)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

……

1. Course Prerequisite(s):

Students are expected to know the fundamentals of Physics, Mathematics, Engineering Mechanics.

2. Course Learning Objectives:

The objectives of the course are to enable the student

- To understand key transportation systems and road development history of India.
- To apply geometric design principles for highway alignment and cross-section elements.
- To design inclusive and accessible infrastructure for public places and transportation.
- To analyze traffic flow and develop effective traffic management solutions.
- To evaluate and design pavement systems using appropriate materials standards.

3. Teaching methodology and evaluation system for the course:

Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies and Field Visits.
Evaluation System –
CIA1: 40 MARKS (25 marks written class test, 15 marks Attendance/assignment)
CIA2: 40 MARKS (25 marks written class test, 15 marks Attendance/assignment)
Final exam: 60 marks

4. Course Content:

Course Name: Transportation Engineering
Course Code: CE-401
Hours per Week: 2L:1T:0P
Credits: 3

Module	Topics	42L	Syllabus coverage (%)
1.	Highway Development and Planning: Introduction to Different Modes of Transportation, History of Road Transportation in India, Jayakar Committee Report, Classification of Roads, Road Development in India, Smart RoadTechnologies, Public-Private Partnership (PPP) in Highway Projects.	4L	10

2.	Highway Geometric DesignandAlignment:HighwayAlignmentandRoutePlanning,HighwayCrossSection Elements;Sight Distance,Design Principles of Highway Alignment, Design Principles of Vertical Alignment, Problems.	6L+2T	19
3.	Accessible Infrastructure Design: Design ofAccessRoutesandWalkways (Elements of walkways, Tactile Navigation Systems, BRT Systems and InclusivePublicTransportation,Pedestrianstreets), OverviewofPedestrian andCyclistFacilities,AccessibleStreetsandMobilityEnvironments(Street ElementsforAccessibility,tactilegroundsurfaceindicators(TGSIs),ramps,hand rails), Inclusive Design of Public Spaces.	5L + 1T	14
4.	TrafficEngineeringandManagement: TrafficCharacteristics,Traffic EngineeringStudies,Traffic Flow and Capacity, Traffic Regulation and Control, DesignofRoadIntersectionsandParkingFacilities,TrafficSigns,HighwayLighting, Introduction to Intelligent Transportation Systems (ITS), Problems.	6L + 2T	19
5.	PavementMaterialsandTesting:MaterialsusedinHighwayConstruction-Soils,Aggregates,BituminousBinders,BituminousPavingMixes;Portland cementandCementConcrete, Testing of PavementMaterials, Recycled andEmerging Materials, Problems.	4L + 2T	14
6.	DesignandMaintenanceof Pavements:Design of Pavements-Introduction; FlexiblePavements-FactorsaffectingDesignandPerformance,Designof FlexiblePavementsasper IRCcodes,andStress Analysis;Rigid Pavements-ComponentsofRigidPavements,FactorsaffectingtheirDesignand Performance,andDesignofConcretePavementsasperIRCstandards;IIT PAVE Softwarefor PavementDesign, Pavement Failures,Remedial Measuresfor Pavement Distresses, Problems.	8L + 2T	24

5. References:

Text Books:

1.HighwayEngineering,Khanna,S.K.,Justo,C.E.GandVeeraragavan,A;Revised 10th Edition, Nem Chand & Bros, 2017.

2. Textbook of Highway Engineering, Srinivasa Kumar, R, Universities Press, 2011.

3. Traffic Engineering and Transport Planning, Kadiyalai, L.R., Khanna Publishers.

Reference Books:

1. Hydraulics and Fluid Mechanics Including Hydraulics Machines by P. N. Modi and S. M. Seth, 23rd Edition, Standard Book House, 2022.
2. Fluid Mechanics and Hydraulic Machines-Problems and Solution by K. Subramanya, 2nd Edition, McGraw Hill Education, 2018.
3. Hydraulics, Fluid Mechanics and Hydraulic Machines by R. S. Khurmi and N. Khurmi, 15th Edition, S Chand & CompanyLtd., 1987.

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Describe the importanceof highway infrastructure, includingmodes,historicaldevelopment,classifica	Describe	Understand

	tion, and trends.		
CO2	Implementdesignprinciplesofsightdistance, cross-sectionelements,andhighwaygeometric alignmentstooptimizesafeandefficientroad networks.	Implement	Apply
CO3	Designinclusiveinfrastructure to ensurecompliancewithaccessibilitystandardsfor all users, including individuals with disabilities.	Design	Create
CO4	Designeffective traffic managementsystems, and implement appropriatetrafficcontrolmeasures based on traffic characteristics.	Design, Implement	Create
CO5	Identifyhighwayconstructionmaterialsand relate the suitabilityof recycledand emergingmaterials for sustainable pavement design.	Identify, Relate	Analyze
CO6	DesignpavementstructuresaccordingtoIRC codes,andrecommendmaintenancestrategiesba sed on observed pavement distresses.	Design	Create

7. Mapping of Course Outcomes (CO) to Module:

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	1	-	-	-	-
2	1	3	-	-	-	-
3	-	-	3	-	-	-
4	-	-	-	3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	1	3

8. Mapping of the Course Outcomes (CO) to Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	-	-	1	-	-	1	-	2
CO2	3	3	2	1	2	2	-	-	1	1	1
CO3	2	2	3	1	1	3	2	2	1	1	1
CO4	3	3	2	2	2	2	1	-	2	2	1
CO5	3	2	2	1	2	3	2	-	1	-	2
CO6	3	3	3	2	2	2	1	-	1	2	1

Average	2.83	2.50	2.17	1.40	1.80	2.17	1.50	2.00	1.17	1.50	1.33

9. Mapping of the Course Outcomes (CO) to Program Specific Outcomes (PSO):

CO	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	2
CO3	3	2	2
CO4	3	2	3
CO5	3	3	2
CO6	3	2	3

Course Name: SURVEYING AND GEOMATICS
Course Code: CE-402
(Semester IV)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

……

1. Course Prerequisite:
   Class-XII level knowledge of Physics, Mathematics, Numerical Methods and Geography; Undergraduate level introductory knowledge of Civil Engineering.

2. Course Learning Objectives:
   i. This course introduces the concepts of sustainability in civil engineering and explores the role of construction materials in developing green infrastructure.
   ii. Students will also learn to design energy-efficient buildings, implement sustainable site planning, navigate green building certifications, and evaluate the economics and ethics of sustainable construction practices.

3. Teaching methodology and evaluation system for the course:
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures and Field Visits.
   Evaluation System –
   Attendance
   Internal Assessment (20 Marks)- Formative Continuous Assessment [Continuous Assessment 1 (10 Marks); Continuous Assessment 2 (10 Marks)]
   Mid-Term Exam (30 Marks)- Summative Assessment
   End-Semester Exam (50 Marks)- Summative Assessment.

4. Course Content:
   Course Name: Surveying and Geomatics
   Course Code: CE-402
   Hours per Week: 3L:0T:0P
   Credits: 3

Module	Topics	42L

1.	Principles of Surveying Introduction, Principles and classification of surveying; Concept of scales; Survey stations and lines – ranging and bearing; Chain surveying – Concept, Instruments, numerical problems on errors due to incorrect chain; Compass Surveying – Applications of different types of compass, traversing, correction due to errors; Plane table surveying – Advantages, disadvantages, parts, methods; Elements of simple and compound curves, concept of transition curve.	10L
2.	Levelling: Levelling – Principles, different methods and instruments used in levelling, Precautions and Difficulties; Differential levelling, Concepts and numerical problems; Contouring.	5L
3.	Triangulation and Trilateration: Theodolite survey – Instruments, measurements of horizontal and vertical angles; Triangulation – Network, signals, numerical examples; Baseline measurement – site selection, measuring equipment, numerical problems o baseline corrections; Trigonometric levelling – Axis signal correction.	7L
4.	Photogrammetric Surveying: Concept; Classification of photogrammetric surveying – terrestrial, aerial and satellite; scale of a vertical photograph; relief displacement and object height determination; Stereoscopic vision – depth perception, parallactic angle, stereoscopes; Object height determination using parallax; Parallax bar; Flight planning – Concept and numerical problems; Photo mosaic; Orthophotography; Stereoscopic plotting instruments.	7L
5.	Remote Sensing: Energy sources and radiation principles; Concept of Electromagnetic Spectrum; Energy interactions in the atmosphere and earth surface features; Data acquisition and interpretation; Platforms and sensors – Geostationary and sun-synchronous orbits, push broom and whiskbroom scanning system, characteristics of IRS, Landsat and Sentinel sensors; Visual image Interpretation, Digital Image Processing: Concept; Image rectification and restoration; Image enhancement; Image classification; Accuracy assessment and post-classification smoothing.	7L
6.	Advanced Surveying: Principle of Electronic Distance Measurement (EDM); Types of EDM instruments; Distomats; Total Station – Parts, advantages, applications, field procedure and errors; Global Positioning System (GPS) – Concept, applications, segments, location determination, errors; Principle of Differential GPS; Terrestrial laser scanner, Applications of Geomatics in Civil Engineering: 3D mapping; Earthquake and landslides; Runoff modeling; Groundwater targeting; Flood risk assessment; Urban planning; Highway and transportation.	6L

5. References:

Text Book:

- “Surveying Vol. 1, 2, & 3" by B.C. Punmia, Ashok Kumar Jain, and Arun Kumar Jain, Laxmi Publications
- "Higher Surveying" by A.M. Chandra, New Age International Publishers
- "Fundamentals of Surveying" by S.K. Roy, PHI Learning Pvt. Ltd. Publishers

Reference Books:

- "Remote Sensing and GIS" by Basudeb Bhatta, Oxford University Press Publishers
- "Textbook of Surveying" by C. Venkatramaiah, University Press Publishers

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level

CO1	To explain and state the scope of surveying and geomatics in civil engineering	Explain	Understand
CO2	To demonstrate the basic principles of surveying and geomatics engineering	Demonstrate	Apply
CO3	To solve the problems using different methods of surveying and geomatics to measure the features of interest	Solve	Apply
CO4	To examine the traditional and advanced methods of surveying	Examine	Analyze
CO5	To relate the different techniques of surveying and geomatics in solving real world problems.	Relate	Analyze
CO6	To develop and construct solutions for real-world problems related to surveying and geomatics.	Develop	Create

7. Mapping of course outcomes to module/course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3	2	-	-
4	-	-	2	3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	0	0	1	0	0	1	0	2
CO2	3	2	1	1	1	1	0	0	1	0	1
CO3	3	3	2	2	2	1	0	0	1	1	1
CO4	2	3	2	2	2	2	1	0	1	1	1
CO5	3	3	3	2	2	2	1	0	2	2	1
CO6	3	3	3	2	2	2	1	0	2	2	1
Total	2.83	2.67	2	1.50	1.50	1.50	0.50	0	1.33	1	1.17

9. Mapping to PSO

	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	2
CO4	2	3	2
CO5	3	2	3
CO6	3	2	3

Course Name: GEOTECHNICAL ENGINEERING

Course Code: CE-403
(Semester IV)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

……

1. Course Prerequisite:
   Engineering Mechanics, Engineering Mathematics.

2. Course Learning Objectives:
   i. This course introduces the study of the behaviour of soils under the influence of internal and external loading conditions and soil-water interactions.
   ii. Students will also learn to predict different soil parameters by using different numerical and graphical methodologies.

3. Teaching methodology and evaluation system for the course:
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures and Field Visits.
   Evaluation System –
   Internal Assessment (40 Marks)- Formative Continuous Assessment [Continuous Assessment 1(CIA1- 25 Marks written class test, 15 Marks Attendance/Assignment); [Continuous Assessment 2(CIA2- 25 Marks written class test, 15 Marks Attendance/Assignment).
   End-Semester Exam (60 Marks)- Summative Assessment.

4. Course Content:
   Course Name: Geotechnical Engineering
   Course Code: CE-403
   Hours per Week: 3L:0T:0P
   Credits: 3

Module	Topics	42L
1.	Soil formation and soil classification: Origin of soil, Formation and types of soil, Formative classification, Some special types of soils, Structure and composition, Clay minerology; Classification of soil by structure, Particle size classification, Textural classification, Unified Classification, AASHTO classification, IS code classification, Plasticity chart.	4L
2.	Physical properties and Index properties: Phase system of soil, Basic definitions, Mass-Volume relationships, Physical properties: Density, Moisture content, specific gravity, Relative density, functional relationships; Index properties: particle size distribution, Mechanical analysis, Sedimentation analysis, Consistency, Atterberg limits, and indices.	8L
3.	Soil Hydraulics and Flow through Soil: Pore-water pressure: Pore water, Total pressure, Effective pressure under different conditions. Permeability: Darcy'sLaw, Coefficient of Permeability, Discharge Velocity, Seepage Velocity, Factors Affecting Permeability, Determination of coefficient of Permeability. Seepage: Seepage pressure, Flow nets, Flow through earthen dam, Estimation of seepage quantity, Construction of flow nets, Piping effect,	6L

Module	Topics	42L
	Uplift due to seepage, Critical hydraulic gradient, Quick sand condition.	
4.	Stress Distribution in Soil: Geostatic stress, Boussinesq's Equation, Determination of stress due to point load, Vertical stress distribution on horizontal plane, Isobar and pressure bulb, Vertical stress distribution on vertical plane, Vertical stress under uniformly loaded circular area, Vertical stress beneath a corner of a rectangular area, Equivalent point load method, 2:1 method, Newmark's influence chart, Vertical stress beneath line and strip load, Westergaard analysis.	6L
5.	Consolidation and Compaction: Consolidation: One-dimensional consolidation, Compressibility, Compression index, Coefficient of compressibility and volume change, Coefficient of consolidation, Degree and rate of consolidation, Time factor, settlement computation, Determination of consolidation parameters: Oedometer test. Compaction: Principle of compaction, Standard and modified proctor compaction test, Factors affecting compaction, Effect of compaction on soil properties, Field compaction methods.	8L
6.	Shear strength of soil: Concept of Shaer resistance and Shear Strength of soil, Mohr circle of stress, Mohr-Coulomb Theory, Relationship between principal stresses and cohesion. Determination of shear parameters, stress-strain relationship of cohesive and cohesionless soils, Concept of critical void ratio, Sensitivity and thixotropy.	10L

5. References:

Text Book:

- Basic and Applied Soil Mechanics, Gopal Ranjan and A.S.R. Rao, New Age International Pvt. Ltd. Publishers.
- Principles of Geotechnical Engineering, B.M. Das, Thomson Brooks/Cole.
- Geotechnical Engineering, Shashi K Gulhati, Manoj Datta, The McGraw-Hill Company.

Reference Books:

- Textbook of Soil Mechanics and Foundation Engineering, V.N.S. Murthy, CBS Publication.
- Soil Mechanics and Foundations, B.C. Punmia and A.K. Jain, Laxmi Publication Pvt. Ltd.

6. Course Outcomes:

After completion of this course, students will be able to

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Classify soil according to soil formation and characteristics.	Explain	Understand
CO2	Determine soil properties from basic relationships among parameters.	Determine	Apply
CO3	Examine the soil-water condition and flow characteristics through the soil.	Investigate	Analyse
CO4	Estimate the stress condition beneath the soil under an external vertical load.	Estimate	Evaluate
CO5	Estimate the degree of consolidation and settlement condition of soil under applied loading.	Estimate	Evaluate
CO6	Determine shear parameters and shear	Determine	Apply

	strength of soil from laboratory testing and mathematical formulations.		

7. Mapping of course outcomes to module/course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3		-	-
4	-	-		3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	-	3

8. Mapping of the Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-
CO5	3	3	3	3	1	-	-	-	-	-	1
CO6	3	3	3	3	1	-	-	-	-	-	1

9. Mapping to PSO

	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	3	-	-
CO3	3	-	-
CO4	3	-	-
CO5	2	2	3
CO6	3	2	3

Course Name: Fluid Mechanics and Hydraulic Engineering
Course Code: CE-404
(Semester IV)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

……

1. Course Prerequisite(s):

Students are expected to know the fundamentals of Physics, Mathematics, Engineering Mechanics, Workshop Processes and Engineering Drawing.

2. Course Learning Objectives:

The objectives of the course are to enable the student

- To understand the basic principles of fluid mechanics.
- To identify various types of flows.

- To understand boundary layer concepts and flow through pipes.
- To evaluate the performance of hydraulic turbines.
- To understand the functioning and characteristic curves of pumps.

3. Teaching methodology and evaluation system for the course:
Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies and Field Visits.
Evaluation System –
CIA1: 40 MARKS (25 marks written class test, 15 marks Attendance/assignment)
CIA2: 40 MARKS (25 marks written class test, 15 marks Attendance/assignment)
Final exam: 60 marks

4. Course Content :

Course Name: Fluid Mechanics and Hydraulic Engineering
Course Code: CE-404
Hours per Week: 2L:1T:0P
Credits: 3

Module	Topics	42L	Syllabus coverage (%)
1.	Properties of Fluids and Fluid Statics : Fluid classifications, hypothesis of continuum, shear stress in a moving fluid, molecular structure of material, density, viscosity, surface tension, capillary effect, vapor pressure, compressibility and the bulk modulus, pressure, Pascal's law of pressure at a point, variation of pressure vertically in a fluid under gravity, equality of pressure at the same level in a static fluid, general equation for the variation of pressure due to gravity from a point to point in a static fluid, pressure and head, hydrostatic paradox. Fluid static, action of fluid pressure on surface, resultant force and center of pressure on a plane surface under uniform pressure and surface immersed in a liquid, pressure diagrams, forces on a curved surface due to hydrostatic pressure, buoyancy, equilibrium of floating bodies, stability of a submerged body and floating bodies, determination of the metacentric height, determination of the position of the metacenter relative to the center of buoyancy.	6L +4T	24
2.	Kinematics and Dynamics of Fluid Flow : Fluid flow, Stream line, path line and streak lines and stream tubes, classification of flows- steady & unsteady, uniform & non uniform, laminar & turbulent, rotational &irrotational flows, frames of reference, analyzing fluid flow, motion of a fluid particle, acceleration of a fluid particle, discharge and mean velocity, continuity of flow, continuity equations for 2-D and 3-D flow in Cartesian coordinates of system, circulation and vorticity, streamlines and the stream functions, velocity potential and potential flow, relation between stream function and velocity potential, stream function and velocity potential for uniform flow, vortex flow. Momentum and fluid flow, Momentum equation for 2-D flow along a	7L + 2T	21

	stream line, momentum correction factor, Euler's equation of motion along a stream line, mechanical energy of a flowing fluid, Bernoulli's theorem, kinetic energy correction factor, changes of pressure in tapering pipe, principle of venturimeter, orifice, rotameter, theory of notches and weirs.		
3.	Dimensional Analysis and Fluid Flow Similarities : Dimension reasoning, dimensional homogeneity, dimensional analysis using Rayleigh's method, Buckingham π-theorem, use of dimensionless numbers in experimental investigation, geometric similarity, dynamic similarity, kinematic similarity, model testing, model laws, undistorted and distorted models.	2L + 1T	7
4.	Viscous and Turbulent Flow :Reynolds' experiment, flow of viscous fluid through circular pipe-Hagen Poiseuille formula, flow of viscous fluid between two parallel fixed plates, power absorbed in viscous flow through - journal, foot step and collar bearing, turbulent flow expression for coefficient of friction -DarchyWeishbach equation, moody diagram, resistance of smooth and rough pipes, shear stress and velocity distribution in turbulent flow through pipes.	2L + 2T	10
5.	Pipe Flow Analysis and Hydraulic Turbine Dynamics : Major and minor energy losses, hydraulic gradient and total energy lines, pipes in series and parallel, equivalent pipes, water hammer in pipes. Force exerted on stationary flat and curved plates held normal, force exerted on moving plate held normal and on a plate when vane is moving in direction of jet, jet striking on curved vane tangentially at one tip and leaving at other end, classification of hydraulic turbines, impulse and reaction turbines, construction, working and analysis of Pelton, Francis and Kaplan turbines, draft tube, governing of the hydraulic turbines, cavitations, performance characteristics.	6L + 2T	19
6.	Hydraulic Pumps and Hydraulic Machines: Pump classification and selection criterion, velocity vector diagrams, pump losses and efficiencies, net positive suction head, pressure rise in impeller, characteristic curves, priming. Reciprocating pumps : Working , Discharge, slip, Indicator Diagram. Hydraulic press, hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic jack, hydraulic lift, hydraulic ram, fluid couplings, fluid torque converter and air lift pump.	6L + 2T	19

5. References:

Text Books:

1. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Revised 9th Edition, Laxmi Publications (P) Ltd., 2010.
2. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, 9thEdition, S.K. Kataria& Sons, 2015.
3. A Textbook of Fluid Mechanics and Hydraulic Machines by R.K. Rajput, 6thEdition, S Chand & Company Ltd., 2015.

Reference Books :

1. Hydraulics and Fluid Mechanics Including Hydraulics Machines by P. N. Modi and S. M. Seth, 23rd Edition, Standard Book House, 2022.

2. Fluid Mechanics and Hydraulic Machines-Problems and Solution by K. Subramanya, 2nd Edition, McGraw Hill Education, 2018.
3. Hydraulics, Fluid Mechanics and Hydraulic Machines by R. S. Khurmi and N. Khurmi, 15th Edition, S Chand & Company Ltd., 1987.

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	To define basic terms, values and laws in the areas of fluid properties and fluid statics.	Define	Remember
CO2	To describe the kinematics and dynamics of fluids, and hydraulic design of pipe systems.	Describe	Understand
CO3	To relate to the boundary layer concept and analyze different types of losses and measurement of flow.	Relate	Analyse
CO4	To distinguish the different types of turbines and examine the performance characteristics of various turbines.	Distinguish	Analyse
CO5	To appraise the working of power absorbing devices like pumps and their performance characteristics.	Appraise	Evaluate
CO6	To recognize the working of various hydraulic machines.	Recognize	Understand

7. Mapping of Course Outcomes (CO) to Module:

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	1	-	-	-	-
2	-	3	-	-	-	-
3	3	1	-	-	-	-
4	-	-	3	-	-	-
5	-	3	1	3	3	-
6	-	-	-	-	1	3

8. Mapping of the Course Outcomes (CO) to Program Outcomes (PO) :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	1	1	-	-	-	-	2
CO2	3	3	3	2	1	2	-	-	-	-	2

CO3	3	3	2	2	1	3	-	-	-	-	2
CO4	2	3	3	2	-	2	-	-	-	-	1
CO5	3	2	2	1	1	3	-	-	-	-	1
CO6	3	3	3	1	1	2	-	-	-	-	1
Average	2.83	2.83	2.5	1.67	1.0	2.17	0	0	0	0	1.5

9. Mapping of the Course Outcomes (CO) to Program Specific Outcomes (PSO):

CO	PSO1	PSO2	PSO3
CO1	3	1	1
CO2	3	1	2
CO3	3	1	2
CO4	3	1	1
CO5	3	1	1
CO6	3	1	2

Course Name: STRUCTURAL ANALYSIS – I
Course Code: CE-405
(Semester IV)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

……

1. Course Prerequisite:
   - Basic understanding of the mechanics of solids and mathematics.
   - Knowledge of engineering materials and their behaviour under load.

2. Course Learning Objectives:
   i. Develop the ability to analyse determinate and indeterminate structures, including calculation of slopes, deflections, internal forces, and influence line diagrams for beams, frames, and arches.
   ii. Apply energy methods (strain energy, virtual work, displacement theorems) to understand and analyse structural behaviour, including cable and space structures.

3. Teaching methodology and evaluation system for the course:
   Teaching methodology –Lectures and Presentations, Interactive Discussions and Case Studies; Problem-solving sessions, tutorials and Field Visits.
   Evaluation System –
   CIA1: 40 MARKS (25 marks written class test, 15 marks Attendance/assignment)
   CIA2: 40 MARKS (25 marks written class test, 15 marks Attendance/assignment)
   Final exam: 60 marks

4. Course Content:
   Course Name: Structural Analysis – I
   Course Code: CE-405
   Hours per Week: 3L:0T:0P
   Credits: 3

Module	Topics	Lecture (42L)
1.	Structural Systems & Basic Concepts: Types of structural systems; Linearity and non-linearity in structural analysis; statically determinate and indeterminate structures; Degree of static indeterminacy; Recapitulation of shear force and bending moment diagrams.	7L
2.	Energy Methods – Strain Energy Strain energy and complementary strain energy, Strain energy due to gradually and suddenly applied loads; Strain energy due to axial force; shear force, bending, and torsion; Displacement of beams and trusses by strain energy method.	7L
3.	Virtual Work Method: Limitations of real work method, Principle of virtual work; Unit load method; Displacement of beams, frames, trusses; Effects of temperature and fabrication errors; Betti's law and Maxwell's reciprocal theorem; Castigliano's theorems and applications.	7L
4.	Slope and Deflection of Beams: Integration method; Moment area method; Conjugate beam method.	6L
5.	Moving Loads & Arches: Moving loads and influence lines; Influence line diagrams for beams and trusses; Maximum internal forces using ILD; Types of arches; Three-hinged arches and analysis; Internal force diagrams & ILD for arches	8L
6.	Advanced Structures – Space Trusses & Cables: Space trusses: introduction, supports, analysis (tension coefficient method); Cable structures: basics; Catenary and parabolic cables; Suspension bridges and stiffening girders.	7L

5. References:
   Text Book:
   - Thandavamoorthy, T.S. – *Structural Analysis*, Oxford University Press.
   - Reddy, C. S. – *Basic Structural Analysis*, Tata McGraw Hill.
   - Punmia, B. C., Jain, A.K., & Jain, A.K. – *Theory of Structures*, Laxmi Publications.
   - Ramamrutham, S. & Narayan, R. – *Theory of Structures*, Dhanpat Rai Publications.

   Reference Books:
   - Kinney, J.S. – *Indeterminate Structural Analysis*, Oxford & IBH Publishing.
   - Ugural, A.C. – *Structural Analysis: Understanding Behavior and Design*, CRC Press.
   - Menon, D. – *Advanced Structural Analysis*, Narosa Publishing.

6. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Describe structural systems and classify various structural elements.	Describe	Understand
CO2	Examine the shear force and bending moments in statically determinate structures.	Examine	Analyze
CO3	Sketch slopes and deflections in beams, frames, and trusses using different methods.	Sketch	Apply
CO4	Use energy and virtual work methods to analyse structural behaviour.	Use	Apply
CO5	Develop and use influence line diagrams for analysing structures under moving loads.	Develop	Create
CO6	Explain the behaviour and analysis of arches, space trusses, and cable structures.	Explain	Understand

7. Mapping of course outcomes to module/course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1. Structural Systems	3	3	-	-	-	-
2. Strain Energy Method	-	-	3	3	-	-
3. Virtual Work Method	-	-	3	3	-	-
4. Slope and Deflection of Beams	-	-	3	-	-	-
5. Moving Loads & Arches	-	-	-	-	3	2
6. Advanced Structures – Space Trusses & Cables	-	-	-	-	-	3

8. Mapping of the Course Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	3	3	-	2	2	-	-	-	-	-	-
CO3	3	2	-	2	2	-	-	-	-	-	-
CO4	3	3	-	2	2	-	-	-	-	-	-
CO5	3	3	2	2	2	-	-	-	-	-	-
CO6	2	2	-	-	-	2	-	-	-	-	-

9. Mapping to PSO

	PSO1	PSO2	PSO3
CO1	3	2	-
CO2	3	2	-
CO3	3	3	-
CO4	3	3	-
CO5	3	2	2
CO6	2	3	2

Course Name: TRANSPORTATION ENGINEERING LABORATORY
Course Code: CE-491
(Semester IV)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

……

1. Course Prerequisite:
   A foundational understanding of civil engineering principles, along with prior coursework in transportation engineering, surveying, and materials science. A basic knowledge of traffic flow theory, highway design, and pavement materials is essential.

2. Course Learning Objectives:
   i. Students will be able to collect and analyze traffic, road, and transportation data using various laboratory equipment and software. They will learn how to interpret the data to make informed decisions in designing and optimizing transportation systems such as highways, intersections, and pavements.
   ii. The course aims to develop students' skills in conducting laboratory tests to evaluate the properties of transportation materials like asphalt, concrete, and aggregates. Students will perform tests for pavement design, material quality assessment, and durability, allowing them to understand material behavior under different traffic loads and environmental conditions.

3. Teaching methodology and evaluation system for the course:
   Teaching methodology – Hands-on Laboratory Sessions, Pre-lab Theoretical Lectures and Discussions, Problem-solving Sessions, Group Projects and Presentations and Lab Reports and Data Interpretation.
   Evaluation System –
   Total Marks: 100 [60(PCIA) + 40(PESE)]
   Section 1: Practical Continuous Internal Assessment (PCIA) - 60 Marks (Continuous assessment, Attendance, viva)
   Section 2: Practical End Semester Examination (PESE) - 40 Marks Written Exam.
4. Course Content:
   Course Name: Transportation Engineering Laboratory
   Course Code: CE-491
   Hours per Week: 0L:0T:2P
   Credits: 1

Module	Topics	14P
1.	Introduction to Highway Materials: Overview of materials & materials selection & testing.	1P
2.	Tests & Testing of Aggregates (Coarse Aggregate): Sieve analysis, Aggregate impact value, Aggregate crushing value, Los Angeles Abrasion test, Specific gravity, Flakiness and Elongation index, and Water Absorption test.	4P
3.	Tests & Testing of Bitumen: Specific Gravity test, Penetration Test, Softening point test, Flash and Fire point test, Ductility Tes, Demonstration of Static and Kinematic viscosity	4P
4.	CBR value of sub-grade (Soaked and unsoaked).	2P
5.	Marshall Stability test.	1L

6.	Demonstration on Stripping value and Loss on heating tests of bitumen, Benkelman beam and bump integrator test.	2L

7. References:

Text Book:

- "Highway Material Testing Manual" by S.K. Khanna, C.E.G. Justo, and A. Veeraragavan, Nem Chand & Bros
- "Laboratory Manual in Highway Engineering" by Ajay Kumar Duggal and Vijay Puri, New Age International Publishers

Reference Books:

- "Pavement Testing, Monitoring and Evaluation" by J. Buchanan and S. Rafeeqi, Prentice Hall
- "Transportation Engineering: An Introduction" by C. Jotin Khisty and B. Kent Lall, Pearson Education

8. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Examine the aggregate samples through different tests to compare the suitability for various types of highway construction.	Examine	Analyze
CO2	Execute the Specific Gravity test, Penetration test, and Static or Kinematic viscosity test on Bitumen.	Execute	Apply
CO3	Execute the Softening point test, Flash and Fire Point test and Ductility test on Bitumen.	Execute	Apply
CO4	Examine the CBR (California Bearing Ratio) values of sub-grade materials under soaked and unsoaked conditions.	Examine	Analyze
CO5	Design the bituminous mix using Marshall stability test.	Design	Create
CO6	Demonstrate the procedures for stripping value, loss on heating tests of bitumen, Benkelman beam, and bump integrator tests.	Demonstrate	Apply

9. Mapping of course outcomes to module/course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	1	-	-	-	-	3
2	2	3	-	-	-	1
3	2	3	-	3	1	1
4	1	-	-	3	1	2
5	3	2	-	-	3	-
6	-	-	3	-	-	-

10. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	-	-	-	1	-	-	3	1	1
CO2	3	1	-	-	-	1	-	-	3	1	1
CO3	3	1	-	-	-	1	-	-	3	1	1
CO4	3	2	-	-	-	1	-	-	3	2	1
CO5	3	2	-	-	-	1	-	-	3	2	1

CO6	3	1	-	-	-	1	-	-	1	1	1

11. Mapping to PSO

	PSO1	PSO2	PSO3
CO1	3	3	1
CO2	3	3	1
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1
CO6	3	3	1

Course Name: SURVEYING AND GEOMATICS LABORATORY
Course Code: CE-492
(Semester III)
Category: MAJOR
Course Broad Category: CORE ENGG (PC)

……

1. Course Prerequisite: Basic knowledge of Surveying and Geomatics theory CE-402.

2. Course Learning Objectives: The objective of this lab is to teach the student the practical knowledge in the field to set out any Civil Engineering work to
   I. Know the principles and methods of surveying using different equipment's & methods
   II. Determination of distance, area using chain, compass and leveling survey.
   III. Apply surveying principles to determine areas and volumes and setting out curves.
   IV. Understand the concept of advanced techniques and operation of modern equipment and perform various experiments by using that.
3. Teaching methodology and evaluation system for the course:
   Teaching methodology - Lectures and Presentations, Interactive Discussions and Case Studies, Field Work, Guest Lectures and Group work.
   Evaluation System –
4. Total Marks: 100 [60(PCIA) + 40(PESE)]
5. Section 1: Practical Continuous Internal Assessment (PCIA) - 60 Marks (Continuous assessment, Attendance, viva)
6. Section 2: Practical End Semester Examination (PESE) - 40 Marks (written exam)
7. Course Content:
   Course Name: SURVEYING AND GEOMATICS LABORATORY
   Course Code: CE-492
   Hours per Week: 0L:0T:02
   Credits: 1

Experiment	Topics	14L
1.	Chain Surveying: Surveying of an area by chain and Field book preparation.	1L
2.	Compass survey: Closed traverse preparation & plotting with prismatic compass.	2L
3.	Levelling: Differential levelling using dumpy level and auto level. Level book preparation, Longitudinal and cross-section and plotting.	2L

4.	Transit Theodolite: Closed traverse by transit theodolite. Preparation of drawing sheet and error elimination. Measurement of Horizontal and vertical angle by theodolite.	1L
5.	Total station: Determination of Area using total station and drawing map using tera model.	1L
6.	Contour map: Traversing using total station for drawing contour map	2L
7.	Leveling (TS): Leveling using total station.	1L
8.	Drone surveying: Basics of Drone surveying.	1L
9.	Curve Setting: Setting out curve using Total station.	1L
10.	Determination of height, remote elevation, Topographic Survey using GPS.	2L

6. References:

Text Book:

- Arora K R, Surveying (Vol 1, 2 & 3), 9th Edition, Standard Book House, Delhi, 2021.
- B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Surveying Vol I & Vol II, Laxmi Publishers, 2023.

Reference Books:

- Chandra A M., Plane Surveying, New Edition, New Age International Pvt. Ltd., Publishers, New Delhi, 2024.

7. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Explain the interdependency and advancement of different surveying methods.	Explain	Understand
CO2	Explain the concepts of leveling, and perform & plot the cross & longitudinal sectioning	Explain	Understand
CO3	Identify of angles using theodolite, and calculate the distance and elevation of the given point using trigonometric leveling.	Identify	Understand
CO4	Construct the area of traverse by total station method and prepare contour maps.	Construct	Create
CO5	Identify the position of points using total station method.	Identify	Apply
CO6	Use modern equipment for curve setting and Locate the position of points using GPS.	Use	Apply

8. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3	-	-	-
4	-	-	-	3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	-	3

9. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	1	2	2	2	1	0	0	0	1
CO2	3	3	1	2	2	2	1	0	0	0	1
CO3	3	3	1	2	2	1	0	0	0	0	1

CO4	3	3	2	2	1	1	0	0	0	0	1
CO5	3	3	2	2	1	1	1	0	0	0	1
CO6	3	3	3	2	1	1	0	0	0	0	1

10. Mapping to PSO

	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	3	1
CO3	3	2	1
CO4	3	2	1
CO5	2	2	1
CO6	3	1	1

Course Name: Basic Geotechnical Engineering Laboratory
Course Code: CE-493
(Semester IV)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

……

1. Course Prerequisite:
   Geotechnical Engineering CE(PC)403
2. Course Learning Objectives:
   i. Understand Soil Properties and Classification
   ii. Perform Soil Sampling and Preparation
   iii. Conduct Standard Laboratory Tests
   iv. Analyze Soil Strength and Compressibility
   v. Evaluate Soil Permeability and Seepage
   vi. Interpret and Report Laboratory Data
   vii. Develop Problem-Solving Skills
   viii. Collaborate in a Team Environment
3. Teaching methodology and evaluation system for the course:
   Teaching methodology – Hands-on Laboratory Sessions, Pre-lab Theoretical Lectures and Discussions, Problem-solving Sessions, Group Projects and Presentations and Lab Reports and Data Interpretation.
   Evaluation System –
   Total Marks: 100 [60(PCIA) + 40(PESE)]
   Section 1: Practical Continuous Internal Assessment (PCIA) - 60 Marks (Continuous assessment, Attendance, viva)
   Section 2: Practical End Semester Examination (PESE) - 40 Marks (written exam)
4. Course Content:
   Course Name: Basic Geotechnical Engineering Laboratory
   Course Code: CE-493
   Hours per Week: 2P
   Credits: 1

Experiment 1	Field identification of different types of soil as per Indian Standards [collection of field samples and identifications without laboratory testing].
Experiment 2	Determination of specific gravity of cohesionless and cohesive soils.
Experiment 3	Determination of in-situ density by core cutter method and sand replacement method and Determination of natural moisture content.

Experiment 4	Determination of relative density of soil.
Experiment 5	Determination of grain size distribution by sieve and hydrometer analysis.
Experiment 6	Determination of Atterberg limits (liquid limit, plastic limit and shrinkage limit).
Experiment 7	Determination of co-efficient of permeability by constant and variable head permeability tests.
Experiment 8	Determination of compaction characteristics of soil by standard proctor compaction test.
Experiment 9	Determining of consolidation parameters by Standard Oedometer Test or Consolidation Test

6. References:

1. Soil Mechanics Laboratory Manual by Braja Mohan Das (Oxford university press).
2. SP: 36 (Part - I and Part - II)

7. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Classify the types of soil and determine its natural moisture content along with specific gravity.	Classify	Understand
CO2	Execute the in-situ density of soil by core cutter and sand replacement method and determination of relative density of soil.	Execute	Apply
CO3	Classify the soil using grain size distribution curve and Atterberg limits.	Classify	Understand
CO4	Examine laboratory tests to determine permeability and compaction characteristics of soil.	Examine	Analyse
CO5	Investigate the compaction characteristics of soil.	Investigate	Create
CO6	Investigate the consolidation parameters of soil.	Investigate	Create

8. Mapping of course outcomes to module / course content

	CO1	CO2	CO3	CO4	CO5	CO6
Experiment 1	2	-	-	-	-	-
Experiment 2	3	-	-	-	-	-
Experiment 3	-	3	-	-	-	-
Experiment 4	-	3	-	-	-	-
Experiment 5	-	-	3	-	-	-
Experiment 6	-	-	3	-	-	-
Experiment 7	-	-	-	3	-	-
Experiment 8	-	-	-	-	3	-
Experiment 9						3

9. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	1	2	2	1	-	3	2	-	1

CO2	3	3	1	3	-	1	-	3	2	-	1
CO3	3	3	1	3	2	1	-	3	2	-	1
CO4	3	3	1	3	-	1	-	3	2	-	1
CO5	3	3	1	3	2	1	-	3	2	-	1
CO6	3	3	2	3	2	1	-	3	2	-	1

10. Mapping to PSO

	PSO1	PSO2	PSO3
CO1	3	1	-
CO2	3	1	-
CO3	3	1	-
CO4	3	1	-
CO5	3	1	-
CO6	3	1	-

Course Name: FLUID MECHANICS LABORATORY
Course Code: CE-494
(Semester IV)
Category: Major
Course Broad Category: CORE ENGG (Professional Core Courses)

……

1. Course Prerequisite:
   Class-XII level knowledge of Physics and Mathematics, and Undergraduate-level introductory knowledge of Fluid Mechanics in Civil Engineering.
2. Course Learning Objectives:
   i. To calibrate and analyze flow measurement devices such as V-notches, orifice meters, and venturi meters to accurately assess fluid flow.
   ii. To determine hydraulic coefficients and assess the performance of pumps and hydraulic machinery through experimental testing.
   iii. To investigate minor losses in pipelines due to sudden changes in diameter and analyze their effects on fluid flow efficiency.
   iv. To measure velocity profiles and flow phenomena using a pitot tube and study hydraulic jumps and water surface profiles for practical applications in engineering.
3. Teaching methodology and evaluation system for the course:
   Teaching methodology – Hands-on Laboratory Sessions, Pre-lab Theoretical Lectures and Discussions, Problem-solving Sessions, Group Projects and Presentations and Lab Reports and Data Interpretation.
   Evaluation System –
   Total Marks: 100 [60(PCIA) + 40(PESE)]
   Section 1: Practical Continuous Internal Assessment (PCIA) - 60 Marks (Continuous assessment, Attendance, viva)
   Section 2: Practical End Semester Examination (PESE) - 40 Marks Written Exam.
4. Course Content:
   Course Name: FLUID MECHANICS LABORATORY
   Course Code: CE-494
   Hours per Week: 0L:0T:2P
   Credits: 1

Experiment	Topics	14 P	100 %
1.	Calibration of V-Notches, Rectangular-Notches, Trapezoidal Notch.	3P	21
2.	Calibration of Orifice meter, Venturi meter	2P	15
3.	Determination of Hydraulic Coefficient of an Orifice	1P	07
4.	Performance Test on Centrifugal Pump & Reciprocating Pump	2P	15
5.	Performance Test on Hydraulic Ram	1P	07
6.	Determination of Minor Losses in Pipes due to Sudden Enlargement and Sudden Contraction	1P	07
7.	Measurement of Velocity by using pitot tube	1P	07
8.	Performance Test on Pelton Wheel Turbine	1P	07
9.	Measurement of water surface profile for flow over Broad crested weir	1P	07
10.	Measurement of water surface profile for a hydraulic jump	1P	07

11. References/Text Book:
    1. Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard Book House
    2. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill.
    3. Open Channel Hydraulics, Ven Te Chow, Tata McGraw Hill

12. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Execute calibration procedures for V-notches and orifice meters to accurately measure fluid flow rates.	Execute	Apply
CO2	Test the performance characteristics of centrifugal pumps, reciprocating pumps, and Pelton wheel turbines through experimental testing.	Test	Analyse
CO3	Examine hydraulic coefficients of orifices to determine their significance in fluid flow applications.	Examine	Analyse
CO4	Investigate and quantify minor losses in pipes caused by sudden enlargement and contraction, assessing their impact on flow efficiency.	Investigate	Create
CO5	Execute and interpret water surface profiles associated with hydraulic jumps, explaining the underlying fluid dynamics.	Execute, Interpret	Apply
CO6	Compare and assess water surface profiles for flow over broad crested weirs, emphasizing practical applications in engineering design.	Compare	Analyse

13. Mapping of course outcomes to module / course content

	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	3	-	-	-	-	-
3	-	-	3	-	-	-

4	-	3	-	-	-	-
5	-	3	-	-	-	-
6	-	-	-	3	-	-
7	3	-	-	-	-	-
8	-	3	-	-	-	-
9	-	-	-	-	-	3
10	-	-	-	-	3	-

14. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	1	-	-	-	1	-	-	1
CO2	2	2	1	2	-	1	1	-	-	-	2
CO3	1	1	1	-	-	-	-	-	-	-	1
CO4	1	-	1	1	-	-	-	-	-	-	1
CO5	-	1	-	-	-	-	-	1	-	-	1
CO6	1	-	-	1	-	-	-	2	-	-	2

15. Mapping to PSO

	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	3	2
CO3	2	2	-
CO4	2	3	1
CO5	1	1	-
CO6	2	2	1

Course Name: Data Science in Civil Engineering Laboratory
Course Code: CE-481
(Semester IV)
Category: Minor
Course Broad Category: MULTIDISCIPLINARY OPEN ELECTIVES COURSE

……

1. Course Prerequisite:
   - Basic understanding of Civil Engineering concepts.
   - Familiarity with basic statistics and data analysis tools..
   - Introductory knowledge of programming concepts (preferably in Python).
2. Course Learning Objectives:
   a. Leverage data to study Civil Engineering problems, identify patterns, and make actionable insights.
   b. Utilize digital and computer tools (e.g., Microsoft Excel, spatial data, data processing) for CE applications.
   c. Apply exploratory data analysis and statistical modeling to various CE domains.
   d. Develop skills in advanced analytical techniques like Logistic Regression, Principal Component Analysis (PCA), and Artificial Neural Networks (ANNs).
   e. Apply distributed computing techniques to process complex Civil Engineering data.
3. Teaching methodology and evaluation system for the course:
   Teaching Methodology –
   a. Hands-on lab sessions focused on real-world civil engineering datasets.
   b. Weekly lab assignments involving data processing, analysis, and visualization using software like Python, R, and GIS.

c. Project-based learning where students apply their knowledge to solve practical Civil Engineering problems using data science techniques.

Evaluation System –

Total Marks: 100 [60(PCIA) + 40(PESE)]

Section 1: Practical Continuous Internal Assessment (PCIA) - 60 Marks (Continuous assessment, Attendance, viva)

Section 2: Practical End Semester Examination (PESE) - 40 Marks (written exam)

4. Course Content:

Course Name: Data Science in Civil Engineering

Course Code: CE-481

Hours per Week: 0L:0T:2P

Credits: 1

Module	Topics	14L
1.	Introduction to Data Science in Civil Engineering: Overview of Data Science and its relevance to Civil Engineering, Introduction to data collection methods and types of data (spatial, temporal, etc.), Introduction to Microsoft Excel for data processing, Overview of data processing and cleaning methods, Descriptive statistics: Measures of central tendency and variability, Data visualization techniques- Histograms, scatter plots, and line charts, Introduction to Python/R for data analysis.	2L
2.	Statistical Methods for Civil Engineering Data: Hypothesis testing- Null and alternative hypotheses, Testing of hypothesis in civil engineering datasets (t-test, chi-square, F-test etc..), Correlation and regression analysis, Logistic regression for binary classification problems	2L
3.	Data Processing and Cleaning Techniques: Handling missing data, outliers, and errors in datasets, Data transformation, normalization, and feature scaling, Introduction to distributed computing and its role in large data processing.	2L
4.	Exploratory Data Analysis and Visualization: Descriptive statistics and exploratory data analysis techniques, Visualizing Civil Engineering data: histograms, scatter plots, heat maps, and GIS-based spatial data visualizations, Tools: Python (Pandas, Matplotlib), R, and QGIS.	2L
5.	Statistical Modeling for Civil Engineering Problems: Linear and non-linear regression modeling, Predictive modeling for structural health monitoring and environmental data, Case studies and applications in transportation, hydrology, and structural analysis.	2L
6.	Applications of Machine Learning in Civil Engineering: Introduction to supervised and unsupervised learning algorithms, Application of classification and clustering in transportation systems and infrastructure monitoring, Tools: Scikit-learn, TensorFlow.	2L
7.	Advanced Data Applications in Civil Engineering: Spatial data analysis for geomatics, Distributed computing for processing large civil engineering datasets, Final project: Students will choose a real-world Civil Engineering problem, analyze the data, and present actionable insights.	2L

8. References:

Text Book:

- Data Science for Civil Engineering: A Beginner's Guide By Rakesh K. Jain, Prashant Shantaram Dhotre, Deepak Tatyasaheb Mane, Parikshit Narendra Mahalle (2023) CRC Publishers.

Reference Books:

- Hastie, Trevor et al., *The Elements of Statistical Learning*, Springer.
- Douglas C. Montgomery, George C. Runger, *Applied Statistics and Probability for Engineers*, Wiley.
- Jeeva Jose, *Machine Learning*, Khanna Publishing House.
- Chopra R. - Machine Learning, Khanna Publishing House.
- Python and R documentation for data science libraries.

9. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Describe the role of data science in Civil Engineering.	Describe	Understand
CO2	Operate data processing and cleaning for Civil Engineering data.	Operate	Apply
CO3	Judge exploratory data analysis and visualize spatial and non-spatial data.	Judge	Evaluate
CO4	Use statistical models to real-world Civil Engineering problems.	Use	Apply
CO5	Implement machine learning algorithms in Civil Engineering applications.	Implement	Apply
CO6	Examine complex Civil Engineering issues using data-driven approaches.	Examine	Analyze

10. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	2	-	-	1	-
2	-	3	-	-	1	-
3	-	-	3	2	-	-
4	-	-	2	3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	-	-
7	-	-	-	-	3	3

11. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	-	-	-	2	-	-	-	-	-
CO2	1	2	3		2	2	-	-	-	-	1
CO3	1	2	3	2	2	2	-	-	-	-	1
CO4	1	2	3	3	2	2	-	-	-	-	2
CO5	1	2	2	2	-	2	-	-	-	-	-
CO6	1	-	-	-	-	2	3	-	-	-	-

12. Mapping to PSO

	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	3	2
CO3	3	2	2
CO4	3	2	2
CO5	1	2	2
CO6	1	3	3

Course Name: Civil Engineering - Societal & Global Impact
Course Code:CE-482
(Semester IV)
Category: Knowledge Enhancement Course
Course Broad Category: Core Engg (Multidisciplinary Non-Credit Course- 2 (MNC)

……

1. Course Prerequisite:
   NIL
2. Course Learning Objectives:
   The course is designed to provide a better understanding of the impact, which Civil Engineering has on the Society at large and on the global arena. Civil Engineering projects have an impact on the Infrastructure, Energy consumption and generation, Sustainability of the Environment, Aesthetics of the environment, Employment creation, Contribution to the GDP, and on a more perceptible level, the Quality of Life. It is important for the civil engineers to realize the impact that this field has and take appropriate precautions to ensure that the impact is not adverse but beneficial.
3. Teaching methodology and evaluation system for the course:
   Teaching methodology –Giving Classroom lectures, board work, interactive session with students and sometime PowerPoint presentation.
   Evaluation System –

   Total Marks: 100 [40(CIA) + 60% of (ESE)]

   - Mid-Semester Evaluation and Attendance: 20 Marks
   - Formative Continuous Assessment [Assignment (Case Studies/ Report writing)/Mini- Project/Group Discussions/ Presentations/Quiz] 20 Marks
   - Summative Assessment. End-Semester Exam. 60 Marks
4. Course Content:
   Course Name: CIVIL ENGINEERING - SOCIETAL & GLOBAL IMPACT
   Course Code: CE-482
   Hours per Week: 3L:0T:0P
   Credits: 0

Module	Topics	42L
1.	Introduction to Course and Overview; Understanding the past to look into the future: preindustrial revolution days, agricultural revolution, first and second industrial revolutions, IT revolution; recent major civil engineering breakthroughs and innovations; present day world and future projections, ecosystems in society and in nature; the steady erosion in sustainability; global warming, its impact and possible causes; evaluating future requirements for various resources; GIS and applications for monitoring systems; human development index and ecological footprint of India vs other countries and analysis	5L
2.	Understanding the importance of civil engineering in shaping and influencing the world; the ancient and modern marvels and wonders in the field of civil engineering; future vision for civil engineering. Development of various materials of construction and methods of construction.	5L

3.	Infrastructure - Habitats, megacities, smart cities, futuristic visions; transportation (roads, railways & metros, airports, seaports, river ways, sea canals, tunnels (below ground, underwater); futuristic systems (ex, hyper loop); energy generation (hydro, solar photovoltaic), wind, wave, tidal, geothermal, thermal energy); water provisioning; telecommunication needs (towers, above-ground and underground cabling); awareness of various codes & standards governing infrastructure development; innovations and methodologies for ensuring sustainability.	10L
4.	Environment - Traditional & futuristic methods; solid waste management, water purification, wastewater treatment & recycling; flood control (dams, canals, river interlinking), multi-purpose water projects, atmospheric pollution; global warming phenomena and pollution mitigation measures, innovations and methodologies for ensuring sustainability. Environmental sustainable materials.	9L
5.	Built environment–facilities management, climate control; energy efficient built environments and LEED ratings, recycling, temperature/ sound control in built environment, security systems; intelligent/ smart buildings; role of urban arts commissions; conservation, repairs & rehabilitation of structures & heritage structures; innovations and methodologies for ensuring sustainability.	7L
6.	Civil Engineering Projects – Environmental impact analysis procedures; waste (materials, work force, equipment) avoidance/ efficiency increase; sustainable construction; advanced construction techniques for better sustainability. Project management paradigms and systems (ex. lean construction), demand and contribution of civil engineering to society; innovations and methodologies for ensuring sustainability during project development.	6L

6. References:

Text Book:

- Civil Engineering Societal & Global Impact by Dr. Shakuntala Acharya – All India Council for Technical Education Nelson Mandela Marg, Vasant Kunj, New Delhi, 110070. November 2023. ISBN: 978-81-963773-7-3.

Reference Books:

- Žiga Turk (2014), Global Challenges and the Role of Civil Engineering, Chapter 3 in: Fischinger M.(eds) Performance-Based Seismic Engineering: Vision for an Earthquake Resilient Society. Geotechnical, Geological and Earthquake Engineering, Vol. 32. Springer, Dordrecht.
- Brito, Ciampi, Vasconcelos, Amarol, Barros (2013) Engineering impacting Social, Economic and Working Environment, 120th ASEE Annual Conference and Exposition.
- NAE Grand Challenges for Engineering (2006), Engineering for the Developing World, The Bridge, Vol 34, No.2, Summer 2004.
- Allen M. (2008) Cleansing the city. Ohio University Press. Athens Ohio.
- Ashley R., Stovin V., Moore S., Hurley L., Lewis L., Saul A. (2010). London Tideway Tunnels Programme – Thames Tunnel Project Needs Report – Potential source control and SUDS applications: Land use and retrofit options
- http://www.thamestunnelconsultation.co.uk/consultation-documents.aspx
- Ashley R M., Nowell R., Gersonius B., Walker L. (2011). Surface Water Management and Urban Green Infrastructure. Review of Current Knowledge. Foundation for Water Research FR/R0014
- Barry M. (2003) corporate social responsibility – unworkable paradox or sustainable paradigm? Proc ICE Engineering Sustainability 156. Sept Issue ES3 paper 13550. p 129-130
- Blackmore J M., Plant R A J. (2008). Risk and resilience to enhance sustainability with application tourban water systems. J. Water Resources Planning and Management. ASCE. Vol. 134, No. 3, May.
- Bogle D. (2010) UK's engineering Council guidance on sustainability. Proc ICE Engineering Sustainability 163. June Issue ES2 p61-63

- Brown R R., Ashley R M., Farrelly M. (2011). Political and Professional Agency Entrapment: An Agenda for Urban Water Research. Water Resources Management. Vol. 23, No.4. European Water Resources Association (EWRA) ISSN 0920-4741.
- Brugnach M., Dewulf A., Pahl-Wostl C., Taillieu T. (2008) toward a relational concept of uncertainty: about knowing too little, knowing too differently and accepting not to know. Ecology and Society 13(2): 30
- Butler D., Davies J. (2011). Urban Drainage. Spon. 3rdEd.
- Cavill S., Sohail M. (2003) Accountability in the provision of urban services. Proc. ICE. Municipal Engineer 156. Issue ME4 paper 13445, p235-244.
- Centre for Water Sensitive Cities (2012) Blueprint for a water sensitive city. Monash University.
- Charles J A. (2009) Robert Rawlinson and the UK public health revolution. Proc ICE Eng History and Heritage. 162 Nov. Issue EH4. p 199-206

7. Course Outcomes:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	CO.1 Discuss the change in trends of civil engineering from the past to present and future in Indian as well as global scenario.	Discuss	Understand
CO2	CO.2 The impact, which Civil Engineering projects have on the Society and identifying the ancient and modern marvels of civil engineering to plan for a better world.	Identify	Understand
CO3	CO.3 Recognize the different infrastructural requirements of civil engineering related to megacities, smart cities, energy generation and communication	Recognize	Understand
CO4	CO.4 Classification of environmental engineering including waste managements, flood control, pollution control to build a sustainable society.	Classification	Understand
CO5	CO.5 Identify the built environment and factors influencing the quality of life ensuring sustainability.	Identify	Understand
CO6	CO.6 Understand the EIA procedures and apply advanced engineering techniques to contribute to GDP and generate employment.	Apply	Apply

8. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	3		-	-
4	-	-		3	-	-
5	-	-	-	-	3	-
6	-	-	-	-	-	3

9. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	2	-	-	-	-	1
CO2	3	3	3	2	-	2	-	-	-	-	1

CO3	3	1	-	-	1	-	-	-	-	-	-
CO4	3	2	2	2	-	3	2	1	-	2	2
CO5	2	2	3	2	-	3	1	-	1	2	2
CO6	3	3	3	3	1	3	2	2	2	2	3

10. Mapping to PSO

	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	3	1	1
CO3	3	1	2
CO4	2	1	2
CO5	2	1	2
CO6	3	2	3