B.E. in Civil and Infrastructure Engineering,
Scheme of Teaching and Examinations-2025
Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS) (Effective from the academic year 2026-27)

IV SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching & Learning Scheme					Examination				Credits
					CI		LI	# TW & SL	TH/S	Duration in	CIE Marks	SEE Marks	Total Marks	
					L	T	P							
1	PCC	1BIF401	Surveying and Geospatial Techniques	TD/PSB-CV/IF	42	0	0	48	90	3	50	50	100	3
2	IPCC	1BIF402	Water Supply and Sanitary Engineering	TD/PSB- CV /IF	42	0	2	50	120	3	50	50	100	4
3	PCC	1BIF403	Analysis of Structures	TD/PSB- CV /IF	42	2	0	50	120	3	50	50	100	4
4	PCC	1BIF404	Building Information Modelling (BIM)	TD/PSB- CV /IF	42	0	0	48	90	3	50	50	100	3
5	PCCL	1BIFL405	Surveying and Geospatial Engineering Laboratory	TD/PSB- CV /IF	0	0	2	02	30	2	50	50	100	1
	AEC	1BIFL406X	Ability Enhancement Course Laboratory**	TD/PSB- CV /IF	0	0	2	02	30	2	50	50	100	1
6	BSC	1BIF407	Biology for Civil Engineers	TD/PSB- CV /IF	28	0	0	32	60	3	50	50	100	2
7	SDC	1BEP408	Environmental Science Project	TD/PSB- CV /IF	0	0	0	30	30	3	50	50	100	1
8	PCC	1BIF409	Concrete Technology	TD/PSB- CV /IF	42	0	0	48	90	3	50	50	100	3
9	NCMC	1BNSK409	National Service Scheme (NSS)	Campus: NSS coordinator	0	0	0	28	28	--	100	---	100	PP
		1BPEK409	Physical Education (PE) (Sports and Athletics)	Physical Education Director										
		1BYOK409	Yoga	Yoga Teacher										
		1BMUS409	Music	Music Teacher										
				Total					598		550	450	1000	22
10	NCMC	1BMATDIP410	Mathematics course for Lateral Entry Students	TD/PSB -Maths Dept	14	0	0	14	28	--	100	--	100	PP
				Total					626	**25**	**650**	**450**	**1100**	22

Ability Enhancement Course (Laboratory) 1BCVL406x

1BIFL406A	AI and Data-Driven Civil and Infrastructure Engineering Lab	1BIFL406C	Intelligent Drone Surveying and Mapping Lab for Infrastructure
1BIFL406B	Water Distribution Network Modelling with EPANET Lab	1BIFL406D	Building Materials Testing Lab

	# TH/S- Total Hours per Semester, TW & SL- Term Work & Self Learning, ** The course 1BXXL406x – Ability Enhancement Course Laboratory can be offered either as a single compulsory course. Alternatively, the Ability Enhancement Course Laboratory course can be offered with multiple elective options under the course codes 1BXXL406x (where *x = A, B, C, D*). **Note to Chairpersons: If only one course is selected, the title of the course may please be entered at serial number 6 of the Scheme of Teaching and Examinations and the above table along with this row shall be deleted. In case, multiple courses are selected the above table shall be filled with the course titles and this row shall be deleted.**

4th Semester Syllabus

SURVEYING AND GEOSPATIAL TECHNIQUES			
Course Code	1BIF401	Scheme	2025
Type of Course	Profession Core Course (PCC)	Semester	IV
Teaching Hours/Week (L: T:P)	42 (3:0:0)	CIE Marks	50
Total Hours of Pedagogy per semester CI (L /T): LI(P):SL&TW:	90 (42:0:0:48)	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course outcome (Course Skill Set)

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

1. **CO1 (L2 – Understand)**: Explain the fundamental principles of surveying, linear and angular measurements, and traditional surveying methods for civil infrastructure projects.
2. **CO2 (L3 – Apply):** Carry out chain, compass, levelling, theodolite, and tacheometric surveys, record field data systematically, and compute areas, reduced levels, and coordinates.
3. **CO3 (L3 – Apply):** Operate modern surveying instruments such as total station and GNSS/GPS receivers for data acquisition, setting out, and topographic mapping.
4. **CO4 (L4 – Analyze):** Analyze and adjust traverse and levelling data, generate contour plans, and perform volume and alignment computations for engineering works.
5. **CO5 (L3 – Apply):** Interpret aerial photographs, satellite imagery, and basic remote sensing products for terrain evaluation and planning of civil engineering projects.
6. **CO6 (L4 – Analyze/Evaluate):** Integrate GIS with surveying and remote sensing data for spatial analysis, decision-making, and management of civil infrastructure assets.

Module-1

Fundamentals of Surveying and Linear Measurements

- Introduction to surveying – definition, objectives, principles (working from whole to part, location by measurements); classification of surveying (plane, geodetic; chain, compass, leveling, theodolite).
- Linear measurements – direct and indirect methods; instruments (chains, tapes, ranging rods, arrows, pegs); chain surveying principles and field procedures.
- Measurement of distances on level ground, sloping ground (slope and horizontal distance corrections); errors in chaining and their elimination.
- Ranging – direct ranging, indirect ranging; obstacles to ranging and chaining; methods of overcoming obstacles.
- Compass surveying – principles, magnetic meridian, true meridian; bearing systems (whole circle bearing, quadrantal bearing, reduced bearing), Plane Table Surveying.
- Prismatic compass – construction, temporary adjustments; measurement of bearings; local attraction and its detection and elimination.

Linked COs: CO1, CO2 **Number of Hours = 8 Hours**

Module-2

- **Leveling, Contouring and Theodolite Surveying**
- Principles of leveling – definitions (level surface, horizontal plane, vertical line, datum, bench mark, reduced level); types of leveling (direct, indirect).
- Leveling instruments – dumpy level, tilting level, automatic level; components (telescope, bubble tube, leveling head, tripod, Leveling staff,); temporary adjustments.
- Differential leveling, fly leveling, profile leveling, cross-sectioning; errors in leveling and precautions; curvature and refraction corrections.
- Contouring – definition, characteristics and uses of contours; contour interval; methods of contouring (direct, indirect); interpolation of contours.
- Uses of contour maps – determination of indivisibility, gradient, catchment area, capacity of reservoir (qualitative); applications in highway and railway alignment.
- Theodolite – types (transit, non-transit); parts and functions; temporary adjustments (leveling, centering, elimination of parallax).

Linked COs: CO1, CO2, CO6 **Number of Hours = 9 Hours**

Module-3

Total Station, EDM and Curves

- Electronic Distance Measurement (EDM) – principles of electromagnetic distance measurement; types (microwave, infrared, laser); accuracy and range.
- Total Station – components and features; integration of electronic theodolite and EDM; coordinate measurement system.
- Total Station operations – setup and orientation, measurement of coordinates, distance and angles; data recording and download; applications in infrastructure projects.
- Coordinate systems – local coordinates, grid coordinates; coordinate transformation; azimuth and bearing computations.
- Curves setting for infrastructure – horizontal curves (simple circular curves); elements of curves; setting curves by offsets, deflection angle method using Total Station.
- Vertical curves – types (crest, sag); elements; computation of elevations along vertical curves for highway and railway alignment.
- Areas and Volumes- Methods of determining areas by trapezoidal and Simpsons' rule. Measurement of volume by prismoidal and trapezoidal formula. Earthwork volume calculations from spot levels and from contour maps; Earthwork calculation in Embankments.

Linked COs: CO2, CO3, CO6. **Number of Hours = 8 Hours**

Module-4

GIS and Remote Sensing

- Introduction to Geographic Information Systems (GIS) – definition, components (hardware, software, data, people, procedures); spatial and attribute data.
- GIS data models – vector data (points, lines, polygons), raster data (grid cells, pixels); topology; data structures and formats (shape files, geo databases).
- Spatial data acquisition – primary sources (field surveys, GPS), secondary sources (maps, aerial photos, satellite imagery); digitization and geo referencing.
- GIS applications in civil infrastructure – site selection, route optimization for highways/pipelines, urban planning, utility mapping, disaster management.
- **Remote sensing fundamentals** – electromagnetic spectrum, passive and active remote sensing; platforms (satellite, airborne, UAV).
- Satellite remote sensing systems – optical sensors (Landsat, Sentinel, Cart sat), radar sensors (SAR); spatial, spectral, temporal, radiometric resolution.
- Image interpretation and analysis – visual interpretation elements (tone, texture, pattern, shape, size, association); digital image processing (enhancement, classification).
- Applications of remote sensing in civil engineering – land use/land cover mapping, terrain analysis, infrastructure monitoring, natural resource assessment.

Linked COs: CO2, CO5, CO6. **Number of Hours = 9 Hours**

Module-5

Advanced Geospatial Technologies for Infrastructure

- LiDAR (Light Detection and Ranging) technology – principles, components (laser scanner, GPS, IMU); airborne LiDAR, terrestrial LiDAR, mobile LiDAR.
- LiDAR data products – point clouds, intensity images, Digital Terrain Model (DTM), Digital Surface Model (DSM); classification of point clouds.
- Applications of LiDAR – corridor mapping for highways/railways, powerline surveys, flood modeling, volume computation, as-built documentation.
- Integration with Building Information Modeling (BIM) – scan-to-BIM workflows; clash detection between design and as-built; facility management applications.
- Geospatial data management – spatial databases, metadata standards, data sharing platforms; open-source GIS software (QGIS awareness).
- Smart infrastructure and IoT integration – sensor networks for infrastructure monitoring; real-time data visualization on GIS platforms; predictive analytics.

- Geospatial applications for sustainable development – smart cities, disaster risk reduction, climate resilience, infrastructure asset management.

Linked COs: CO4, CO5, CO6. **Number of Hours = 8 Hours**

Suggested Learning Resources

Textbooks:

1. Punima, B. C., Jain, A. K., & Jain, A. K. Surveying (Volumes I, II, and III) (17th Edition). Laxmi Publications.
2. Duggal, S. K. Surveying (Volumes I and II). Tata McGraw-Hill.
3. Kanetkar, T. P., & Kulkarni, S. V. Surveying and Levelling (Volumes I and II). Pune Vidyarthi Griha Prakashan.
4. Bhavikatti, S. S. Surveying and Levelling (Volumes I and II). I.K. International Publishing House.

Reference Books:

1. Schofield, W., & Breach, M. Engineering Surveying (6th Edition). CRC Press.
2. Ghilani, C. D., & Wolf, P. R. Elementary Surveying: An Introduction to Geomatics (15th Edition). Pearson.
3. Burrough, P. A., McDonnell, R., & Lloyd, C. D. Principles of Geographical Information Systems (3rd Edition). Oxford University Press.
4. Lillesand, T., Kiefer, R. W., & Chipman, J. Remote Sensing and Image Interpretation (7th Edition). Wiley.
5. Shan, J., & Toth, C. K. Topographic Laser Ranging and Scanning: Principles and Processing (2nd Edition). CRC Press.
6. IS Codes – IS 1024 (Chain Surveying), IS 1760 (Total Station), Survey of India publications.

Web links and e-Resources:

Web links and Video Lectures (e-Resources):

- NPTEL courses on Surveying (IIT Roorkee, IIT Kharagpur) – chain, compass, leveling, theodolite, total station.
- NPTEL courses on Geometrics Engineering and Remote Sensing and GIS (IIT Roorkee, IIT Bombay).
- NPTEL course on Principles and Applications of Building Information Models (BIM) – integration with geospatial data.
- Esri Training – Free GIS courses and tutorials: https://www.esri.com/training
- QGIS Tutorials and Tips: https://www.qgistutorials.com
- YouTube channels: The Engineering Surveyor, Surveying & Levelling (educational content on modern surveying).
- Survey of India – Maps, publications, and surveying standards: https://www.surveyofindia.gov.in
- NASA Earth Observing System – Satellite data and remote sensing resources: https://earthdata.nasa.gov/
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Teaching-Learning Process (Innovative Delivery Methods):
The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Site Visit
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play

Assessment Structure:
The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks.**
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks.**
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks.**

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks.**

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development.**

Students' Learning activities: These activities shall be:

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity
- Use of MOOCs and Online Platforms

Students' activities for TW/SL under NCrF: Samples only

As per National credit farmwork (NCrF) students must spend 90 hours of study for 3 credit courses, which include Course instructions (CI-42 hour) and Teamwork/ Selfe learning (TW/Sl-48 hours). Hence, students must complete minimum of two actives as part of NCrF. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below. The course coordinators can also design their own activities based on the course outcomes.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Surveying Fieldwork Mini-Project: Conduct field surveying for a selected infrastructure site (road corridor, campus, or land parcel) using leveling, traversing, and total station/GNSS. Prepare contour maps, profiles, and digital terrain models along with field notes and error analysis.	24
2.	Geospatial Case Study Portfolio: Analyze case studies of infrastructure projects (highways, railways, urban development) focusing on applications of GIS, remote sensing, and drone surveying. Evaluate data acquisition methods, accuracy, challenges, and decision-making outcomes; present findings through a seminar..	24
3.	Survey Data Processing and Mapping Workbook: Develop a computational workbook (Excel/GIS/CAD tools) for processing survey data, coordinate transformation, area and volume estimation, route alignment, and integration with GIS platforms for infrastructure planning.	24

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	Study online modules on modern surveying techniques (Total Station, GNSS, remote sensing fundamentals) through platforms like NPTEL/Coursera.	24
2.	Explore geospatial standards, mapping techniques, and applications using GIS platforms through webinars and tutorials from organizations like ISRO and Open Geospatial Consortium...	24
3.	Complete self-paced tutorials on GIS and mapping software such as QGIS and ArcGIS, including spatial analysis, map creation, and infrastructure data visualization.	24

A. Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

1. Field Surveying Project / GIS Analysis – Rubric

Criterion	Exemplary (3)	Proficient (2)	Basic (1)	Weight
Field data collection And procedure (CO1, CO2, CO3)	Systematic field observations with proper instrument setup and usage; Complete measurements recorded with stations, bearings, distances, and elevations; field book maintained professionally; safety protocols Followed.	Field work mostly systematic; minor Procedural gaps or incomplete recordings; Generally proper Instrument use.	Unsystematic field work; significant data gaps or errors in measurements; improper instrument handling	20%

Calculations And data processing (CO2, CO3, CO4)	All computations accurate (traverse closure, angular/linear disclosure, coordinates, reduced levels, GIS operations); proper formulas used; calculations clearly presented with units and significant figures.	Calculations mostly correct with minor arithmetic errors; formulas generally appropriate adequate presentation	Significant calculation errors; wrong formulas or methods; poor presentation or missing units	30%
Plotting And visualization (CO2, CO4)	Accurate plotting to scale; proper symbology and legends; neat, professional maps/drawings; contours/traverse correctly represented; GIS maps well-designed with appropriate layers and labeling	Generally accurate plots; minor scaling or symbology issues; acceptable map quality with some labeling gaps.	Significant plotting errors; poor scale selection; unprofessional appearance; inadequate legends or missing features.	20%
Technical interpretation and analysis (CO4, CO5, CO6)	Insightful engineering interpretation of results (alignment suitability, slope analysis, spatial relationships); error sources identified and discussed; practical applications to Infrastructure clearly articulated.	Basic interpretation provided; some discussion of results and applications; error analysis partially addressed.	Minimal or no interpretation; results presented without engineering context; no error discussion	20%
Report quality and documentation (CO6)	Comprehensive report with introduction, methodology, observations, calculations, results, maps, discussion, conclusions; professional formatting; explicit SDG 9/11 linkage for sustainable infrastructure.	Report generally complete; minor sections weak; acceptable formatting; brief SDG mention.	Incomplete report; missing key sections (methodology, results, conclusions); poor formatting; no SDG linkage.	10%

Continuous Internal Evaluation (CIE):

(i) The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.

(ii) Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.

(iii) The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.

(iv) A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE:

i. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.

ii. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

iii. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

WATER SUPPLY AND SANITARY ENGINEERING			
Course Code	1BIF402	Scheme	2025
Type of course	IPCC	Semester	IV
Teaching Hours/Week (L:T:P)	70 (3:0:2)	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL&TW	120 (42:0:28:50)	SEE Marks	50
Credits	4	Total Marks	100
Type of Examination (IPCC):	Theory- CIE +SEE, and Lab- CIE only.	Exam Hours	03

Course outcome (Course Skill Set)

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

1. **CO1 (L2 – Understand):** Explain water demand estimation, sources, quality parameters and basic planning considerations for water supply schemes in urban and rural contexts.
2. **CO2 (L3 – Apply):** Apply principles of water treatment unit operations (sedimentation, filtration, disinfection) and design simple treatment units for potable water production.
3. **CO3 (L4 – Analyze):** Analyse water distribution networks using pipe flow principles, Hardy–Cross method and software tools (EPANET), and evaluate pressure adequacy and losses.
4. **CO4 (L3 – Apply):** Apply sanitary engineering principles to design house drainage, sewerage systems and simple sewage pumping and conveyance facilities.
5. **CO5 (L4 – Analyze):** Analyse wastewater treatment processes (primary, secondary and tertiary) and their role in environmental protection and public health.
6. **CO6 (L5 – Evaluate):** Evaluate sustainability, resilience and climate adaptation aspects in water supply and sanitation systems with reference to SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities) and SDG 13 (Climate Action)

Module-1

Water Demand, Sources and Quality

Water Demand Estimation

- Population forecasting methods – arithmetic increase, geometric increase, incremental increase and logistic curve (simple numericals).
- Types of water demand – domestic, commercial, industrial, institutional, public uses and fire demand; factors affecting per capita demand.
- Design period, average daily demand, maximum daily demand and peak hourly demand; empirical formulae and typical values.

Sources of Water Supply

- Surface water sources – rivers, lakes, reservoirs; advantages, limitations and suitability.
- Groundwater sources – wells, tube wells, infiltration galleries; aquifer types, safe yield concept.
- Rainwater harvesting – methods, storage and integration into urban water supply (qualitative).

Water Quality and Standards

- Physical parameters – turbidity, colour, taste and odour; measurement and significance.
- Chemical parameters – pH, hardness, alkalinity, chlorides, fluorides, nitrates and dissolved oxygen; permissible limits as per BIS/WHO standards.
- Water quality for different uses – drinking, domestic, industrial and construction.

CO linkage: CO1, partial CO6 **Number of Hours: 8 Hours**

Module-2

Water Treatment: Unit Operations and Processes

Introduction to Water Treatment

- Treatment philosophy – barriers to contamination, multi-barrier approach, fit-for-purpose water.
- Overview of treatment train – screening, aeration, sedimentation, coagulation/flocculation, filtration, disinfection.
- Unit operations vs unit processes.

Plain Sedimentation

- Principles of sedimentation – types of settling (discrete, flocculent, hindered, compression).
- Design of plain sedimentation tanks – detention period, overflow rate, inlet and outlet arrangements; simple numericals.

Coagulation and Flocculation

- Coagulants – alum, ferric chloride, polyelectrolytes; mechanism of coagulation.
- Jar test – determination of optimum coagulant dose.
- Flocculation – mixing, flocculator design concepts (qualitative).

Filtration

- Slow sand filters – construction, working, maintenance, advantages and limitations.
- Rapid gravity filters – media specifications, filter runs, backwashing, head loss considerations;
- Pressure filters and multi-media filters (overview).

Disinfection

- Methods of disinfection – chlorination, ozonation, UV irradiation (qualitative comparison).
- Chlorination – breakpoint chlorination, chlorine demand, residual chlorine; dosage calculations.
- Storage and handling of chlorine; safety considerations.

Linked COs: CO2, partial CO6 **Number of Hours: 8 Hours**

Module-3

Water Distribution Systems and Network Analysis

Water Distribution System Layout

- Types of distribution systems – gravity, pumping and combined systems.
- Layout patterns – tree/branch, grid-iron, ring/loop and radial systems; comparative advantages.
- Service reservoirs – location, capacity determination (balancing and fire storage).

Pipe Materials and Appurtenances

- Pipe materials – CI, DI, HDPE, PVC, GI; selection criteria.
- Valves – gate, sluice, non-return, air and scour valves; hydrants and service connections.

Hydraulic Analysis of Distribution Networks

- Pipe flow fundamentals – Hazen-Williams and Darcy-Weisbach equations; head loss calculations.
- Pipes in series and parallel – equivalent pipe concept.
- Looped network analysis – Hardy-Cross method (iterative procedure for simple networks); nodal and loop formulation.

CO linkage: CO3, partial CO6 **Number of Hours: 8 Hours**

Module-4

Sanitary Engineering: House Drainage and Sewerage

House Drainage and Plumbing

- Objectives and principles of house drainage; sanitary fixtures and traps – water seal, types of traps.
- Inspection chambers and septic tanks – construction, working and maintenance (qualitative).

Sewerage Systems

- Definitions – sewage, sullage, storm water; characteristics of sewage (physical, chemical and biological).
- Systems of sewerage – separate, combined and partially separate systems; suitability and comparison.
- Estimation of sewage flow – domestic, commercial, industrial and infiltration contributions; design flow calculations.

Sewer Design

- Hydraulic design of sewers – Manning's formula for gravity sewers; minimum and maximum velocities; self-cleansing velocity concept.
- Design procedure for sanitary sewers – discharge, diameter, slope and velocity determination; worked examples.
- Sewer appurtenances – manholes, drop manholes, inverted siphons, catch basins, flushing tanks and grease traps (qualitative).

Sewage Pumping and Conveyance

- Necessity of pumping stations; types, layout and capacity estimation (awareness level).

- Force mains and rising mains – design considerations.

CO linkage: CO4, partial CO6 **Number of Hours: 9 Hours**

Module-5

Wastewater Treatment and Sustainable Sanitation

Introduction to Wastewater Treatment
- Objectives of wastewater treatment; BOD, COD, suspended solids and nutrients – significance and permissible discharge limits.
- Treatment stages – preliminary, primary, secondary and tertiary.

Preliminary and Primary Treatment
- Screening – bar screens, comminutors, grit chambers (types and design considerations).
- Primary sedimentation tanks – design parameters, detention period, surface overflow rate; scum and sludge removal.

Secondary (Biological) Treatment
- Principles of biological treatment – aerobic and anaerobic processes.
- Activated sludge process (ASP) – process description, aeration tank, return sludge, excess sludge; BOD removal efficiency (qualitative).
- Trickling filters – construction, working, dosing and recirculation (overview).
- Oxidation ponds and waste stabilisation ponds (awareness level).

Tertiary Treatment and Disinfection
- Nutrient removal – nitrogen and phosphorus removal processes (qualitative).
- Disinfection of treated effluent – chlorination and UV methods.

Sludge Treatment and Disposal
- Sludge characteristics, thickening, digestion (aerobic and anaerobic), dewatering and drying.

Sustainable and Climate-Resilient Sanitation
- Decentralised wastewater treatment systems – community-scale and household treatment.
- Nature-based solutions – constructed wetlands, phytoremediation.
- Water reuse and resource recovery – nutrient recovery, biogas generation, circular economy principles.
- Climate adaptation in sanitation – flood-resilient systems, drought management, linkage to SDG 6, SDG 11 and SDG 13.

CO linkage: CO5, CO6 **Number of Hours: 9 Hours**

PRACTICAL COMPONENTS OF IPCC

PART – A: FIXED SET OF EXPERIMENTS

1. Determination of pH, acidity and alkalinity of water – using pH meter and titration (aligns with IS 10500 pH 6.5–8.5 and alkalinity limits).
2. Measurement of turbidity by nephelometer – comparison with BIS turbidity limits (1 NTU acceptable, 5 NTU permissible).
3. Determination of total dissolved solids (TDS) and electrical conductivity – using gravimetric/evaporation method and conductivity meter (TDS 500–2000 mg/L as per IS 10500).
4. Determination of total, calcium and magnesium hardness – EDTA titration, linked to BIS hardness limits (200–600 mg/L as $CaCO_3$).
5. Determination of chlorides in water – argentometric titration, compared with BIS limits (250–1000 mg/L).
6. Determination of sulphates and nitrates – spectrophotometric methods, checked against BIS limits (SO_4 200–400 mg/L, NO_3 45 mg/L).
7. Determination of dissolved oxygen (DO) – Winkler's iodometric method; foundation for BOD and treatment process design.
8. Determination of 5-day BOD of treated/untreated water – incubator method at 20 °C, checking organic pollution relevant to supply from surface sources.
9. Jar test for determination of optimum alum (or other coagulant) dose – studying coagulation– flocculation and turbidity removal for conventional treatment plants.

10. Determination of percentage of available chlorine in bleaching powder – iodometric titration, to design disinfection dosage.
11. Determination of residual chlorine in treated water – starch–iodine method or DPD method, ensuring residual free chlorine 0.2–0.5 mg/L as per standards.
12. Breakpoint chlorination and chlorine demand study – preparation of chlorine–residual curve to identify breakpoint dosage for safe disinfection

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Birdie, G. S., Birdie, J. S. Water Supply and Sanitary Engineering. Dhanpat Rai Publishing.
2. Punmia, B. C., Jain, A. K., Jain, A. K. Water Supply Engineering. Laxmi Publications.
3. Garg, S. K. Water Supply Engineering. Khanna Publishers.
4. Metcalf & Eddy. Wastewater Engineering: Treatment and Resource Recovery. McGraw-Hill.

Reference books / Manuals:

1. Modi, P. N. Water Supply Engineering. Standard Book House.
2. Srinivasa Raghavan, Gupta, Environmental Engineering (Vol. I & II). PHI Learning.
3. BIS Standards – IS 10500 (Drinking Water), IS 456 (Water for Construction), CPHEEO Manual on Water Supply and Treatment.
4. WHO Guidelines for Drinking-water Quality.

Web links and Video Lectures (e-Resources):

1. NPTEL / SWAYAM courses on Water Supply Engineering, Environmental Engineering and Sanitary Engineering (IITs and NITs).
2. MOOCs on water and wastewater treatment (Coursera, edX).
3. EPANET software tutorials and user manual (EPA, USA).
4. CPHEEO (Central Public Health and Environmental Engineering Organisation) manuals and guidelines.
5. Manufacturer websites for pumps, filters, chlorinators and treatment equipment.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Flipped Classroom
2. Problem-Based Learning (PBL)
3. Case-Based Teaching
4. Simulation and Virtual Labs
5. Partial Delivery of course by Industry expert/ industrial visits
6. ICT-Enabled Teaching
7. Role Play

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE Theory component will be **25 marks** and CIE Practical component will be **25 marks**.

The CIE Theory component consists of IA tests for 25 marks. The CIE Practical component for continuous assessments will be for 15 marks through rubrics and for lab tests will be for 10 marks.

- To qualify and become eligible to appear for SEE, in the **CIE theory component**, a student must score at least **40% of 25 marks**, i.e., **10 marks**.
- To qualify and become eligible to appear for SEE, in the **CIE Practical component**, a student must secure **a minimum of 40% of 25 marks**, i.e., **10 marks**.
- To pass the **SEE**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.

- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

CIE Practical component:

The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The summation of all the experiments marks to be scaled down to 15 marks.

The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 10 marks. For laboratory test, the student is required to conduct one experiment.

Students' activities for TW/SL under NCrF: Samples only: As per National credit farmwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Selfe learning (TW/Sl-50 hours). Hence, students must complete minimum of two actives as part of NCrF. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below. The course coordinators can also design their own activities based on the course outcomes.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Integrated Design Mini-Project: Design a small water supply scheme (source to distribution) or a sanitary system (house drainage to STP) covering demand estimation, treatment unit sizing, network/sewer layout and sustainability considerations.	25
2.	Programming & Tools Workbook: Build an Excel/MATLAB/Python/EPANET workbook for water and sanitation engineering problems – water demand forecasting, treatment unit design (sedimentation, filter), Hardy-Cross network analysis, sewer design and BOD removal calculations.	25

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	**MOOC +GATE/Open- Book Track.:** Complete selected FM MOOC modules and GATE-style tests, plus at least one integrated open-book exam on conceptual/design problems.	25
2.	**Case Study & Literature Portfolio**: Prepare 3–4 case briefs on real water supply/sanitation projects or failures (e.g., Chennai water crisis, Bengaluru STP performance, NRW reduction case studies)	25

Sample Rubric: Integrated Water Supply or Sanitation Design Mini-Project

Criterion	Exemplary (3)	Proficient (2)	Basic (1)	Weight
Problem definition and scope	Clear objective, realistic water supply/sanitation system, complete data (population, demand, source/site) and assumptions documented; all five modules scoped.	Objective mostly clear; minor gaps in data or assumptions; most modules covered.	Vague problem; key data or assumptions missing or inconsistent; weak linkage across modules.	10%

Demand estimation / flow calculations (M1, M4)	Accurate population forecasting, per capita demand and design flows calculated with clear justification and correct use of formulae.	Generally, correct with minor calculation errors; method appropriate.	Frequent errors in demand estimation or flow calculations; method unclear or incorrect.	15%
Treatment design (M2, M5)	Correct sizing of treatment units (sedimentation tank, filter, etc.) or STP components; design parameters justified with standards; calculations clear and complete.	Mostly correct design with minor parameter gaps; some justification provided.	Incomplete or incorrect design; major parameter gaps; weak justification.	25%
Network/sewer design (M3, M4)	Accurate pipe sizing, head loss calculations, Hardy-Cross analysis or EPANET simulation for water network; or correct sewer design with Manning's formula; layout logical and well-documented.	Generally correct approach with minor errors in pipe sizing or head loss; layout acceptable.	Frequent errors in hydraulic calculations; layout unclear or illogical.	25%
Sustainability and SDG linkage (M1–M5, CO6)	Clear discussion of water conservation, energy efficiency, climate resilience, NRW reduction, wastewater reuse or nature-based solutions; explicit SDG 6, 11, 13 links.	Some discussion of sustainability or climate aspects; SDG links implied or brief.	Little or no discussion of sustainability beyond basic technical design.	15%
Use of tools and software	Appropriate selection and correct use of EPANET, Excel or other tools; results cross-checked with hand calculations; neat diagrams and plots.	Tools used with minor setup/interpretation issues; diagrams acceptable.	Minimal or incorrect use of tools; no meaningful comparison with hand calculations; poor or missing diagrams.	10%

Suggested rubrics for Practical continuous assessment:

Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)

Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output (3)	Student will be able to run the program but not able to analyze the output (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

Continuous Internal Evaluation (CIE) :

A. **Theory component**

The CIE marks of 25 shall be earmarked for two tests.

The first test shall be conducted after completing two modules of the syllabus and the second one after completing the rest three modules.

Each test shall be conducted for 25 marks. The average of the two tests scaled down to 25 marks shall constitute the test marks for a maximum of 25 marks.

B. **Laboratory component**

i. Out of 25 marks, 15 marks shall be assigned for assessment as per the rubrics listed in the course syllabus. The remaining 10 marks shall be based on the practical test conducted by two Internal examiners appointed by the HoD. The allotment of marks shall be as per the rubrics defined for regular class work and practical test as indicated in the Table – ICs/IPCCs 1.

ii. To qualify and become eligible to appear for the SEE of the IC/IPCC, a student shall secure at least 40 % of 25 marks, i.e., 10 marks, in the CIE theory component, and at least 40 % of 25 marks, i.e., 10 marks in the CIE Practical component.

C. **Passing requirement in SEE**

i. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of

ii. 100. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

iii. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

Table – ICs/IPCCs 1 Distribution of marks		
Component	**Description**	**Marks**
Allotment of marks for regular class work		
Ability in Conducting Experiments	Initiative, skill, safety practices, teamwork, and independent handling of equipment during regular lab sessions.	5 marks
Laboratory Record / Journal	Regular and neat maintenance of lab record, accuracy of results, and timely submission.	10 marks
	Subtotal	**15**
Allotment of marks for CIE practical test		
Laboratory Test / Experiment Performance	Ability to set up apparatus, follow procedure, take observations, and obtain correct results in the test experiment.	5 marks
Viva-Voce	Understanding of theory, concepts, and experimental procedure; ability to explain results and answer related questions.	5 marks
	Subtotal	**10**
	Total	**25**

ANALYSIS OF STRUCTURES			
Course Code	1BIF403	Scheme	**2025**
Type of Course	Professional Core Course (PCC)	Semester	IV
Teaching Hours/Week (L:T:P)	70 (42:28:0)	CIE Marks	50
Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL	120(42:28:0:50)	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	**Theory**	Exam Hours	03

Course outcome (Course Skill Set):

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

1. CO1 (L2 – Understand): Explain concepts of static determinacy and indeterminacy, stability, and behaviour of beams, trusses and frames under various loading conditions.
2. CO2 (L3 – Apply): Apply classical methods to analyse determinate beams, trusses, and arches for internal forces, reactions, and influence lines.
3. CO3 (L3 – Apply): Compute deflections of beams and frames using energy methods, moment–area, conjugate beam and unit load methods.
4. CO4 (L4 – Analyze): Analyse indeterminate structures using slope–deflection, moment distribution and related classical stiffness concepts.
5. CO5 (L4 – Analyze): Formulate and solve basic matrix stiffness equations for beams and plane frames and interpret results in the context of civil engineering design.
6. CO6 (L5): Evaluate the suitability of different analysis methods (classical vs. matrix vs. software-based) for given structural problems, and reflect on modelling assumptions, limitations, and safety implications.

Module-1

Fundamentals of Structural Analysis and Review:

- Concept of structure; idealisation of structures: beams, trusses, frames, arches; load types and load paths.
- Stability, static determinacy and indeterminacy: degree of static and kinematic indeterminacy for beams, trusses and frames (simple numerical examples).
- Support conditions and their idealisation; load types (point, UDL, UVL, temperature, settlement, lack-of-fit) and load combinations as per typical codes.
- Review of basic statics: equilibrium equations, free body diagrams (FBDs) and Support reaction for determinate structures (brief only).
- Shear force and bending moment diagrams for determinate beams and frames (brief review only; detailed treatment in Solid Mechanics 1BCV303).

Linked COs: CO1, CO2 **Number of Hours: 14 hours**

Analysis of Determinate Structures:

- Analysis of plane trusses by method of joints and method of sections; zero-force members; simple civil examples (roof and bridge trusses).

  Compound and continuous trusses: introduction and illustrative problems.
- Three-hinged arches: types (parabolic, circular); determination of reactions, normal thrust, radial shear and bending moment; influence of temperature and support settlement (qualitative).
- Influence lines for reactions, shear force and bending moment for determinate beams: Müller-Breslau principle (qualitative) and simple numerical examples.
- Use of influence lines in moving load problems: maximum shear and bending moment for single concentrated load, several loads, and UDL on simply supported beams.
- Energy methods: strain energy in axial, flexural and torsional members; Castigliano's theorems (statement and use) for deflection of beams and pin-jointed trusses.
- Unit load (dummy load) method for deflection of determinate beams and simple frames (single displacement).

Linked COs: CO2, CO3 **Number of Hours: 14 hours**

Module-3

Deflection of Beams and Frames:

- Differential equation of the elastic curve for beams (concept); relation between bending moment, slope and deflection.
- Moment–area theorems: derivation (statement and proof) and application to computation of slope and deflection of simply supported, cantilever and overhanging beams.
- Conjugate beam method: concept of conjugate beam, fixed and free ends; application to standard beam configurations.
- Deflection of simple frames using moment-area and conjugate beam methods (introductory level).

Linked COs: CO3 **Number of Hours : 12 hours**

Module-4

Analysis of Indeterminate Structures (Classical Methods):

- Concept of indeterminacy; review of compatibility conditions and force/displacement relations; introduction to flexibility and stiffness.
- Clapeyron's theorem of three moments and its application to continuous beams (with and without support settlements).
- Slope–deflection method: derivation of slope–deflection equations for prismatic members; analysis of single-bay single-storey portal frames and continuous beams (with and without joint translation).
- Moment distribution method: basic idea, carry-over and distribution factors; analysis of continuous beams and simple portal frames, including sway (numerical examples).
- Qualitative discussion of side-sway, drift and stiffness concepts in multi-storey frames; relation to modern computer-based analysis (no detailed numericals).

Linked COs: CO3, CO4 **Number of Hours: 16 hours**

Module-5

Matrix Methods of Structural Analysis and Software Exposure:

- Basic matrix operations required in structural analysis: vectors and matrices, transposition, partitioning, assembly idea (no rigorous linear algebra).
- Element stiffness matrix for axially loaded bar and prismatic beam elements in local coordinates; nodal DOFs, nodal forces and nodal displacements.
- Transformation of stiffness matrices from local to global coordinates: concept and simple 2D examples.
- Assembly of global stiffness matrix for simple pin-jointed trusses and plane frames.
- Imposition of boundary conditions, solution of global equilibrium equations, and extraction of member forces and support reactions for single-bay single-storey frames and trusses (hand-calculation-level problems).
- Software Demonstration Session (Non-Examinable but Mandatory): At least one tutorial/lab session demonstrating a structural analysis software package (e.g., STAAD.Pro, SAP2000, ETABS, OpenSees, SkyCiv) on simple beams or frames, highlighting the underlying matrix concepts introduced in this module. Student engagement is recorded via CCA/TWSL activities.

Linked COs: CO4, CO5, CO6 **Number of Hours: 14 hours**

Suggested Learning Resources

Text Books

1. Ghali, A., Neville, A. M., & Brown, T. G., "Structural Analysis – A Unified Classical and Matrix Approach", Latest edition.
2. Reddy, C. S., "Basic Structural Analysis", Tata McGraw-Hill.
3. Bhavikatti, S. S., "Structural Analysis – Vol. 1 and Vol. 2", New Age / Vikas.

Reference Books / Manuals

1. Hibbeler, R. C., "Structural Analysis", Pearson.
2. Wang, C. K., "Intermediate Structural Analysis", McGraw-Hill.
3. Gere, J. M. & Weaver, W., "Matrix Analysis of Framed Structures", Cengage / CBS.

Web links and Video Lectures (e Resources)

1. NPTEL: “Structural Analysis I”, “Structural Analysis II”, “Advanced Structural Analysis” – lecture series with examples and assignments aligned to Indian civil engineering curricula.
2. Other MOOCs / OCW: “Structural Analysis”, “Matrix Methods of Structural Analysis” for additional concept explanation, computational labs and problem practice.

Teaching-Learning Process (Innovative Delivery Methods):

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. Concept driven lectures using visualization of deformation shapes, influence lines and structural idealization for real civil engineering systems (buildings, bridges, industrial frames).
2. Regular tutorial/problem solving sessions on classical and matrix methods, with structured worksheets that mix examination-style and design-oriented problems.
3. Short case snippets on serviceability and failure (e.g., excessive deflections, progressive collapse, connection failures) to connect analytical results with safety and codal provisions.
4. Demonstration of structural analysis software (e.g., STAAD, ETABS, open source tools) for simple frames, highlighting the underlying matrix concepts introduced in the course (Industry 5.0 / NEP 2020 orientation).
5. Use of spreadsheets/Matlab/Python to build small stiffness matrices and explore parameter sensitivity and model idealizations as self-learning activities.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the CIE, a student must score at least 40% of 50 marks, i.e., 20 marks.
- To pass the SEE, a student must score at least 35% of 50 marks, i.e., 18 marks.

Notwithstanding the above, a student is considered to have passed the course, provided the combined total of CIE and SEE is at least 40 out of 100 marks.

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]. A minimum of two Internal Assessment Tests (IA) shall be conducted, carrying a total of 25 marks. In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks. It is recommended to include a maximum of two learning activities as part of the CCA to foster the holistic development of students. These activities shall be:

- Course Project,
- Case Study Presentation,
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels
- Any other relevant and innovative academic activity

Students' activities for TW/SL under NCrF: Samples only

As per National credit framework (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-52 hour) and Teamwork/ Self learning (TW/Sl-64 hours). Hence, students must complete minimum of two actives as part of NCrF. These students learning activities shall be conceded as CCA components of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below. The course coordinators can also design their own activities based on the course outcomes.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)		
Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	**Activity A – Influence Line and Moving Load Study (CO2, CO3):** Students model a simply supported or continuous beam (e.g., corridor or small bridge), construct influence lines for reactions, shear and bending moment and use them to obtain maximum effects for selected moving load patterns; short reflection on design implications.	25
2.	**Activity B – Portal Frame Behaviour Mini-Project (CO3, CO4):**Group work: given geometry and loading of a simple portal frame, compare results from slope–deflection, moment distribution and software, and comment on sway, stiffness and load path.	25
3.	**Activity C – Matrix Analysis Workbook (CO4, CO5):** Students prepare a small digital workbook (Excel/Matlab/Python) to assemble and solve global stiffness matrices for simple trusses/frames and interpret member forces and displacements.	25
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	Completion of mapped NPTEL/MOOC modules on "Structural Analysis" / "Matrix Methods of Structural Analysis" with reflective summaries and selected problem sets.	25
2.	Short literature/technical review on structural failures related to analysis assumptions (e.g., support idealisation, load modelling) and learning journal on insights for better modelling in practice.	25

Continuous Internal Evaluation (CIE):

(i) The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.

(ii) Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.

(iii) The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.

(iv) A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE:

i. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.

ii. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

iii. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

BUILDING INFORMATION MODELLING (BIM)			
Course Code	1BIF404	Scheme	2025
Type of Course	Professional Core Course (PCC)	Semester	IV
Teaching Hours/Week (L:T:P)	42 (3:0:0)	CIE Marks	50
Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL	90(42:0:0:48)	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course outcome (Course Skill Set)

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

1. CO1 (L2 - Understand): Explain BIM, digital construction, lifecycle information, stakeholder roles, BIM uses, VDC, IDD, and the responsible use of BIM in civil engineering projects.
2. CO2 (L2/L3 - Understand/Apply): Identify BIM model structure, information content, model generation methods, LOD/LOI/LOIN, properties, classifications, relationships, and common model-quality limitations.
3. CO3 (L3 - Apply): Use basic BIM authoring/viewing workflows to create or inspect simple building/civil models, generate drawings, schedules, quantities, and basic model-based outputs.
4. CO4 (L3/L4 - Apply/Analyse): Explain and inspect openBIM exchanges using IFC, MVD/exchange-view logic, BCF, COBie, CDE workflows, naming, revision, status, suitability, and basic information validation.
5. CO5 (L4 - Analyse): Analyse model coordination, issue management, clash/clearance problems, missing information, model reliability, and data-drop acceptance using structured checklists and issue logs.
6. CO6 (L4 - Analyse/Evaluate): Relate BIM to construction delivery, VDC, IDD, BIM-GIS, reality capture, digital twins, handover, asset information, sustainability, data security, and Indian BIM implementation challenges.

Module-1

BIM Fundamentals, Roles, Stakeholders and Responsible Use:

- Evolution from CAD to BIM: transition to digital construction and information management; BIM as an integrated model, information system, and process—not just 3D modeling.
- Built-asset lifecycle: stages include strategic definition, briefing, design, coordination, procurement, construction, commissioning, handover, operation, and renewal.
- BIM roles and responsibilities: BIM modeller, discipline modeller, BIM coordinator, BIM manager, information manager, CDE manager, and asset information manager; awareness of RACI/RASCI frameworks.
- Stakeholder engagement in BIM: roles of owner/client, consultant, designer, engineer, quantity surveyor, planner, contractor, subcontractor, supplier, facility manager, and public authority.
- BIM uses across stages: visualization, coordination, quantity take-off, 4D/5D planning, logistics, safety, fabrication, handover, facility management, sustainability, and digital twin readiness.
- Software and hardware selection: based on BIM use, data needs, interoperability, exchange formats, project scale, accessibility, cost, and suitability for teaching.
- Indian BIM context: influenced by BIS/IBC/CPWD; challenges include fragmented delivery, weak information requirements, unclear roles, CDE misuse, handover gaps, and uneven maturity.
- Benefits, limitations, and responsible use: avoid over-reliance on software, BIM washing, false model certainty, overmodelling, and superficial template-based compliance.
- Practical activity: develop a stakeholder-role map and BIM-use map for a small building or infrastructure project, specifying information needs, responsibilities, suitable open/free tools, basic hardware, and expected deliverables.

Linked COs: CO1, CO5, CO **Number of Hours: 08 Hours**

Module-2

Information Modelling, BIM Model Structure and Model Generation:

- Information modelling types: object-based, spatial, attribute/property, relationship, classification, workflow/process, requirement-based, exchange-based, database/query-based, geospatial, and time–cost modelling.
- BIM model structure: hierarchy includes project, site, facility/building, storey/level, zone, space, system, element, type, asset, and associated documents.
- Graphical and non-graphical data: geometry along with properties, quantities, materials, specifications, asset tags, cost codes, maintenance data, and document links.
- LOD, LOI, and LOIN: levels of graphical detail, information content, and overall information need to ensure model suitability for intended purposes.
- BIM generation approaches: design-authoring BIM, CAD-to-BIM, scan-to-BIM, GIS/context BIM, fabrication/shop models, as-built/record models, asset information models, and digital-twin input models.
- Software and hardware considerations: selection of authoring tools, IFC viewers, point-cloud and GIS tools, drones, laser scanners, 360 cameras, mobile devices, and appropriate workstation capabilities.
- Model reliability and quality issues: missing or incorrect data, misclassification, duplicate elements, poor spatial containment, coordinate errors, outdated revisions, overmodelling, and mismatch between geometry and data.
- Practical activity: analyze an IFC/model file and a basic point-cloud or GIS dataset to identify hierarchy, objects, properties, data gaps, modelling approach, suitable tools, hardware/data capture needs, and reliability limitations.

Linked COs: CO2, CO3, CO4 **Number of Hours: 08 Hours**

Module-3

BIM Authoring Principles, BIM Uses and Model-Based Outputs:

- Object-based modelling fundamentals: levels, grids, units, coordinates, spatial setup, object types, families/libraries, and model breakdown for building and civil examples.
- Basic architectural and structural modelling: walls, doors, windows, slabs, stairs, beams, columns, foundations, and relevant infrastructure/civil elements based on available tools.
- Modelling for purpose: apply naming conventions, classification, properties, material data, location assignment, element responsibility, and downstream information requirements rather than focusing on appearance.
- Model-based documentation: generation of plans, sections, elevations, 3D views, schedules, sheets, and revision control.
- 4D fundamentals: linking model elements to activities, defining work breakdown structure, sequencing, dependencies, and using progress visualization for decision support (not just animation).
- Quantity take-off and 5D basics: quantities, units, measurement rules, classification and cost-code linkage, with awareness of limitations of model-derived quantities and rate data.
- Software and hardware for production: selection of open/free authoring, viewing, and QTO tools; consideration of workstation capability, file size, graphics needs, and classroom/lab feasibility.
- BIM use-case alignment: selecting appropriate modelling methods and information content for design, coordination, construction, costing, handover, and asset management decisions.
- Practical activity: develop or update a small model using a free/open tool, generate drawings and schedules, export and review IFC, extract quantity schedules, and document the software and hardware setup used.

Linked COs: CO2, CO3, CO5 **Number of Hours: 08 Hours**

Module-4

Open BIM, IFC, MVD, CDE, Interoperability, Coordination and Validation:

- Open BIM principles: vendor-neutral information exchange; distinction between native models and exchange models.
- IFC fundamentals: open schema acting as a queryable built-asset database; includes hierarchy, entities, property sets, quantity sets, materials, classifications, systems, and relationships.
- MVD/exchange views: different uses (coordination, quantity, energy, fabrication, FM) require specific information subsets; a valid IFC file may still be unusable if not aligned to purpose.
- Interoperability planning: define exchange purpose, file format and schema/version, coordinate reference system, model scope, required properties and classifications, checking procedures, and acceptance criteria.
- Supporting standards and tools: BCF for issue tracking, COBie for structured asset data, bSDD for classification, and IDS for defining and validating information requirements.
- CDE principles: workflows across WIP, shared, published, and archived states; management of information containers, naming conventions, metadata, revisions, status, suitability, transmittals, approvals, and audit trails.
- Model federation and coordination: combining models, detecting clash/clearance/workflow/information issues, and managing issue assignment, response, closure, and evidence.
- IFC inspection and querying: use of viewers or tools like IfcOpenShell to check object counts, properties, missing data, and generate basic schedules/reports.
- Practical activity: conduct an interoperability exercise by exporting/opening an IFC file, verifying exchange purpose/MVD, reviewing properties, preparing a BCF-style issue log, and writing a brief model validation and acceptance note.
- Sources

  Cited sources from search will appear here.

Linked COs: CO4, CO5, CO6 **Number of Hours: 09 Hours**

Module-5

VDC, IDD, Handover, Software/Hardware Selection and Digital Initiatives:

- VDC in project delivery: model-based constructability review, 4D planning, logistics, safety planning, work packaging, subcontractor coordination, digital issue tracking, and model-to-site information flow.
- IDD as an integration framework: connects BIM, CDE, VDC, GIS, project controls, procurement, documentation, handover, and asset information across the delivery chain.
- Reality capture: drone photogrammetry, laser scanning, 360-degree capture, point clouds, scan-to-BIM, as-built verification, accuracy, and limitations.
- BIM-GIS and infrastructure context: coordinates, site context, terrain, roads, utilities, drainage, geospatial layers, and QGIS/open data awareness.
- Handover and asset information: data drops, commissioning evidence, COBie or equivalent asset registers, AIM, FM/CMMS/BMS interfaces, soft landings, and operational readiness.
- Digital twins: distinction between BIM model, PIM, AIM, and live operational digital twin; role of sensors, dashboards, and maintained information.
- Software, hardware, and infrastructure selection: workstations, network, CDE/cloud/local storage, tablets/mobile devices, VR/AR viewers, drones, scanners, cameras, sensors, backups, security, and maintenance cost.
- Data security and implementation risks: intellectual property, access control, cyber risk, AI-output verification, sustainability/carbon-data awareness, and practical challenges in Indian project conditions.
- Practical activity: prepare a VDC/IDD mini delivery plan for a small project, including model-to-schedule mapping, site/logistics issues, handover data sample, CDE workflow, software-hardware selection matrix, and interoperability risk note.

Linked COs: CO1, CO5, CO6	**Number of Hours: 09 Hours**

Suggested Learning Resources:

Text books:

1. Sacks, R., Eastman, C., Lee, G., and Teicholz, P. BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers, 3rd Edition, Wiley, 2018.
2. Hardin, B. and McCool, D. BIM and Construction Management: Proven Tools, Methods, and Workflows, 2nd Edition, Wiley, 2015.
3. Kumar, B. A Practical Guide to Adopting BIM in Construction Projects, Whittles Publishing, 2015.
4. Baldwin, A. and Bordoli, D. A Handbook for Construction Planning and Scheduling, Wiley-Blackwell, 2014.
5. Smith, D. K. and Tardif, M. Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers, Wiley, 2009.
6. Holzer, D. The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering and Construction, Wiley, 2015.
7. Nawari, N. O. Building Information Modeling: Automated Code Checking and Compliance Processes, CRC Press, 2018.
8. Pauwels, P. and McGlinn, K. (eds.). Buildings and Semantics: Data Models and Web Technologies for the Built Environment, CRC Press/Balkema, 2023.

Reference books / Manuals:

1. Indian Building Congress. BIM & Digital Initiative in Construction Projects, 2026.
2. Bureau of Indian Standards draft guidelines for BIM and Digital Initiatives: Owner Organization, General Contractor, and Consultants/Suppliers/Specialist Contractors.
3. CPWD. Introducing BIM in CPWD, Government of India, 2024.
4. ISO 19650 introductory and project-management perspective resources; BSI Little Book of BIM / ISO 19650 awareness materials.
5. Building SMART International resources on IFC, BCF, IDS, bSDD, openBIM and professional learning outcomes.
6. Building SMART Global IFC Mandates and public openBIM case studies.
7. Selected NPTEL/SWAYAM resources on construction management, project planning, digital construction, GIS and BIM.

Web links and Video Lectures (e-Resources):

1. NPTEL / SWAYAM modules related to construction planning, project management, GIS, digital construction and BIM fundamentals.
2. Building SMART International: openBIM, IFC, BCF, IDS, bSDD and learning resources.
3. IfcOpenShell documentation, Bonsai/BlenderBIM resources, FreeCAD BIM resources, IFC.js/web-ifc examples and open-source BIM viewer documentation.
4. Public BIM and digital-construction case studies from India, Singapore, Norway, Europe, USA and other public-sector programmes.
5. Institutional sample datasets: IFC model, simple native/openBIM model, drawings, schedule template, issue log, quantity schedule, MIDP/TIDP-style delivery table, CDE folder/status workflow and asset-data template.
6. Software-vendor learning portals may be used for optional demonstrations only; no single vendor platform shall become the academic backbone of the course.

Software / Hardware / Digital Tools: function-based and vendor-neutral (free/open tools preferred)

Learning Function	Preferred free/open or accessible tools / hardware	Purpose in course
IFC viewing and model	BIMvision, Open IFC Viewer,	Open, inspect and review IFC models;

inspection	usBIM.viewer, IFC.js/web-ifc viewers; standard lab PCs	check elements, properties, spaces and exchange issues.
Native IFC / openBIM authoring	Bonsai / BlenderBIM; FreeCAD BIM Workbench; workstation with adequate RAM/GPU	Simple model creation and native/openBIM thinking.
IFC processing and querying	IfcOpenShell, IfcConvert, Python notebooks where feasible	Object counts, property extraction, missing-data checks and simple schedules.
Issue management and coordination	BCF viewers/tools, BIMcollab free/viewer options where available, spreadsheets	Issue assignment, responsibility, comments, closure and evidence.
GIS and context interoperability	QGIS, GeoPackage/open data, simple map layers; GPS/mobile data where available	Coordinates, site context, utilities, terrain and infrastructure linkage.
Reality capture and field data	Demonstration/exposure to drone imagery, 360 camera, phone LiDAR, laser scan/point cloud datasets	Understand scan-to-BIM, as-built verification, accuracy, data size and hardware constraints.
Information delivery and asset data	LibreOffice/Excel, CSV, simple databases, COBie-style sheets	Schedules, asset registers, MIDP/TIDP-style deliverables and handover data.
CDE workflow simulation	Nextcloud/Google Drive/SharePoint-style folder workflow; local server/cloud classroom setup	WIP/shared/published/archive states, access control, naming, revision and controlled exchange.
Hardware and infrastructure selection	Workstations/laptops, tablets, network bandwidth, storage/backup, displays/VR optional, security controls	Select hardware by model size, viewing, authoring, field capture, CDE access, interoperability and budget.
Optional commercial exposure	Institutionally available tools may be shown only as examples	Exposure only; not mandatory, not vendor-locked, not the basis of assessment.

Teaching-Learning Process (Innovative Delivery Methods):
Suggested methods include flipped classroom, problem-based learning, case-based teaching, mini-projects, model review workshops, site/office visits, ICT-enabled demonstrations, role-play coordination meetings and structured self-learning.

- Each module shall include a small practical/studio activity linked to its theory content.
- Use short conceptual lectures to distinguish BIM, VDC, IDD, CDE, digital twin and openBIM.
- Use role-play exercises where students act as owner, consultant, contractor, BIM coordinator, QS/planner, supplier and facility manager.
- Use sample IFC/model datasets to inspect objects, properties, quantities, classifications, model reliability and missing information.
- Use mini-workshops on software/hardware selection, CDE workflow, naming/status/revision, issue logs, BCF-style comments and data-drop acceptance.
- Use case discussions from Indian BIM implementation, BIS/IBC/CPWD direction and international openBIM examples.
- Use open/free tools for modelling, viewing, IFC inspection, QTO, issue management and BIM-GIS context.

Use small construction/VDC exercises linking model elements to schedule, logistics, safety, site decision-making and handover. Use reflective activities on BIM risks, software dependence, overmodelling, false model certainty and handover failures.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the CIE, a student must score at least 40% of 50 marks, i.e., 20 marks.
- To pass the SEE, a student must score at least 35% of 50 marks, i.e., 18 marks.

Notwithstanding the above, a student is considered to have passed the course, provided the combined total of CIE and SEE is at least 40 out of 100 marks

Continuous Comprehensive Assessments (CCA)+ **Internal Assessment Test (IA)** = Continuous Internal Evaluation CIE [25+25=50 marks]. A minimum of two Internal Assessment Tests (IA) shall be conducted, carrying a total of 25 marks. In addition, Continuous Comprehensive Assessment (CCA) shall be conducted for a total of 25 marks. It is recommended to include a maximum of two learning activities as part of the CCA to foster the holistic development of students. These activities shall be:

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity

Students' activities for TW/SL under NCrF: Samples only

As per National credit farmwork (NCrF) students must spend 90 hours of study for 3 credit courses, which include Course instructions (CI-42 hour) and Teamwork/ Selfe learning (TW/Sl-48 hours). Hence, students must complete minimum of two actives as part of NCrF. These students learning activities shall be conceded as CCA components of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below. The course coordinators can also design their own activities based on the course outcomes.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester -Samples

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	**Module 1 practical:** stakeholder-role map, BIM-use map, RACI/RASCI awareness and software/hardware suitability note for a small project.	24
2.	**Module 2 practical:** inspect a sample model/IFC and context dataset; identify information modelling type, generation method, hierarchy, properties and reliability gaps.	24
3	**Module 3 practical:** create or update a simple model, generate drawings/schedules/quantities, export/inspect IFC and record lab software/hardware setup.	24
4	**Module 4 practical:** interoperability exercise using IFC/MVD awareness, property checks, BCF-style issue log, CDE	24

	status/revision workflow and validation note.	
5	**Module 5 practical:** VDC/IDD mini delivery package with model-schedule link, logistics/safety issue, handover data sample, software-hardware selection matrix and risk note.	24
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	Number of Hours / Semester
1.	Complete online/tutorial exposure on BIM fundamentals, openBIM, IFC viewing, Bonsai/BlenderBIM, FreeCAD BIM, IfcOpenShell basics, QGIS and CDE workflow.	24
2.	Prepare a short comparative note on BIM software and hardware selection for viewing, authoring, coordination, reality capture, VDC/IDD and handover use cases.	24
3	Review IFC/MVD/BCF/IDS/COBie/bSDD concepts using buildingSMART and open-source documentation and prepare a simple interoperability checklist.	24
4	Case-study review of Indian and international BIM/digital-construction implementation, including stakeholder benefits, risks, data security and handover failures.	24

Rubrics for Students learning activities -TW/SL - (Samples)

1. Sample Rubrics -Integrated Design Mini-Project

Criterion	**Exemplary (3)**	**Proficient (2)**	**Basic (1)**	**Weight**
BIM role, stakeholder, use-case and tool-selection logic (CO1, CO6)	Clearly maps stakeholder roles, BIM uses, decisions, responsibilities, software choices and hardware needs across lifecycle stages; distinguishes BIM, VDC, IDD and digital twins.	Maps main roles, uses and tools with minor gaps in lifecycle, responsibility or hardware logic.	Generic explanation; unclear role/use-case/tool link; software-centric framing.	20%
Model structure, information modelling and generation logic (CO2, CO3)	Correctly identifies model hierarchy, objects, properties, relationships, classifications, LOD/LOI and generation route suitability.	Identifies most model elements and information fields; some gaps in relationships or suitability.	Mostly visual/model-only description; little understanding of information content.	25%
OpenBIM exchange, interoperability, CDE and validation awareness (CO4, CO5)	Uses IFC/MVD/BCF/COBie/IDS concepts appropriately; checks missing data, naming, revision/status, exchange purpose and acceptance criteria.	Demonstrates basic IFC/CDE/issue-log/interoperability understanding with partial checking.	Treats exchange as simple file export; weak checking and issue tracking.	20%

BIM use for construction, VDC/IDD and handover (CO3, CO5, CO6)	Links model data to QTO, 4D/VDC, IDD workflow, coordination, site decisions, handover, asset information and risk control with clear evidence.	Shows basic use for quantities, coordination or sequence but with limited decision explanation.	Outputs are descriptive; weak link to construction or handover decisions.	20%
Portfolio	Well-structured report/portfolio with diagrams, screenshots, schedules, issue logs, references and clear limitations.	Generally organized; minor clarity, labelling or evidence gaps.	Disorganized; missing key evidence, outputs or explanation.	15%

Continuous Internal Evaluation (CIE):

(i) The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.

(ii) Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.

(iii) The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.

(iv) A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE:

i. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.

ii. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.

iii. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade ‘F’ (Fail).

SURVEYING AND GEOSPATIAL ENGINEERING LABORATORY		Scheme	2025
Course Code	**1BIFL405**	Semester	IV
Teaching Hours/Week (L:T:P)	28 (0:0:2)	CIE Marks	50
Total Hours of Pedagogy CI(L:T):LI(P):SLTW	30 (0:0:28:2)	SEE Marks	50
Credits	1	Total Marks	100
Examination type (SEE)	**Practical**	Exam Hours	03

Course outcome (Course Skill Set)

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

1. CO1: Use basic surveying instruments and perform field observations for linear and angular measurements. (L3)
2. CO2: Determine elevations, contours, and site features using leveling and tacheometric methods. (L3)
3. CO3: Conduct topographic and route surveys using modern surveying techniques. (L3)
4. CO4: Process survey data and prepare plans, sections, and geospatial outputs. (L4)
5. CO5: Apply geospatial tools, GPS/GNSS, and digital mapping concepts for civil engineering applications. (L3)

Note:

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 6 conventional experiments, PART-B has 6 typical open-ended experiments. The maximum marks for the laboratory course are 100.
2. Both PART-A and PART-B are considered for CIE and SEE.
3. Students have answer 1(one) question from PART-A and 1(one) question from PART-B.
   a. The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for **70 marks** out of the maximum 100 marks.
   b. The open-ended question set for SEE shall be any other open-ended question and not selected from the experiments under PART-A. It shall be evaluated for **30 marks.**
4. For Continuous Internal Evaluation (CIE) during the semester, classwork shall typically include open-ended questions from **Part-B**, along with other similar questions designed to enhance the students' skills.

PART – A
FIXED SET OF EXPERIMENTS

1. Chain surveying.
   Measurement of a simple field by chain and tape, including offsets and sketch preparation.
2. Compass surveying.
   Traversing with compass, observation of bearings, and computation of included angles.
3. Levelling.
   Fly levelling and check levelling using dumpy or automatic level; reduction of levels by H.I. or rise and fall method.
4. Theodolite experiment.
   Measurement of horizontal and vertical angles using theodolite.
5. Tacheometry Experiment
   To determine horizontal distances and elevations of points by tacheometric methods
6. Study of Total Station.
   Identification of parts, temporary adjustments, setting up, centring, levelling, and instrument operation.
7. Traverse using Total Station.
   Observation of angles and distances, computation of coordinates, and checking traverse closure.
8. Remote height and distance using Total Station.
   Determination of inaccessible height/distance of a point, building, or object.
9. GPS survey.
   Recording coordinates of survey points using GPS and understanding absolute/differential positioning.

PART – B
OPEN ENDED EXPERIMENTS

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning. Students may be assigned any one of the open-ended problem statements during assessment. **The sample open-ended problems are provided as reference. Course coordinators are encouraged to design and assign context-specific open-ended problem statements aligned with the defined Course Outcomes (COs), ensuring relevance to contemporary practices and learner needs.**

1. **Topographic survey project** for a small campus/site using total station or GPS and preparation of plan with contours.
2. **Route survey project** for a road, pipeline, or utility corridor with longitudinal profile and cross-sections.
3. **Building set-out exercise** for a proposed structure using surveying instruments and site control points.
4. **Area and volume computation** from surveyed data for earthwork estimation.
5. **Geospatial data preparation** using GIS tools for thematic mapping of land use, drainage, or utilities.
6. **Integration of surveying and CAD/GIS outputs** for a civil engineering site layout and report generation.

Suggested Learning Resources:

Textbooks:

1. B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Surveying, Laxmi Publications.
2. S.K. Duggal, Surveying, McGraw Hill.
3. N.N. Basak, Surveying and Levelling, McGraw Hill.
4. J.P. Kothari, Elements of Geomatics,
5. R. Subramanian, Surveying and Levelling, Oxford University Press.

Reference books / Manuals:

1. G.S. Sehgal, *Advanced Surveying*.
2. P. L. Bhatia, *Surveying and Geodesy*.
3. Relevant BIS standards and departmental surveying manuals.

Web links and Video Lectures (e-Resources):

1. NPTEL lectures on Surveying and Geospatial Engineering.
2. GNSS/GPS and GIS practical tutorials.
3. Digital cartography and geospatial data processing resources.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average of marks for report and test shall be out of 50 marks.

For both CIE and SEE, the student is required to conduct one experiment each from both Part A and Part B.

Eligibility for SEE:

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.

Rubrics suggested for Practical continuous assessment

Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output. (3)	Student will be able to run the program but not able to analyze the output. (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

Ability Enhancement Course (Laboratory) Syllabus

AI AND DATA-DRIVEN CIVIL AND INFRASTRUCTURE ENGINEERING LAB			
Course Code	1BIFL406A	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV
Teaching Hours/Week (L :T : P)	28 (0:0:2)	CIE Marks	50
Total Hours of Pedagogy CI(L :T):LI(P):SL:TW	30 (0:0:28:2)	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	03

Course outcome (Course Skill Set)

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

1. CO1 (L2 – Understand): CO1 (L2 – Understand): Describe fundamentals of data collection, preprocessing, and exploratory data analysis techniques for civil engineering datasets including sensor data, structural monitoring, and infrastructure assets.
2. CO2 (L3 – Apply): Apply Python-based libraries to process and analyze civil engineering data for predictive modeling and optimization.
3. CO3 (L3 – Apply): Develop machine learning models (regression, classification, clustering) for civil engineering applications.
4. CO4 (L4 – Analyze): Evaluate and compare different AI/ML algorithms using appropriate metrics and validation techniques for infrastructure datasets.
5. CO5 (L5 – Evaluate): Create data-driven solutions to real-world civil engineering problems.

SET OF EXPERIMENTS (LI =28 Hours)

1. Data Exploration and Visualization for Building Performance: Understand data collection techniques and visualization methods for civil engineering datasets.
2. Data Preprocessing and Feature Engineering for Infrastructure Datasets: Preprocess real-world noisy civil engineering data and create engineered features.
3. Regression Analysis for Structural Property Prediction: Develop and evaluate regression models for predicting civil engineering parameters
4. Classification for Infrastructure Risk Assessment Apply classification algorithms for civil engineering decision-making tasks.
5. Clustering and Anomaly Detection for Monitoring Data: Identify patterns and anomalies in infrastructure monitoring datasets.
6. Time-Series Forecasting for Infrastructure Predictions: Develop models for predicting future infrastructure behavior.

Suggested Learning Resources

Text books:

1. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron – Practical ML fundamentals with Python; excellent for civil engineering applications and model implementation.
2. "Introduction to Statistical Learning" by James, Witten, Hastie, Tibshirani – Foundational ML theory with R and Python examples; covers regression, classification, and model selection relevant to civil engineering.
3. "Data Science for Civil Engineers" by David E. Newcombe – Specifically tailored to civil engineering applications of data science and machine learning.

Reference Books:

1. "Python for Data Analysis" by Wes McKinney – Essential guide to Pandas and data manipulation; critical for preprocessing civil engineering datasets.
2. "Machine Learning in Civil Engineering: A Review" (Journal Articles) – Recent reviews on AI/ML applications in structural health monitoring, traffic management, and sustainable construction.
3. "Feature Engineering for Machine Learning" by Alice Zheng and Amanda Casari – Practical guide to creating effective features from civil engineering data.
4. "Applied Machine Learning in Python for Engineers" by Nishanth Koganti – Engineering-focused ML applications with practical Python implementations

Web links and Video Lectures (e-Resources):

1. Coursera: "Machine Learning" by Andrew Ng – Comprehensive foundational course on ML algorithms.
2. Kaggle Learn: Free ML courses and datasets; excellent for practicing with real engineering datasets.
3. YouTube NPTEL: "Soft Computing and Machine Learning" and "Data Mining" – Lectures applicable to civil engineering contexts.
4. Microsoft Learn: ML fundamentals with Python and Scikit-learn modules.

Software Tools:

A. Commercial Software

Software	Best For	Key Features	Education Access
MATLAB	Data exploration, regression, forecasting, signal/time-series analysis	Strong plotting, statistics, machine learning, and forecasting toolboxes; widely used in engineering labs	Student and campus licenses available
Microsoft Excel	Basic data cleaning, visualization, and introductory analysis	Easy tabular analysis, charts, pivot tables, and quick preprocessing for small datasets	Usually available through institutional Microsoft licenses
Tableau	Interactive dashboards and visual analytics for engineering datasets	Drag-and-drop visualization, KPI dashboards, and map-based analytics for building performance data	Academic licenses available
Power BI	Reporting and data visualization for infrastructure monitoring	Interactive dashboards, filters, KPIs, and real-time reporting for civil datasets	Academic use supported through Microsoft licensing
IBM SPSS Modeler	Classification and regression for decision-support tasks	Visual workflow-based modeling, data preparation, and predictive analytics	Educational licenses available
SAS Viya	Large-scale analytics, classification, and forecasting	Enterprise-grade analytics, model management, and advanced statistical tools	Academic licensing available
Minitab	Statistical analysis and regression for engineering data	Easy statistical workflows, regression, hypothesis testing, and quality analysis	Student and academic licenses available

B. Open-Source Software

Software	Best For	Key Features	License
Python (Jupyter Notebook)	Data exploration, preprocessing, regression, classification, clustering, forecasting	Flexible notebooks for end-to-end workflows; supports visualization, machine learning, and automation	Open-source
NumPy	Numerical computation and	Fast array operations and mathematical processing for engineering datasets	Open-source

	feature engineering		
Matplotlib / Seaborn	Data visualization	Static statistical plots, trends, distributions, scatter plots, and heatmaps	Open-source
Stats models	Regression and statistical modeling	Linear models, time-series tools, residual analysis, and statistical inference	Open-source
XG Boost / Light GBM	Classification and regression for infrastructure prediction	High-performance tree-based models for structured civil engineering datasets	Open-source
Prophet	Time-series forecasting	Forecasting with trend and seasonality handling for infrastructure behavior prediction	Open-source
TensorFlow / PyTorch	Advanced forecasting and predictive modeling	Deep learning support for complex nonlinear regression and forecasting tasks	Open-source

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average marks for report and test shall be out of 50 marks.

Eligibility for SEE:

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks.**
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks.**

Rubrics suggested for Practical continuous assessment

Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)

	design with proper reason (5)			
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output. (3)	Student will be able to run the program but not able to analyze the output. (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

WATER DISTRIBUTION NETWORK MODELLING WITH EPANET LAB			
Course Code	**1BIFL406B**	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV
Teaching Hours/Week (L :T : P)	28 (0:0:2)	CIE Marks	50
Total Hours of Pedagogy CI(L :T):LI(P):SL:TW	30 (0:0:28:2)	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	03

Course outcome (Course Skill Set)

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

1. CO1 (L3 – Apply): Use EPANET to create and edit water distribution network models, define junctions, pipes, reservoirs, pumps and demands.
2. CO2 (L3 – Apply): Run hydraulic and water quality simulations and extract node/pipe results (pressure, flow, head, quality).
3. CO3 (L4 – Analyze): Analyze simulation outputs to identify low pressure zones, bottlenecks, and mass balance issues.
4. CO4 (L4 – Analyze): Calibrate a simple distribution network model using field data and demand patterns.
5. CO5 (L3 – Apply): Develop scenario analyses (pipe closure, pump scheduling, demand growth) and compare results.
6. CO6 (L5 – Evaluate): Evaluate operational strategies (leak detection prioritization, pressure management, emergency response) and prepare a professional lab report with recommendations.

SET OF EXPERIMENTS (LI =28 Hours)

1. EPANET introduction, software interface, creating a new project, units and network elements (junctions, pipes, tanks, reservoirs, pumps, valves).
2. Create a small example network (5–10 nodes), assign demands and run steady state hydraulic analysis; interpret node pressures and pipe flows.
3. Visualizing results: contours, pipe flow arrows, node reports and time series plots for hydraulic variables.
4. Demo: reservoir/tank modeling and extended period simulation (EPS) basics (demand patterns, time steps).
5. Pump curves and patterns: modeling variable speed pumps and simple pump scheduling.
6. Valves (PRV, PSV) and their effects on network hydraulics; pressure control scenarios.
7. Water quality simulation basics: constituent setup, reaction coefficients, and tracing a conservative tracer.
8. Leak / closed pipe scenario: simulate pipe closure and identify alternate flows and critical links.
9. Pipe roughness, Hazen Williams coefficient sensitivity study and its effect on pressures and flows.
10. Demand estimation: create/modify diurnal demand patterns and analyze peak vs base conditions.
11. Model calibration exercise: compare simulated vs provided field pressures/flows, adjust demands or roughness to improve fit.
12. Scenario analysis: demand growth or fire flow requirement simulation and identify required upgrades.

Suggested Learning Resources:

Textbooks:

1. Rossman, L. A. *EPANET 2 Users Manual* / EPANET technical documentation. This is the core reference for hydraulic and water quality modelling in EPANET.

2. Walski, T. M., et al. *Advanced Water Distribution Modeling and Management*. A useful reference for network analysis, calibration, and operational studies.
3. Mays, L. W. *Water Distribution Systems Handbook*. Helpful for design principles, pressure management, and system planning.
4. AWWA manuals and selected civil engineering water supply texts for distribution network fundamentals and practical design guidance.

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3. Mays, L. W. Water Distribution Systems Handbook. Helpful for design principles, pressure management, and system planning.
4. AWWA manuals and selected civil engineering water supply texts for distribution network fundamentals and practical design guidance.

Web links and Video Lectures (e-Resources):

1. EPANET official page, U.S. EPA.
2. EPANET training and tutorial resources from university or professional training sites.
3. NPTEL / MOOC lectures on water distribution systems and hydraulic modelling.
4. Video demonstrations of EPANET network creation, steady-state analysis, and extended period simulation.

Software Tools:

A. Commercial Software

Software	Best For	Key Features	Education Access
EPANET	Water distribution network hydraulic and water quality simulation	Creates and analyzes pressurized pipe networks; supports steady-state analysis, extended period simulation, pumps, valves, tanks, reservoirs, and water quality tracing	Free software; widely used in academic teaching
InfoWater Pro	Advanced urban water distribution modeling and design	EPANET-based workflow with GIS integration, scenario analysis, and detailed operational controls	Educational licenses may be available
Bentley WaterGEMS	Municipal water network analysis and design	Strong for hydraulic modeling, pump/valve simulation, calibration, and scenario testing	Educational licenses may be available
Autodesk InfoWorks WS Pro	Large-scale water network planning and operations	Supports network hydraulics, demand analysis, pump scheduling, and operational scenarios	Educational licenses may be available

B. Open-Source Software

Software	Best For	Key Features	License
EPANET	Introductory and advanced water distribution analysis	User interface for drawing networks, assigning demands, running hydraulic and quality simulations, and viewing	Free

		results	
EPANET-js	Browser-based teaching and worked examples	Web interface for building networks, running steady-state analysis, viewing pressures and flows, and EPS tutorial	Open-source
QGIS	Mapping and spatial visualization of network layouts	Useful for backdrop maps, asset location, and spatial interpretation of water network models	Open-source
Python (Jupyter Notebook)	Scenario analysis, sensitivity studies, optimization, and post-processing	Can be used to organize EPANET outputs, compare scenarios, and automate repeated runs	Open-source
Excel	Demand pattern preparation, result tables, and calibration worksheets	Useful for creating diurnal demand patterns, comparing observed vs simulated values, and summarizing results	Widely available

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average marks for report and test shall be out of 50 marks.

Eligibility for SEE:

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks.**
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks.**
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks.**

Suggested rubrics for Practical continuous assessment:

Performance Indicator	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for his/her problem statement and capable of proving the best suitable design with proper reason (5)	Student is capable of discussing few designs for his/her problem statement but not capable of selecting best (4)	Student is capable of discussing single design with its merits and de-merits (3)	Student is capable of explaining the design (1-2)
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)

Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output (3)	Student will be able to run the program but not able to analyze the output (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

INTELLIGENT DRONE SURVEYING AND MAPPING LABORATORY FOR INFRASTRUCTURE			
Course Code	**1BIFL406C**	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV
Teaching Hours/Week (L: T: P)	28 (0:0:2)	CIE Marks	50
Total Hours of Pedagogy CI (L: T):LI(P):SL:TW	30 (0:0:28:2)	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	03

Course outcome (Course Skill Set)

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

1. **CO1 (L3 – Apply):** Apply unmanned aerial vehicle (UAV) flight planning and image acquisition procedures for photogrammetric data collection in civil engineering contexts.
2. **CO2 (L3 – Apply):** Implement image pre-processing, geotagging, and basic control point workflows using photogrammetry software and spreadsheets.
3. **CO3 (L4 – Analyze):** Analyze image overlap, ground control placement, and processing parameters to produce orthophotos and digital surface models (DSMs).
4. **CO4 (L3 – Apply):** Develop simple quantity extraction and area/volume estimation sheets from orthomosaics using GIS/spreadsheet tools.
5. **CO5 (L4 – Analyze):** Interpret outputs (orthomosaic, DSM, point cloud) to assess accuracy, detect errors, and suggest corrective actions for engineering decisions.
6. **CO6 (L5 – Evaluate):** Evaluate the suitability and sustainability implications of drone-based photogrammetric products for site surveying, mapping, and asset inspection and prepare a professional lab report.

SET OF EXPERIMENTS (LI =28 Hours)

1. Introduction to UAV systems and payloads, safety, regulatory considerations, and basic mission planning for photogrammetry.
2. Flight planning exercise: defining ground sampling distance (GSD), image overlap, flight altitude, and camera settings using mission-planning software.
3. Ground control points (GCP) procedure: marking, surveying (use of total station/GNSS demo), and recording coordinates for photogrammetric control.
4. Conducting a supervised field flight (simulated or live depending on approvals) to collect nadir imagery for a small test site.
5. Image pre-processing: geotagging, image quality checks, deblurring, and organizing datasets using folder/spreadsheet records.
6. Image alignment and sparse/dense point cloud generation in photogrammetry software; interpretation of tie-point distribution and alignment reports.
7. Generating orthomosaic and digital surface model (DSM) products and understanding projection/coordinate systems.
8. Accuracy assessment: using GCPs and check-points to compute RMSE and prepare a short accuracy summary in a spreadsheet.
9. Extraction of planimetric features (contours, roads, boundaries) from orthomosaics and basic vectorization.
10. Volume/area estimation: calculate cut/fill and stockpile volumes from DSMs and capture results in a quantity-estimation spreadsheet.
11. Creating a simple inspection report: measuring cracks, roof areas, or drainage features from orthophotos and preparing annotated figures.
12. Integration exercise: combine photogrammetric outputs with existing GIS layers and produce a comparative thematic map.
13. Preparation and presentation of a final lab report/portfolio that includes datasets, processing steps, spreadsheets (quantity & accuracy sheets), orthomosaics, DSMs, and interpretation.

Suggested Learning Resources Text books:

1. Joe, J., and Smith, A. Principles of Photogrammetry and Remote Sensing for Engineers, (recommended publishers/edition to be chosen by department).
2. James, M. Drone Mapping and Photogrammetry for Civil Engineers, (practical guide / recent edition).
3. Wolf, P. R., and Dewitt, B. A. Elements of Photogrammetry with Applications in GIS, (standard text).
4. Jensen, J. R. Introductory Digital Image Processing: A Remote Sensing Perspective, (for image pre-processing)

Reference Books:

1. Selected vendor manuals: Agisoft Metashape, Pix4D, DroneDeploy user guides.
2. Civil/GIS integration: QGIS documentation, ArcGIS tutorial for orthophoto handling.
3. NPTEL/online lectures on remote sensing and UAV data processing.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average marks for report and test shall be out of 50 marks.

Eligibility for SEE:

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks.**

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each). The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester/after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average marks for report and test shall be out of 50 marks.

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Rubrics suggested for Practical continuous assessment

Performance Indicators	**Excellent**	**Very Good**	**Good**	**Satisfactory**
Fundamental Knowledge (4) (PO1)	The student has well depth knowledge of the topics related to the course (4)	Student has good knowledge of some of the topics related to course (3)	Student is capable of narrating the answer but not capable to show in depth knowledge (2)	Student has not understood the concepts clearly (1)
Design Of Experiment (5) (PO2 & PO3)	Student is capable of discussing more than one design for	Student is capable of discussing few designs for his/her problem	Student is capable of discussing single design with its merits	Student is capable of explaining the design (1-2)

	his/her problem statement and capable of proving the best suitable design with proper reason (5)	statement but not capable of selecting best (4)	and de-merits (3)	
Implementation (8) (PO3 & PO8)	Student is capable of implementing the design with best suitable algorithm considering optimal solution. (7-8)	Student is capable of implementing the design with best suitable algorithm and should be capable of explaining it (5-6)	Student is capable of implementing the design with proper explanation. (3-4)	Student is capable of implementing the design. (1-2)
Result &Analysis (5) (PO4)	Student is able to run the program on various cases and compare the result with proper analysis. (5)	Student will be able to run the program for all the cases. (4)	Student will be able to run the code for few cases and analyze the output (3)	Student will be able to run the program but not able to analyze the output (1-2)
Demonstration (8) (PO9)	The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth. (7-8)	The lab record is organized, with clear sections, but some sections are not well-defined. (5-6)	The lab record lacks clear organization or structure. Some sections are unclear or incomplete. (3-4)	The lab record is poorly organized, with missing or unclear sections. (1-2)

BUILDING MATERIALS TESTING LAB			
Course Code	**1BIFL406D**	Scheme	2025
Type of Course	Ability Enhancement Course (Laboratory)	Semester	IV
Teaching Hours/Week (L :T : P)	28 (0:0:2)	CIE Marks	50
Total Hours of Pedagogy CI(L :T):LI(P):SL:TW	30 (0:0:28:2)	SEE Marks	50
Credits	1	Total Marks	100
Type of Examination	Practical	Exam Hours	03

Course outcome (Course Skill Set)

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

1. CO1 (L3 – Apply): Perform standard tests on bricks, timber, cement, fine aggregate, and coarse aggregate using relevant procedures and equipment.
2. CO2 (L3 – Apply): Determine physical properties and strength characteristics of building materials and compute required test results accurately.
3. CO3 (L4 – Analyze): Interpret test data to assess suitability of materials for construction applications.
4. CO4 (L4 – Analyze): Compare material properties with relevant specifications and identify defects or deviations.
5. CO5 (L5 – Evaluate): Recommend appropriate materials for specific construction uses based on test outcomes and field observations.
6. CO6 (L5 – Evaluate): Prepare a professional laboratory record with observations, calculations, conclusions, and viva voce responses.

SET OF EXPERIMENTS (LI =28 Hours)

1. Water absorption and compression test on bricks.
2. Bulking of sand.
3. Flexural test on timber.
4. Sieve analysis of fine aggregate.
5. Specific gravity and moisture content test on fine aggregate.
6. Elongation index and flakiness index of coarse aggregate.
7. Standard consistency test on cement.
8. Fineness test on cement.
9. Initial and final setting time test on cement.
10. Soundness test on cement.
11. Compressive strength test on cement mortar and concrete cubes.
12. Compression and Tension test on steel.
13. Universal Testing Machine (UTM) Test with Digital Data Acquisition and Stress-Strain Curve Analysis (Demo).

Suggested Learning Resources:

Textbooks:

1. M. L. Gambhir and Neha Jamwal, *Building and Construction Materials: Testing and Quality Control*, McGraw Hill Education (India) Pvt. Ltd.
2. Davis, Troxell and Hawk, *Testing of Engineering Materials*, McGraw Hill Book Co.
3. C. B. Kukreja, K. Kishore and Ravi Chawla, *Material Testing Laboratory Manual*, Standard Publishers & Distributors.
4. A. K. Suryanarayana, *Testing of Metallic Materials*, Prentice Hall of India Pvt. Ltd.
5. K. A. Holes, *Experimental Strength of Materials*, English Universities Press Ltd.
6. Building and Construction Materials: Testing and Quality Control by S. K. Duggal, Edition: 4th Edition , Publisher: McGraw Hill Education India, ISBN-13: 9781259029660, ISBN-10: 1259029662, Volume: Single volume.
7. Laboratory Manual on Testing of Engineering Materials by H. S. Sood, Standard technical publication, ISBN: 9788180140990.

Reference Books

1. Relevant latest IS Codes, BIS, New Delhi.
2. IRICEN, *Handbook of Material Testing* published by the Indian Railways Institute of Civil Engineering
3. IS 3495 (Part 1):1992 – Compressive strength of bricks
4. IS 3495 (Part 2):1992 – Water absorption test for bricks
5. IS 2386 (Part 1):1963 – Particle size distribution (sieve analysis)
6. IS 2386 (Part 4):1963 – Mechanical properties of aggregates
7. IS 4031 (Part 1–15) – Physical tests for cement
8. IS 2386 – Field identification of aggregates
9. IS 383:2016 – Aggregate quality requirements
10. IS 10262:2019: Main code for concrete mix proportioning/design.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. Total marks for the all report shall be scaled down to 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and Marks scored shall be scaled down to 20 marks. Final average marks for report and test shall be out of 50 marks.

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BIOLOGY FOR CIVIL ENGINEERS			
Course Code	1BIF407	Scheme	2025
Type of Course	Basic Science Course (BSC)	Semester	IV
Teaching Hours/Week (L:T:P)	28 (2:0:0)	CIE Marks	50
Total Hours of Pedagogy per semester CI (L /T) :LI(P):SL&TW:	60(28:0:0:32)	SEE Marks	50
Credits	2	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

1. CO1 (L2): Explain fundamental biological concepts relevant to civil engineering (microbial ecology, plant–soil interactions, ecosystem services).
2. CO2 (L3): Apply biological principles to classify and select suitable biological treatments and green infrastructure options for water, soil and waste management.
3. CO3 (L3): Apply methods for basic site biological characterization (microbial indicators, soil biology, vegetation surveys) and interpret simple results.
4. CO4 (L4): Analyse performance and limitations of biological systems (constructed wetlands, phytoremediation, bioreactors) under field-relevant conditions.
5. CO5 (L5): Evaluate sustainability, regulatory and safety aspects and propose biologically informed solutions for simple civil engineering case studies.

Module-1

Fundamentals of Biology for Civil Engineers:

- Topics: Cells, microbes and communities; basics of microbial metabolism and catabolic pathways; plant physiology relevant to phytoremediation; soil biology and ecosystem services.
- **Learning focus**: key terms, concepts and relevance to infrastructure and environmental systems.

Linked COs: CO1 **Number of Hours: 6 Hours**

Module-2

Biological Processes in Water and Waste Treatment:

- Topics: Microbial processes for wastewater treatment (aerobic/anaerobic digestion, biofilms, nitrification/denitrification), natural and engineered treatment wetlands, biofilm reactors and basic reactor concepts.
- **Learning focus**: process mechanisms, design parameters (DO, retention time, SRT), simple performance indicators.

Linked COs: CO2, CO4 **Number of Hours: 6 Hours**

Module-3

Soil, Groundwater and Solid Waste Biology:

- Topics: Soil microbiology and biodegradation, biodegradation of hydrocarbons and common contaminants, biodegradation vs. immobilisation for metals, biological aspects of landfills and composting, basics of bioremediation approaches used in civil practice.
- **Learning focus:** when biology can remediate vs when engineering controls are needed.

Linked COs: CO2, CO3. **Number of Hours: 6 Hours**

Module-4

Field Characterization, Monitoring and Data Interpretation:

- Topics: Sampling strategies, indicator organisms and parameters (coliforms, BOD, COD), simple microbiological and biochemical assays (culture-based counts, basics of qPCR concept), use and limits of monitoring data; introduction to simple modelling concepts for fate and transport.
- **Learning focus:** sampling design, data interpretation and uncertainty.

Linked COs: CO3, CO4. **Number of Hours: 5 Hours**

Module-5

Biological systems, sustainability and case studies (5 hours)

- Biological systems in green infrastructure: constructed wetlands, bio-swales, vegetated filter strips, green roofs and urban vegetation used for stormwater, water-quality and microclimate benefits.
- Phytoremediation systems and bioreactors: conceptual layouts, typical applications (nutrients, organics, some metals), performance indicators and common limitations under field conditions.
- Sustainability, regulatory and safety aspects: overview of regulatory guidance and good practice for

bioremediation, wetlands, biological treatment and biosafety at sites (national/international guidelines such as U.S. EPA resource documents).

- Biologically informed solutions: simple civil-engineering case studies (e.g., small contaminated site, drain receiving organic loads, solid-waste facility) where students propose biological/green-infrastructure options, considering sustainability, safety and regulatory compliance.

Linked COs: CO4, CO5. **Number of Hours: 5 Hours**

Suggested Learning Resources:

Textbooks:

1. Rittmann, B. E., and McCarty, P. L., Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill Education, 2018. ISBN: 978-1260441611.
2. Tchobanoglous, G., Stensel, H. D., Tsuchihashi, R., and Burton, F. L. (eds.), Wastewater Engineering: Treatment and Resource Recovery (Metcalf & Eddy), 5th Edition, McGraw-Hill Education, 2014. ISBN: 978-0073401188.
3. Vymazal, J., Constructed Wetlands for Wastewater Treatment: Principles and Practice, 3rd Edition, IWA Publishing (or Springer depending on edition), 2011 (check edition used). ISBN (typical): 978-1843391954.

Reference Books:

1. Rittmann, B. E., and McCarty, P. L., Environmental Biotechnology: Principles and Applications — supplementary chapters and worked examples, McGraw-Hill Education, 2018. ISBN: 978-1260441611.
2. Qasim, S. R., and Zhu, G., Wastewater Treatment and Reuse: Theory and Design Examples, CRC Press, 2018. ISBN: 978-1138386703. (useful supplementary reference for design examples).

Web links and e-Resources:

- NPTEL — Environmental Biotechnology / Wastewater Treatment lecture series, National Programme on Technology Enhanced Learning (NPTEL), IITs/NITs — online video lectures and course notes, available at NPTEL portal. (Access date: insert date when you cite).
- U.S. EPA — Bioremediation Resource Guide and technical documents, U.S. Environmental Protection Agency — useful guidance on remediation approaches and case studies. (Access date: insert date).
- crcCARE — Bioremediation guidance documents and technology roadmaps, crcCARE online resources. (Access date: insert date).

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the CIE, a student must score at least 40% of 50 marks, i.e., 20 marks.
- To pass the SEE, a student must score at least 35% of 50 marks, i.e., 18 marks.
- Notwithstanding the above, a student is considered to have passed the course, provided the combined total of CIE and SEE is at least 40 out of 100 marks..

Continuous Comprehensive Assessments (CCA)+ Internal Assessment Test (IA) = Continuous Internal

Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development.** These activities shall be:

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity
- Any other relevant and innovative academic activity

Students' activities for TW/SL under NCrF: Samples only

As per National credit formwork (NCrF) students must spend 60 hours of study for 2 credit courses, which include Course instructions (CI-28 hour) and Teamwork/ Selfe learning (TW/Sl-32 hours). Hence, students must complete minimum of two actives as part of NCrF. These learning activities shall be considered as CCA components of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below. The sample activities are given below. The course coordinator can also give their own TW/SL activities as per the course outcomes.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	**Group mini-project — Pilot design of a small biological treatment/green solution (CO2, CO3, CO5):** Students form teams (3–4) to design a pilot constructed wetland, phytoremediation bed or small bioreactor for a given site/problem **Task:** site description, selection of biological method, process flow diagram, basic sizing/retention time estimate, monitoring plan, short cost & sustainability note.	16
2.	**Field visit and structured report:** Visit a local wastewater treatment plant, constructed wetland, landfill or composting facility to observe biological processes in practice. **Task:** pre-visit questions, on-site observation checklist (processes, monitoring, safety), post-visit critical report linking observations to theory.	16

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester
1.	Individually complete a selected NPTEL module or short course segment (e.g., Environmental Biotechnology / Wastewater Treatment) and submit a 500–750-word report.	16
2.	**Tool / software exploration assignment:** Short assignment to export/inspect example data from simple modelling or monitoring tools (e.g., Excel mass balance for BOD removal, simple fate–transport spreadsheet, or GIS site-mapping demo).	16

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):

1. Sample Rubrics - Biological Solution Mini-Project

Criterion	Excellent	Good	Satisfactory	Needs Improvement
Problem identification	Clearly identifies the site/problem, contamination or service need, and objective of the project.	Identifies the problem well with minor gaps.	Gives a general description with limited clarity.	Problem is unclear, incomplete, or incorrect.
Method selection and justification	Selects the most suitable biological method with strong technical justification.	Selects a suitable method with adequate justification.	Method is partially suitable, but justification is weak.	Method choice is inappropriate or unsupported.
Technical process explanation	Explains the biological process, working principle, and key steps clearly and correctly.	Explanation is good with minor omissions.	Basic explanation with limited detail.	Incomplete or incorrect explanation.
Design / planning details	Provides a logical process flow, basic sizing or planning steps, and monitoring plan.	Provides most planning elements with minor gaps.	Includes some planning details, but incomplete.	Planning is minimal or absent.
Data use / site understanding	Uses relevant site data, assumptions, or observations effectively.	Uses data reasonably with minor limitations.	Uses limited data or weak interpretation.	No meaningful data use or understanding.
Cost, safety, and sustainability	Balanced discussion of cost, safety, environmental impact, and sustainability.	Addresses most aspects with limited depth.	Mentions a few aspects only.	No meaningful discussion.
Presentation / report quality	Well organized, clear, concise, and professionally presented.	Mostly clear and organized with minor issues.	Adequate but lacks polish or clarity in places.	Poorly organized or difficult to follow.
Team contribution / participation	Equal and active contribution from	Minor imbalance in contribution.	Uneven participation	Poor teamwork or little contribution.

	team members is evident.		with limited evidence.	

Continuous Internal Evaluation (CIE):

(i) The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
(ii) Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
(iii) The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
(iv) A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE:

i. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
ii. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
iii. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

ENVIRONMENTAL SCIENCE PROJECT			
Course Code	**1BEP408**	Scheme	**2025**
Type of Course	Societal Development Course (SDC)	Semester	IV
Teaching Hours/Week (L:T:P)	28 (2:0:0)	CIE Marks	50
Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL	30 (28:0:0:2)	SEE Marks	50
Credits	**1**	Total Marks	100
Examination type (SEE)	**Theory**	Exam Hours	03

Course Objectives:

The Environmental Science Project is a practical, applied-learning course that builds students' environmental awareness and responsibility. It focuses on real issues such as climate change, pollution, biodiversity, resource use, soil erosion, and thermal comfort, using field surveys, case studies, data collection, audits, and analysis to develop feasible and sustainable solutions. Students may work individually or in groups of up to four, including interdisciplinary topics, and assessment is based on the prescribed rubrics.

Course outcome (Course Skill Set):

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

1. **CO1 (L2 – Understand):** Identify and analyse environmental problems through field interaction and technical assessment.
2. **CO2 (L3 – Apply):** Develop skills in project planning, field survey, data collection, implementation, documentation and reporting.
3. **CO3 (L4 – Analyze):** Formulate feasible environmental problem statements and solutions considering practical constraints and sustainability aspects.
4. **CO4 (L3 – Apply):** Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.
5. **CO5 (L4 – Analyze):** Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.
6. **CO6 (L5 – Evaluate):** Demonstrate teamwork and communication skills while interacting with technical and non-technical stakeholders and reflect on project impact on society.

Restrictions and professional conduct:

Environmental Science Projects should be academic, socially responsible, technically focused, and politically neutral. Students and faculty must maintain professionalism, ethical conduct, and respect while working with communities and stakeholders, and avoid any political, ideological, commercial, or disruptive activities. Projects should also consider practical constraints such as cost, resources, safety, environmental impact, and stakeholder cooperation.

SET OF PROJECT ACTIVITIES (TW/SL = 28 HOURS)

Methods for project identification:

Students may identify the project topic using one or more of the following methods: interaction with local rural or urban stakeholders such as local leaders, corporation/municipality personnel, NGOs, panchayat representatives, etc.; review of issues highlighted in print and electronic media, and social networks; and, after selecting a broad topic, collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and define the problem statement and objectives clearly.

List of Project Topics and Engineering Outcomes:

The following structured sequence of activities is to be carried out during the semester:

Sl. No.	Project title	Measurable engineering outcome	Mapped POs	SDGs
1	Rural and urban water conservation and management systems	Prepare a site-specific water-saving plan, estimate water demand–supply gap, and propose a feasible conservation intervention with quantified savings.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 6, SDG 11, SDG 12
2	Waste management and recycling	Conduct waste audit, classify waste streams, and design a segregation/recycling workflow with measurable reduction in mixed waste.	PO2, PO3, PO4, PO6, PO8, PO10	SDG 11, SDG 12, SDG 13

3	Afforestation	Identify a degraded area, prepare plantation layout, and demonstrate survival-rate tracking and maintenance schedule for saplings.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
4	Biogas generation and power generation	Estimate organic waste availability, size a small biogas system, and document expected gas output or energy yield.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 11, SDG 12
5	DPR for solar power rural plant	Prepare a DPR with load assessment, panel sizing, cost estimate, and projected energy generation and payback.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 9, SDG 11
6	DPR for electrification of village/tribal community	Map unserved/underserved households, propose electrification layout, and estimate coverage, losses, and implementation cost.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 7, SDG 9, SDG 10
7	DPR for rural drainage system	Survey drainage bottlenecks, develop a drainage layout, and estimate runoff handling capacity and flood-risk reduction.	PO1, PO2, PO3, PO4, PO6, PO10	SDG 6, SDG 9, SDG 11
8	Sustainability and environmental health projects	Assess local environmental health issues and propose interventions with measurable improvement in hygiene, safety, or resource use.	PO2, PO3, PO4, PO6, PO7, PO8	SDG 3, SDG 6, SDG 11, SDG 12
9	Plastic free campaigns	Measure plastic usage before and after awareness intervention and report percentage reduction or behavioural change.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
10	Health and nutrition awareness	Conduct baseline and post-program awareness survey and document improvement in awareness score or adoption of healthier practices.	PO2, PO6, PO7, PO8, PO9, PO10	SDG 2, SDG 3, SDG 11
11	Societal projects involving health wellness	Identify a community health need and develop an awareness/service module with measurable participation and feedback outcomes.	PO2, PO3, PO6, PO8, PO9, PO10	SDG 3, SDG 11, SDG 17
12	Air quality monitoring system	Collect air-quality data, compare with reference limits, and present trends along with possible mitigation suggestions.	PO2, PO3, PO4, PO5, PO6, PO10	SDG 3, SDG 11, SDG 13
13	Plastic waste reduction campaign	Track collection, segregation, and replacement actions, and quantify reduction in plastic waste generation or littering.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
14	Urban greening projects	Prepare greening plan, identify planting locations, and assess environmental benefits such as shade, aesthetics, or heat mitigation.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
15	Smart agriculture solution	Design a low-cost monitoring or irrigation support solution and estimate improvement in water use efficiency or crop support.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 9
16	Smart irrigation system	Estimate crop water requirement, propose control logic, and quantify water savings compared with conventional irrigation.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 12

17	Food security initiatives / cold storage system	Estimate storage need, design a simple cold-chain concept, and document reduction in spoilage or wastage.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 9, SDG 12

Suggested Learning Resources

Particulars	Titles and Publishers
Textbooks	1. Benny Joseph, Environmental Studies, Tata McGraw-Hill, 2nd Edition (or latest reprint available in VTU-affiliated libraries). 2. R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 2005 (or latest edition). 3. Erach Bharucha, Textbook of Environmental Studies, University Press, latest edition as available in library. 4. M. P. Poonia and S. C. Sharma, Environmental Studies, Vikas/Khanna Publishing House, latest edition as available. 5. Phadke, N. D., *Community Engagement and Social Innovation*, Oxford University Press, New Delhi. 6. Garg, N. R., *Project-Based Learning in Engineering Education*, Pearson India Education Services, Noida. 7. Gupta, A. and P. Singh, *Service Learning and Community Projects*, McGraw-Hill Education (India), New Delhi. 8. Wilson, G., *Practical Guide to Community Development Projects*, Routledge, London.
Reference books	1. NPTEL courses on Project-Based Learning and Social Innovation. 2. SWAYAM courses on community engagement and sustainability. 3. UN Sustainable Development Goals portal. 4. MyGov India and local civic body portals for community initiatives. 5. YouTube resources on design thinking, social innovation, and community service learning. 6. NGO and government field-action case studies related to sanitation, water, health, education, and environment.
Web links and Video Lectures (e-Resources)	1. NPTEL courses on Engineering Geology. 2. NPTEL courses on Soil Mechanics and Foundation Engineering. 3. Virtual Labs – Geotechnical Engineering Virtual Lab. 4. Geological Survey of India. 5. YouTube channels on civil engineering experiments. 6. American Society of Civil Engineers (ASCE) – Geotechnical resources and standards.

Teaching Learning Process:

The suggested TLP for Community / Societal Project is as follows;

Week / Phase	**Teaching–Learning Activity**	**Faculty Role**	**Student Activity**	**Output / Evidence**
1	Course introduction, objectives, ethics, conduct, and assessment briefing	Explain course scope, rules, rubrics, and expected deliverables	Understand course requirements and form teams	Team list, course plan
2	Community problem identification and topic selection	Guide topic framing and feasibility	Identify local issues through discussion and observation	Shortlisted project topic
3	Stakeholder interaction and preliminary survey	Demonstrate survey methods and stakeholder engagement	Collect initial data from community/users	Survey notes, interview record

4	Problem statement and objective formulation	Review and refine problem statement	Prepare problem statement, scope, and objectives	Approved problem statement
5	Literature/case study review and baseline analysis	Suggest relevant references and examples	Study existing solutions and compare approaches	Baseline analysis summary
6	Project planning and role assignment	Help teams organize tasks, timeline, and responsibilities	Plan activities, divide roles, and prepare schedule	Work plan / Gantt chart
7	Feasibility analysis and solution brainstorming	Check technical feasibility and practicality	Generate possible engineering solutions	Solution alternatives sheet
8	Selection of final solution and design approach	Review final concept and design logic	Finalize concept, methods, and expected outcome	Concept note / design outline
9	Data processing / calculations / sizing / mapping	Support computations and technical review	Analyze data, perform calculations, prepare maps/charts	Technical analysis sheet
10	Prototype / model / audit / DPR / app development	Monitor progress and correct technical issues	Develop the selected output	Working model / draft DPR / map / app
11	Testing, refinement, and implementation planning	Evaluate technical correctness and improvements	Test prototype or validate proposal with users	Test results / revised output
12	Field implementation / demonstration / awareness activity	Facilitate community interaction and documentation	Conduct implementation or demonstration	Photos, attendance, implementation record
13	Documentation of outcomes, feedback, and impact	Review report structure and completeness	Compile findings, stakeholder feedback, and observations	Draft report
14	Presentation preparation and viva practice	Conduct mock presentation and feedback	Prepare slides/poster and rehearse	Presentation deck
15	Final presentation, submission, and reflection	Evaluate performance using rubrics	Present project, submit report, reflect on learning	Final report, presentation, viva

Assessment structure:

A. Continuous Internal Evaluation (CIE) – 50 marks

- Students, in batches of 3–4, shall undertake at least one project (or a combination of two related activities) aiming, as far as possible, at a logical implemented or implementable outcome.
- CIE will be conducted by a departmental committee (HoD/nominee, guide and one senior faculty) using the following rubrics totalling 50 marks:

CIE pass requirement:

A student shall secure a minimum of 20 marks out of 50 in CIE to become eligible to appear for SEE.

- Students who fail to earn the required CIE marks may be given additional opportunities before closure of the semester; no re-doing of CIE is permitted after the end of the semester.

B. Semester End Examination (SEE) – 100 marks (scaled to 50)

- Examination duration: 2 hours.
- Maximum examination marks: 100 (entered as 100 in the VTU portal; the ITI-SMU module automatically scales 100 → 50 for result processing).
- The SEE shall be conducted batch-wise by a committee of three faculty: project guide, one faculty from the same department and one from a different department.

SEE pass requirement and overall passing rule:

- For a pass in SEE, a student shall secure minimum 35 marks out of 100.
- For declaration of a pass grade, the sum of CIE marks (out of 50) and scaled SEE marks (out of 50) shall be ≥ 40; otherwise, the student is awarded grade F (Fail).

CIE Rubric — Continuous Internal Evaluation (Total 50 marks):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & relevance to society/environment	8	Problem clearly identified with strong evidence of relevance and well-defined scope.	Relevant problem with clear scope and adequate evidence.	Problem defined but justification is weak.	Problem unclear or not relevant.
Formation of problem statement; engineering approach, innovation & feasibility	10	Precise statement; sound, innovative, feasible approach.	Adequate statement; feasible with minor gaps.	Partial statement; marginal feasibility.	Missing or infeasible.
Interaction with stakeholders; data collection, analysis & interpretation	8	Thorough engagement; comprehensive data and well-interpreted analysis.	Good engagement; adequate data and analysis.	Limited engagement; incomplete data and superficial analysis.	Little or no stakeholder contact; no data/analysis.
Project documentation; clarity, organization & problem-solving demonstrated	10	Complete, well-organized, analytical, and strong problem-solving.	Complete and clear with some analytical content.	Basic with omissions; problem-solving limited.	Missing/poorly organized; no clear problem-solving.
Communication & presentation skills	6	Confident, structured, and answers queries fully; visuals effective.	Clear and satisfactory; responds to most queries.	Acceptable but lacks clarity or confidence; weak responses.	Poor or absent; unable to respond.
Contribution & benefit to society (impact, sustainability)	8	Clear, demonstrable societal benefit and realistic sustainability path.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear benefit; sustainability weak.	No evident benefit or sustainability.

Notes for CIE rubric:

- Minimum CIE pass requirement: 20/50 to be eligible for SEE. [Use departmental committee (HoD/guide + senior faculty) to apply the rubric and record marks.]

SEE Rubric — Semester End Examination (Enter marks out of 100; scaled to 50 later):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & relevance to society/environm ent	16	Clearly articulated with strong evidence and context.	Clear with reasonable evidence.	Problem stated but evidence/context weak.	Poorly defined or irrelevant.
Formation of problem statement; engineering approach, innovation & feasibility	20	Precise; demonstrates engineering depth, novelty and feasibility.	Technically sound and feasible with minor limitations.	Basic; limited technical depth or feasibility concerns.	No viable engineering approach or infeasible plan.
Interaction with stakeholders; data collection, analysis & interpretation	16	Excellent engagement; rigorous data collection and insightful analysis.	Good engagement and acceptable analysis.	Superficial data collection and limited analysis.	Inadequate or no data; poor analysis.
Project documentation; clarity, technical rigor & problem-solving demonstrated	20	Comprehensive, technically rigorous, and systematic.	Complete and technically correct with minor gaps.	Lacks technical depth or has notable omissions.	Missing key elements or technically incorrect.
Communication, presentation & viva-voce responses	12	Presents expertly, defends work persuasively and answers all queries correctly.	Good presentation and satisfactory answers to most queries.	Adequate but fails to answer some technical questions.	Poor presentation and unable to defend work.
Contribution & benefit to society; impact assessment & sustainability	16	Clear, evidence-based impact assessment with scaling recommendations .	Reasonable impact discussion and sustainability considerations.	Limited evaluation of impact or sustainability.	No coherent assessment of impact or sustainability.

SEE pass rule:

- Student must secure at least 35/100 in SEE itself to be eligible for pass consideration.
- Final passing is based on CIE (out of 50) + SEE (scaled to 50) >= 40. Otherwise, grade F (Fail) is awarded.

Suggested implementation notes (for BoS / exam committees):

- Use numerical scores from the rubric and keep brief evaluator comments for each criterion.
- For team projects: record individual contribution within the documentation and adjust individual marks using a peer-evaluation sheet or guide's assessment.
- Maintain evidence (field notes, photos, questionnaires, DPRs, reports) as annexures for SEE moderation.
- Use standardized score sheet (spreadsheet) mapping rubric items to columns for easy aggregation and archival.

- Awareness Campaign on Single-Use Plastic and E-Waste Management

Suggested Learning Resources:

Text Books:

1. Benny Joseph, *Environmental Studies*, Tata McGraw-Hill, 2nd Edition.
2. R. Rajagopalan, *Environmental Studies: From Crisis to Cure*, Oxford University Press, 2005.
3. Erach Bharucha, *Textbook of Environmental Studies*, University Press, latest edition as available in library.
4. M. P. Poonia and S. C. Sharma, *Environmental Studies*, Vikas Publishing House, latest edition as available

Reference Books:

1. R. Sivakumar, Principles of Environmental Science and Engineering, Cengage Learning, 2nd Edition.
2. G. Tyler Miller Jr., Environmental Science: Working with the Earth, Thomson Brooks/Cole, 11th Edition.
3. Pratibha Singh, Anoop Singh, and Piyush Malaviya, Text Book of Environmental and Ecology, Acme Learnin 1st Edition.
4. S. M. Prakash, Environmental Studies, Elite Publishing House, Mangalore, 3rd Edition, 2018.

Web links and Video Lectures (e-Resources):

1. VTU e-Learning Centre: http://elearning.vtu.ac.in
2. VTU e-Resources / e-Content: http://elearning.vtu.ac.in/e-Res.php
3. VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php
4. VTU Consortium Digital Resources: https://access.vtuconsortium.com/msec
5. VTU e-Learning Centre: http://elearning.vtu.ac.in
6. VTU e-Resources / e-Content: http://elearning.vtu.ac.in/e-Res.php
7. VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php
8. VTU Consortium Digital Resources: https://access.vtuconsortium.com/msec

Assessment Structure:

Continuous Internal Evaluation (CIE) shall be conducted by the Departmental Project Review Committee consisting of a Senior Professor, the Project Guide, and one additional faculty member nominated by the Head of the Department. Semester End Evaluation (SEE) shall be conducted by university-appointed examiners. The evaluation shall be based on rubrics designed to assess the attainment of NBA-defined graduate attributes, including problem analysis, investigation, design of solutions, communication, teamwork, and professionalism.

The weightage of marks for CIE and SEE is 50% each.

Pass Criteria: A candidate shall secure a minimum of 40% of the total marks prescribed for Project Work, subject to the required minimum in Continuous Internal Evaluation and Semester End Evaluation as per VTU regulations.

Sample Rubrics for Campus water-quality and development of a water-conservation plan.

Criterion	Weight (%)	4 - Excellent	3 - Good	2 - Satisfactory	1 - Needs improvement
Problem definition and campus context	10	Clearly defines campus water issue, boundaries, water sources, and purpose.	Defines issue and context with minor gaps.	Basic problem stated, but scope is incomplete.	Vague or incorrect problem definition.
Water-quality data collection	15	Uses appropriate sampling points, methods, and frequency; data are well documented.	Methods are mostly appropriate with minor omissions.	Limited methods or incomplete documentation.	Weak or unclear data collection.
Water-quality	20	Correctly analyzes	Analyzes most	Some	Minimal or

Criterion	Weight (%)	4 - Excellent	3 - Good	2 - Satisfactory	1 - Needs improvement
parameters and analysis		key physical, chemical, and microbiological parameters and interprets results.	parameters correctly with minor interpretation gaps.	parameters analyzed, but interpretation is weak.	incorrect analysis.
Evidence and standards comparison	15	Compares results against relevant standards/guidelines and draws valid conclusions.	Compares most results with reasonable conclusions.	Comparison is partial or uneven.	No meaningful comparison with standards.
Diagnosis of issues and causes	10	Identifies likely causes of poor quality or water loss using evidence.	Identifies main causes with some support.	Causes are mentioned, but weakly supported.	Causes are speculative or absent.
Conservation plan objectives and measures	15	Plan includes clear goals, realistic measures, prioritization, and campus suitability.	Plan is relevant and mostly realistic.	Plan has some useful measures but limited prioritization.	Plan is generic or impractical.
Feasibility and implementation	10	Addresses resources, responsibilities, timeline, and implementation steps clearly.	Covers most implementation aspects.	Implementation is partial or underdeveloped.	Little or no implementation planning.
Cost, savings, and sustainability	5	Provides reasonable cost-benefit thinking and expected savings.	Includes some cost or savings discussion.	Limited financial/savings analysis.	No cost or savings consideration.
Presentation and documentation	0–10	Clear structure, tables/figures, references, and professional report quality.	Well organized with minor issues.	Acceptable but uneven formatting or writing.	Poorly organized and difficult to follow.

CONCRETE TECHNOLOGY			
Course Code	**1BIF409**	Scheme	2025
Type of Course	Professional Cor Course (PCC)	Semester	IV
Teaching Hours/Week (L:T:P)	42(3:0:0)	CIE Marks	50
Total Hours of Pedagogy per semester CI (L /T) :LI(P):SL&TW:	90(42:0:0:48)	SEE Marks	50
Credits	3	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

1. CO1: Relate material characteristics (cement, aggregates, water, admixtures and supplementary cementitious materials) to the microstructure and basic properties of concrete.
2. CO2: Distinguish fresh concrete behavior based on workability, segregation, bleeding and setting characteristics, and identify suitable measurement and control methods.
3. CO3: Evaluate hardened concrete strength, elasticity, creep, shrinkage and durability under different exposure conditions using appropriate test methods and standards.
4. CO4: Proportion concrete mixes (including high-strength and special concretes) using IS 10262 and other codal provisions, meeting specified performance requirements and sustainability considerations.
5. CO5: Select and justify suitable concrete types (RMC, SCC, fibre-reinforced, geopolymer, high-performance and other special concretes) and site practices for given structural and durability demands.
6. CO6: Demonstrate familiarity with modern quality assurance, non-destructive testing, and sustainability frameworks applicable to concrete production and construction.

Module-1

Concrete Ingredients and Sustainability:

- Cement: Manufacture, types of cement (OPC, PPC, PSC, LHSC etc.), chemical composition and significance, hydration mechanism and microstructure formation, heat of hydration, low-carbon and blended cements, and measures for reducing carbon footprint in cement production.
- Supplementary Cementitious Materials (SCMs): Fly ash, GGBS, silica fume, metakaolin, rice husk ash and other pozzolanic/cementitious materials; influence on workability, strength, durability and sustainability.
- Fine Aggregates: Functions, grading requirements, properties; alternatives to river sand; manufactured sand (M-sand) – production, properties, codal provisions and environmental implications.
- Coarse Aggregates: Size, shape, texture, strength and durability; grading and blending; recycled aggregates; acceptance criteria and tests.
- Water: Quality requirements for mixing and curing water; impact on concrete properties.
- Sustainability in Concrete: Use of industrial waste, recycled aggregates, life-cycle approach, green ratings (LEED, GRIHA), and measures for reducing embodied carbon in concrete.

Linked COs: CO1, CO4, CO5. **Number of Hours: 8 Hours**

Module-2

Fresh Concrete – Production, Workability and Site Practices:

- Concrete production process: Batching (weigh/volume), mixing (site and central plant), transporting (conventional and RMC logistics), placing, compaction and finishing; good and bad practices in site concreting.
- Workability: Concept, importance and influencing factors (w/c ratio, aggregate properties, admixtures, temperature); tests – slump, compaction factor, Vee-Bee consistometer, flow table, L-box, U-box and other SCC tests as relevant.
- Fresh concrete phenomena: Segregation, bleeding, setting and early-age cracking; control measures and good site practices.
- Chemical admixtures: Plasticizers, superplasticizers, accelerators, retarders, air-entraining agents and viscosity-modifying agents – properties, dosage and typical applications.
- Mineral admixtures/SCMs and blended systems: Performance-based selection of SCMs and admixtures for durability and sustainability.

- Curing: Methods and technologies – water curing, membrane curing, steam curing, accelerated curing,self-curing agents; curing regimes for different structural and durability needs.
- Ready-Mixed Concrete (RMC): Plant layout, batching accuracy, transportation, pumping, placing and quality control; relevant Indian codes and QCI RMCPCS guidelines.
- Concreting in hot and cold weather, mass concreting and temperature control measures.

Linked COs: CO2, CO4, CO5. **Number of Hours:8 Hours**

Module-3

Hardened Concrete – Mechanical Properties, Durability and Testing

- Strength of concrete: Compressive, tensile and flexural strength; influencing factors such as w/c ratio, aggregate characteristics, curing, compaction, age; maturity concept and gel/space ratio.
- Mechanical properties: Modulus of elasticity, Poisson's ratio, fatigue, impact, fracture behavior; relevance to structural design.
- Time-dependent deformations: Creep and shrinkage (plastic and drying), influencing factors and mitigation strategies.
- Durability: Definition and significance; mechanisms of deterioration – sulphate attack, chloride ingress, carbonation, freezing and thawing, alkali–aggregate reaction and reinforcement corrosion; durability requirements as per IS 456 and other standards.
- Special exposure conditions and service life considerations, including marine, industrial and aggressive environments; basic introduction to performance-based durability design.
- Destructive and non-destructive testing (NDT): Standard cube/cylinder tests; in-situ tests such as rebound hammer, ultrasonic pulse velocity, core tests, penetration and pull-out tests – principles, applications and limitations.

Linked COs: CO3, CO6. **Number of Hours: 9 Hours**

Module-4

Concrete Mix Proportioning and Quality Assurance:

- Mix proportioning concepts: Parameters influencing mix design (strength grade, workability, exposure conditions, aggregate properties, SCMs and admixtures); statistical basis for strength and quality control.
- Mix design methods: IS 10262 procedure, numerical examples for different grades including use of SCMs and admixtures;
- overview of ACI, DOE and other international methods: Treated as comparative references only, not as parallel full methods.
- High-strength and high-performance concrete mix design considerations: Aggregate packing, low w/c ratio, high-range admixtures, curing and quality control requirements.
- Field control and quality assurance: Sampling, testing frequency, acceptance criteria for RMC and site concrete; role of QA/QC engineers and checklists; basic concepts of statistical quality control.
- Introduction to digital tools: Use of mix design software, batching plant data logs and simple analytics for concrete quality monitoring (linking to industry 4.0 concepts where relevant).

Linked COs: CO4, CO6. **Number of Hours: 9 Hours**

Module-5

Special Concretes and Sustainable Practices:

- Self-Compacting Concrete (**SCC**): Concept, materials, EFNARC-based mix approach; tests (slump flow, T_{50}, L-box, V-funnel); use in congested reinforcement and precast.
- Fibre-Reinforced Concrete (**FRC):** Fibre types (steel, synthetic, glass, natural); improved toughness, crack control, impact resistance; applications in pavements and precast.
- **Lightweight Concrete:** Fibre types (steel, synthetic, glass, natural); improved toughness, crack control, impact resistance; applications in pavements and precast.
- **Geopolymer Concrete:** Fly ash/GGBS-based alkali activation; low carbon footprint, good durability.
- **High-Performance Concrete:** High strength, low w/c; used in high-rise and bridges.
- **Sustainability:** Use of industrial waste, recycled aggregates; life-cycle approach; green ratings (LEED, GRIHA) carbon footprint reduction strategies.

Linked COs: CO5, CO6. **Number of Hours: 8 Hours**

Suggested Learning Resources:

Textbooks:

1. A.M. Neville, *Properties of Concrete*, 4th Edition, Longman.
2. M.S. Shetty, *Concrete Technology: Theory and Practice*, S. Chand & Company, New Delhi.
3. P. Kumar Mehta and Paulo J.M. Monteiro, *Concrete: Microstructure, Properties and Materials*, 4th Edition, McGraw Hill Education.
4. A.R. Santha Kumar, *Concrete Technology*, Oxford University Press, New Delhi.

Reference Books:

1. M.L. Gambhir, Concrete Technology, McGraw Hill Education.
2. N.V. Nayak and A.K. Jain, Handbook on Advanced Concrete Technology.
3. IS 456 – Plain and Reinforced Concrete – Code of Practice.
4. IS 10262 – Concrete Mix Proportioning – Guidelines.
5. IS 4926 – Ready-Mixed Concrete – Code of Practice; QCI RMCPCS Criteria for Production Control of RMC.
6. EFNARC Specification and Guidelines for Self-Compacting Concrete.
7. Additional BIS/IRC/IS codes on durability, NDT and special concretes as relevant.

Web links and e-Resources:

1. NPTEL/SWAYAM courses on Concrete Technology, Durability of Concrete, Advanced Concrete Construction and related topics.
2. BIS standards portal and QCI RMCPSC documentation for updated codes and guidelines.
3. Industry white papers and case studies on RMC, SCC, geopolymer concrete and sustainable concrete technologies.

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt in addition to chalk and talk to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play

Suggested strategies:

- Problem-Based Learning (PBL) on site issues such as low strength, poor workability, segregation, cracking or durability problems, where students diagnose causes and propose remedial measures.
- Case-based teaching using real project examples (bridges, high-rise buildings, pavement works, RMC plants) to illustrate best practices and failures in concrete technology.
- Simulation and virtual labs using simple digital tools for mix design, workability tests and NDT interpretation.
- Partial delivery of course content by industry experts (from RMC plants, QC laboratories, structural

consultants) and industrial visits to RMC plants and major construction sites.

- ICT-enabled teaching through video demonstrations of tests (workability, NDT, durability), online dashboards of RMC plant data and reference codes.

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE** is at least **40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA)+Internal Assessment Test (IA)= Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests (IA)** shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development.**

Students' activities for TW/SL under NCrF: Samples only

As per National credit formwork (NCrF) students must spend 90 hours of study for 3 credit courses, which include Course instructions (CI-42 hour) and Teamwork/ Self learning (TW/Sl-48 hours). Hence, students must complete minimum of two actives as part of NCrF. These learning activities shall be considered as CCA components of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below. The sample activities are given below. The course coordinator can also give their own TW/SL activities as per the course outcomes.

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1	**TW1 – Concrete Materials Profiling Exercise:** Collect data on locally available cement types, aggregates, SCMs and admixtures; characterize basic properties; compile a material database and present findings using tables/charts. Linked COs: CO1, CO4.	24
2	**TW2 – Site Workability and Quality Assessment:** Conduct field observations or simulated exercises on workability tests, mixing, placing and curing in an RMC or site setup; document good and bad practices and propose improvements. Linked COs: CO2, CO4.	24
3	**TW3 – Durability and NDT Case Study:** Undertake a mini-project on diagnosing concrete distress in an existing structure using NDT data and durability concepts; recommend repairs and preventive measures. Linked COs: CO3, CO6.	24

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

Sl. No.	Self-Learning (SL) Activity	Number of Hours / Semester

1	**SL1 – Policy/Guideline Review :** Read relevant BIS codes (IS 456, IS 10262, RMC guidelines) or sustainability frameworks and prepare a reflective note on their implications for practice. Linked COs: CO4, CO6.	24
2	**SL2 – RMC Plant / Special Concrete Technology Review (24 hours):** Review one RMC plant's quality system or a special concrete technology (SCC, geopolymer, HPC) via online resources and summarize its advantages, limitations and implementation challenges. Linked COs: CO5, CO6.	24
3	**SL3 – MOOC/Video Module on Concrete Durability and Sustainability :** Complete a MOOC or video module on durability, corrosion or sustainable concrete and submit a learning note. Linked COs: CO3, CO6.	24

Rubric for Students learning Activities-TW

Criterion	4 – Excellent	3 – Good	2 – Satisfactory	1 – Needs Improvement
Problem understanding	Problem is clearly defined with strong justification and clear objectives.	Problem is mostly clear with minor gaps in framing or justification.	Problem is stated but lacks clarity or detailed justification.	Problem is poorly defined or unclear.
Data and method	Data collected/used is appropriate and sufficient; methods/tools are well chosen and logically applied.	Data and methods are generally appropriate with minor issues or omissions.	Limited or partially relevant data; methods are basic or inconsistently applied.	Data is inadequate/irrelevant; methods are inappropriate or missing.
Analysis	Analysis is thorough; interpretations are logically argued and results are valid.	Analysis is generally sound with minor errors or missing details.	Analysis is partial; contains gaps or superficial interpretation.	Analysis is weak, incorrect, or largely missing.
Recommendations	Recommendations are feasible, context-specific, and clearly derived from analysis.	Recommendations are relevant but may have minor limitations or lack detail.	Recommendations are generic or only loosely connected to analysis.	Recommendations are incomplete, unrealistic, or absent.
Presentation	Work is very well organized, neat, and professionally presented (structure, figures, language).	Work is well organized with minor issues in formatting or clarity.	Presentation is acceptable but uneven; structure or formatting needs improvement.	Work is poorly organized, difficult to follow, or untidy.