

| PROBABILITY AND STATISTICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                              |             |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1BMATCV301                   | Scheme      | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Applied Science Course (ASC) | Semester    | III  |
| Teaching Hours/Week (L: T: P)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 70 (3:2:0)                   | CIE Marks   | 50   |
| Total Hours of Pedagogy per semester<br>CI (L /T):LI(P):SL&TW:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 120 (42:28:0:50)             | SEE Marks   | 50   |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 4                            | Total Marks | 100  |
| Examination type (SEE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Theory                       | Exam Hours  | 03   |
| <b>Course outcome (Course Skill Set):</b><br>At the end of the course, the student will be able to:<br>CO1: Understand and explain basic statistical concepts, descriptive measures, and data visualization.<br>CO2: Apply probability rules, random variables, and common probability distributions to engineering problems.<br>CO3: Use sampling distributions, estimation, and hypothesis testing to draw statistical inferences.<br>CO4: Interpret statistical results, discuss assumptions and limitations, and relate them to engineering practice.<br>CO5: Analyze relationships between variables using correlation and regression models. |                              |             |      |
| <b>Module-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |             |      |
| <b>DESCRIPTIVE STATISTICS:</b> Role of statistics in engineering; types of data, scales of measurement, collection and presentation of data. Frequency distribution, histograms, bar diagrams, pie charts, and box plots. Measures of central tendency: mean, median, and mode for grouped and ungrouped data. Measures of dispersion: range, variance, standard deviation, and coefficient of variation. Concept of skewness and kurtosis.<br><b>(RBT Levels: LI, L2 and L3)</b> <span style="float: right;"><b>Number of Hours: 14</b></span>                                                                                                    |                              |             |      |
| <b>Module-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |             |      |
| <b>PROBABILITY AND RANDOM VARIABLES</b><br><b>Review</b> on sample space, events, axioms of probability, conditional probability, independence of events, total probability theorem, and Bayes theorem.<br>Random variables, discrete and continuous types, probability mass function, probability density function, cumulative distribution function. Expectation and variance. Joint distributions for two discrete variables.<br><b>(RBT Levels: LI, L2 and L3)</b> <span style="float: right;"><b>Number of Hours: 14</b></span>                                                                                                               |                              |             |      |
| <b>Module-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |             |      |
| <b>PROBABILITY DISTRIBUTIONS</b><br>Discrete distributions: Binomial, Geometric, and Poisson - definitions, mean, and variance.<br>Continuous distributions: Uniform, exponential, and normal - definitions, mean, and variance and related problems.<br><b>(RBT Levels: LI, L2 and L3)</b> <span style="float: right;"><b>Number of Hours: 14</b></span>                                                                                                                                                                                                                                                                                          |                              |             |      |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |             |      |
| <b>SAMPLING AND ESTIMATION</b><br>Sampling concepts: population, sample, parameter, statistic, random sampling, bias, and standard error. Sampling distributions and central limit theorem. Point estimation and interval estimation. Confidence intervals for mean and proportion.<br>Hypothesis testing: null and alternative hypotheses, type I and type II errors, one-tailed and two-tailed tests. Basic tests for mean and proportion for large sample; student's t-distribution, chi-square test for goodness of fit.<br><b>(RBT Levels: LI, L2 and L3)</b> <span style="float: right;"><b>Number of Hours: 14</b></span>                   |                              |             |      |
| <b>Module-5: CORRELATION, REGRESSION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |             |      |
| Statistics: Principles of least squares, Curve fitting by the method of least squares in the form: $y = a + bx$ , $y = a + bx + cx^2$ , $y = ax^b$ and $y = ae^{bx}$ . Correlation, Coefficient of correlation, Lines of regression, Angle between regression lines, rank correlation. Introduction to multiple regression.<br><b>(RBT Levels: LI, L2 and L3)</b> <span style="float: right;"><b>Number of Hours: 14</b></span>                                                                                                                                                                                                                    |                              |             |      |

**Suggested Learning****Resources Textbooks:**

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Publishing.
2. V.K. Rohatgi and A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, Wiley.
3. S. Ross, A First Course in Probability, Pearson India.
4. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House.
5. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

**Reference Books:**

1. M.R. Spiegel, J. Schiller, and R.A. Srinivasan, Schaum's Outline of Probability and Statistics, McGraw Hill.
2. A.M. Mood, F.A. Graybill, and D.C. Boes, Introduction to the Theory of Statistics, McGraw Hill.
3. S. C. Gupta, Statistical Methods, S. Chand Publishing.
4. R. Ramakrishnan, Statistics for Engineers and Scientists, Tata McGraw Hill.

**Web links and e-Resources:**

NPTEL (National Programme on Technology Enhanced Learning) - Probability and Statistics courses for Engineers: <https://nptel.ac.in/>.

SWAYAM learning modules on statistics and data analysis.

Coursera(Empower employability with online learning for universities) Understanding statistics requires building foundational skills in descriptive statistics: <https://www.coursera.org/>

**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. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self-study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students to learn groups to improve their creative and analytical skills.
6. Show short-related video lectures in the following ways:
  - As an introduction to new topics (pre-lecture activity).
  - As a revision of topics (post-lecture activity).
  - As additional examples (post-lecture activity).
  - As an additional material of challenging topics (pre-and post-lecture activity).
  - As a model solution of some exercises (post-lecture activity).

**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.

The CIE Theory component consists of average of TWO IA tests for 25 marks and Continuous Comprehensive Assessments (CCA) for 25 marks.

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):**

CCA will be conducted with a total of 25 marks. It is recommended to include a maximum of two learning activities aimed at enhancing the holistic development of students. These activities should align with course objectives and promote higher-order thinking and application-based learning.

**Learning Activity-1:** Tutorial: Practicing problems (Two objective type assessments for 7.5 marks each (Total 15 marks).

**Learning Activity-2:** Choose either lab activity or seminar or case study for 10 marks

**Lab activity:** Execute the following lab exercises with the aid of any modern technological tool (Matlab/ Mathematica/ Scilab/ Python/ Maxima, etc).

**Seminars:** The students have to present applications of mathematics related to syllabus as a group maximum of four members.

**Case study:** Analyze engineering data using descriptive statistics by collecting a relevant dataset, performing descriptive statistical analysis, fitting probability distributions, evaluating a reliability-based problem, preparing a brief report with probability plots, return-period and risk analysis, and developing a digital workbook (Excel/R/Python/MATLAB) implementing descriptive statistics, distribution fitting, regression, confidence intervals, and basic reliability metrics.

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

As per National credit formwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Self learning (TW/SL-50 hours). Hence, students must complete minimum of two activities 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 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 seminars, micro projects, industrial visits, any other student activities etc.)

| Sl. No. | Term Work (TW) Activity                                                                                                                                                                                                                                   | Number of Hours / Semester |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 1.      | <b>Analysis of engineering data using descriptive statistics.:</b> Collect or obtain a dataset of specific programme and perform descriptive statistics, fit distributions, and pose at least one reliability-style question with a short report.         | 25                         |
| 2.      | <b>Mini Project:</b> Prepare concise case studies on extreme events or demand patterns (e.g., flood peaks, daily traffic), using probability plots, return-period calculations and risk statements with a short seminar.                                  | 25                         |
| 3.      | <b>Programming &amp; Tools Workbook:</b> Develop a digital workbook in Excel/R-programming/Python/MATLAB implementing core course computations: descriptive stats, distribution fitting, regression, confidence intervals and simple reliability metrics. | 25                         |

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

##### 1. Sample Rubrics - Mini-Project

| Criterion                                         | Exemplary (3)                                                                                          | Proficient (2)                                                                       | Basic (1)                                                         | Weight |
|---------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------|--------|
| Problem definition & data                         | Clear, relevant civil-engineering questions; data source and limitations documented.                   | Mostly clear; minor gaps in context or data description.                             | Vague questions or poorly documented data.                        | 10%    |
| Data processing & descriptive statistics          | Correct cleaning, visualization, and computation of key measures; patterns clearly highlighted.        | Mostly correct; minor computational errors.                                          | Significant errors, missing key measures or plots.                | 25%    |
| Probabilistic modeling (distributions, inference) | Appropriate distributions and tests used; assumptions stated; results interpreted in context.          | Reasonable choice of models; some assumptions implicit; interpretation mostly sound. | Inappropriate or poorly justified models; limited interpretation. | 30%    |
| Civil engineering insight / risk framing          | Clear link to design/assessment decisions, safety and uncertainty; limitations discussed.              | Some discussion of implications; limited treatment of limitations.                   | Minimal civil engineering interpretation on beyond numbers.       | 20%    |
| Report & communication                            | Well-structured report, clear figures/tables, reproducible calculations; effective brief presentation. | Acceptable structure; some clarity issues; presentation adequate.                    | Disorganized or incomplete report; weak presentation.             | 15%    |

| FLUID MECHANICS AND HYDRAULIC MACHINERY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                             |             |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1BCV302                                     | Scheme      | 2025 |
| Type of course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Integrated Professional Core Courses (IPCC) | Semester    | III  |
| Teaching Hours/Week (L:T:P)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 70 (3:0:2)                                  | CIE Marks   | 50   |
| Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 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   |
| <b>Course outcome (Course Skill Set):</b><br>At the end of the course, the student will be able to: <ol style="list-style-type: none"> <li>CO1 (L2): Explain fluid properties, hydrostatic laws, and pressure measurement techniques.</li> <li>CO2 (L3): Apply kinematics and dynamics principles to analyze fluid flow patterns and energy equations.</li> <li>CO3 (L3): Compute discharges in pipes, notches, weirs, and design pipe networks with losses.</li> <li>CO4 (L4): Design open channels for uniform/non-uniform flows and analyze hydraulic jumps.</li> <li>CO5 (L4): Analyze performance of hydraulic turbines and pumps for hydropower applications.</li> <li>CO6 (L5): Evaluate sustainable hydraulic systems integrating Industry 5.0 digital twins and flood modelling.</li> </ol> |                                             |             |      |
| <b>Module-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                             |             |      |
| <b>Fluid Properties &amp; Hydrostatics:</b><br>Introduction to fluids, density, specific weight, viscosity (Newton's law), surface tension, capillarity, vapor pressure, compressibility. Hydrostatic law, Pascal's law, pressure measurement (manometers, piezometers, digital gauges). Total pressure and center of pressure on plane/curved surfaces. Buoyancy, metacenter, stability of floating bodies, metacentric height.<br><b>CO linkage: CO1.</b> <span style="float: right;"><b>Number of Hours (CI): 10 hours:</b></span>                                                                                                                                                                                                                                                                |                                             |             |      |
| <b>Module-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                             |             |      |
| <b>Fluid Kinematics &amp; Dynamics:</b><br>Types of flow (steady/unsteady, uniform, laminar/turbulent, rotational/irrotational). Streamlines, pathlines, continuity equation (Cartesian coordinates). Velocity potential, stream function, flow nets. Euler's equation, Bernoulli's theorem (applications: venturimeter, orifice meter, pitot tube). Momentum equation<br><b>CO linkage: CO2.</b> <span style="float: right;"><b>Number of Hours (CI): 8 hours</b></span>                                                                                                                                                                                                                                                                                                                            |                                             |             |      |
| <b>Module-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                             |             |      |
| <b>Flow Measurement &amp; Pipe Flow:</b><br>Flow through orifices, mouthpieces, notches (rectangular/trapezoidal), weirs. Flow in pipes: Darcy-Weisbach equation, friction factor (Moody chart), minor losses, pipes in series/parallel, Impact of jet on vanes, water hammer.<br><b>CO linkage: CO3.</b> <span style="float: right;"><b>Number of Hours (CI): 8 hours</b></span>                                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |             |      |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                             |             |      |
| <b>Open Channel Flow</b><br>Geometrical properties, velocity distribution. Uniform flow: Chezy/Manning equations, most economical sections (rectangular/trapezoidal). Specific energy, critical flow. Non-uniform flow: gradually varied flow (GVF) equations, hydraulic jump.<br><b>CO linkage: CO4.</b> <span style="float: right;"><b>Number of Hours (CI): 8 hours</b></span>                                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |             |      |
| <b>Module-5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                             |             |      |
| <b>Hydraulic Turbines &amp; Pumps:</b><br>Turbines: Classification, Pelton/Francis/Kaplan (components, velocity triangles, efficiencies). Pumps: Centrifugal/reciprocating (working, characteristics, NPSH, cavitation). Performance curves, selection for civil applications (dams, irrigation).<br><b>CO linkage: CO5, CO6.</b> <span style="float: right;"><b>Number of Hours (CI): 8 hours</b></span>                                                                                                                                                                                                                                                                                                                                                                                            |                                             |             |      |

| <b>PRACTICAL COMPONENTS OF IPCC</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>SET OF EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| Students shall perform practical exercises related to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| <ol style="list-style-type: none"> <li>1. Verification of Bernoulli's theorem (CO1, CO2)</li> <li>2. Experimental determination of force exerted by a jet on flat and curved plates (Hemispherical Vane) (CO2)</li> <li>3. Calibration of venturimeter/orifice meter (CO1, CO3)</li> <li>4. Determination of friction factor in pipes (CO2, CO3)</li> <li>5. Calibration of V-notch and rectangular notch (CO3, CO4)</li> <li>6. Calibration of Ogee weir, Broad-crested weir, and venturiflume (CO3, CO4)</li> <li>7. Performance testing of Pelton turbine (CO5, CO6)</li> <li>8. Efficiency of centrifugal pump (CO5, CO6)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| <b>Suggested Learning Resources: (Textbook/ Reference Book/ Manuals): Textbooks:</b> <ol style="list-style-type: none"> <li>1. Modi &amp; Seth, <i>Fluid Mechanics</i>, Standard Book House.</li> <li>2. Rajput, R. K. – <i>Fluid Mechanics and Hydraulic Machines</i>, S. Chand.</li> <li>3. Bansal, R. K. – <i>A Textbook of Fluid Mechanics and Hydraulic Machines</i>, Laxmi Publications.</li> <li>4. Subramanya, K. – <i>Flow in Open Channels</i>, McGraw-Hill</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| <b>Reference books / Manuals:</b> <ol style="list-style-type: none"> <li>1. White, F. M. – <i>Fluid Mechanics</i>, McGraw-Hill.</li> <li>2. Cengel, Y. A. &amp; Cimbala, J. M. – <i>Fluid Mechanics: Fundamentals and Applications</i>, McGraw-Hill.</li> <li>3. Subramanya, K. – <i>Hydraulic Machines</i>, McGraw-Hill.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
| <b>Web links and Video Lectures (e-Resources):</b> <ol style="list-style-type: none"> <li>1. NPTEL: Fluid Mechanics for Civil Engineers (<a href="https://nptel.ac.in">https://nptel.ac.in</a>).</li> <li>2. SWAYAM: Hydraulic Machines.</li> <li>3. Autodesk/HEC-RAS tutorials for hydraulic modeling.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| <b>Teaching-Learning Process (Innovative Delivery Methods):</b> <p>Suggested Innovative Delivery Methods may include (but are not limited to):</p> <ul style="list-style-type: none"> <li>• Flipped Classroom</li> <li>• Problem-Based Learning (PBL)</li> <li>• Case-Based Teaching</li> <li>• Simulation and Virtual Labs</li> <li>• Partial Delivery of course by Industry expert/ industrial visits</li> <li>• ICT-Enabled Teaching</li> <li>• Role Play</li> </ul> <p>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.</p> <ol style="list-style-type: none"> <li>1. Concept-oriented lectures with frequent physical interpretations and small in-class demonstrations.</li> <li>2. Problem-solving sessions focused on civil-engineering-type examples (pipes, channels, water-supply and drainage).</li> <li>3. Flipped-classroom segments for selected topics (e.g., Bernoulli applications, pipe systems, hydraulic jump) using pre-class videos and in-class collaborative problem solving.</li> <li>4. Mini-projects and open-ended lab tasks that integrate SDG-6, SDG-11, SDG-13, Industry 5.0 (digital tools) and NEP 2020 emphasis on experiential, multidisciplinary learning.</li> </ol> |  |

**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 framework (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Self learning (TW/SL-50 hours). Hence, students must complete minimum of two learning activities 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.

**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.      | <b>Activity 1 (C02, C03, C06):</b> Mini-project on campus water-distribution/drainage line – data collection, simple hydraulic analysis, and sustainability recommendations (SDG-6, SDG-11, SDG-13).    | 25                         |
| 2.      | <b>Activity 2 (C03, C04):</b> Open-book assignment on pipe and open-channel problems using spreadsheets, including comparison of options for energy loss minimisation.                                  | 25                         |
| 3.      | <b>Activity 3 (C05, C06):</b> Short group task on pump/turbine selection for a given water supply or micro hydro context, considering technical and sustainability criteria (Industry 5.0 perspective). | 25                         |

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

| Sl. No. | Self-Learning (SL) Activity                                                                                                                                             | Number of Hours / Semester |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 1.      | <b>MOOC +GATE/Open- Book Track.:</b> Complete selected FM MOOC modules and GATE-style tests, plus at least one integrated open-book exam on conceptual/design problems. | 25                         |

|    |                                                                                                                                                                                    |    |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 2. | <b>Case Study &amp; Literature Portfolio:</b> Prepare 3–4 case briefs on real FM systems/events plus short reviews of 3–5 papers/standards (e.g., drainage, floods, water supply). | 25 |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|

**Rubric for Students learning activities - Mini-Project - (sample)**

| Criterion                        | Exemplary (3)                                                                                   | Proficient (2)                                                                  | Basic (1)                                                          |
|----------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------|
| Problem definition & scope       | Clear objective, realistic hydraulic system, complete data and assumptions documented.          | Objective mostly clear; minor gaps in data/assumptions.                         | Vague problem; key data/assumptions missing or inconsistent.       |
| Fluid mechanics calculations     | Correct, consistent application of FM principles with clear steps and units.                    | Mostly correct with a few non-critical errors; reasoning generally sound.       | Frequent conceptual/arithmetic errors; reasoning unclear.          |
| Design decisions & justification | Pipe/channel sizes, components, and operating conditions well-justified using results.          | Most design choices linked to results; some justification qualitative or brief. | Design choices arbitrary or unsupported by analysis.               |
| Use of diagrams/tools            | Neat schematics and, where used, digital tools (Excel/MATLAB/EPANET) applied appropriately.     | Diagrams or tools used but with minor omissions or limited integration.         | Poor or missing diagrams; tools misused or not used when expected. |
| Documentation & reflection       | Well-structured report with clear tables/figures and focused reflection on learning and limits. | Report understandable but uneven; reflection brief or descriptive.              | Disorganized report; little or no reflection on learning.          |

**Suggested rubrics for Practical continuous assessment:**

| Performance Indicators               | Excellent                                                                                                                                                  | Very Good                                                                                                        | Good                                                                                      | Satisfactory                                      |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------|
| Fundamental Knowledge (4) (P01)      | 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 clear (1) |
| Design Of Experiment (5) (P02 & P03) | 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 demerits (3)           | Student is capable of explaining the design (1-2) |

|                                      |                                                                                                                                                         |                                                                                                                         |                                                                                                      |                                                                              |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Implementation<br>(8)<br>(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<br>(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 able to analyze the output (1-2) |
| Demonstration<br>(8)<br>(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 unclear section (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

- 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.
- 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

- For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 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.
- If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

| <b>Table – ICs/IPCCs 1 Distribution of marks</b> |                                                                                                                         |              |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Component</b>                                 | <b>Description</b>                                                                                                      | <b>Marks</b> |
| <b>Allotment of marks for regular class work</b> |                                                                                                                         |              |
| 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     |
| <b>Subtotal</b>                                  |                                                                                                                         | <b>15</b>    |
| <b>Allotment of marks for CIE practical test</b> |                                                                                                                         |              |
| 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      |
| <b>Subtotal</b>                                  |                                                                                                                         | <b>10</b>    |
| <b>Total</b>                                     |                                                                                                                         | <b>25</b>    |
|                                                  |                                                                                                                         |              |

| <b>SOLID MECHANICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                |             |                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-------------|----------------------------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1BCV303                        | Scheme      | <b>2025</b>                |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Professional Core Course (PCC) | Semester    | III                        |
| Teaching Hours/Week (L:T:P)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 70 (42:28:0:50)                | 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>4</b>                       | Total Marks | 100                        |
| Examination type (SEE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Theory</b>                  | Exam Hours  | 03                         |
| <b>Course outcome (Course Skill Set)</b><br>At the end of the course, the student will be able to: <ol style="list-style-type: none"> <li>1. CO1 (L2 – Understand): Explain fundamental concepts of stress, strain, elastic constants and factor of safety for common civil engineering materials.</li> <li>2. CO2 (L3 – Apply): Apply equilibrium and deformation relations to determine stresses and elongations in axially loaded members and circular shafts under torsion.</li> <li>3. CO3 (L3 – Apply): Construct shear force and bending moment diagrams for statically determinate beams and determine bending and shear stresses for standard cross sections.</li> <li>4. CO4 (L4 – Analyze): Analyse two-dimensional stress states, determine principal stresses and maximum shear using transformation equations and Mohr’s circle, and interpret their significance.</li> <li>5. CO5 (L3 – Apply): Apply column buckling concepts to estimate critical loads and assess the stability of compression members under idealised end conditions.</li> <li>6. CO6 (L4 – Analyze/Evaluate): Use strain energy and combined loading ideas to check safety and serviceability of simple civil engineering components and comment on the effect of modelling assumptions.</li> </ol> |                                |             |                            |
| <b>Module-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |             |                            |
| <b>Introduction, stress-strain and axial members:</b> <ul style="list-style-type: none"> <li>• Concepts of rigid and deformable bodies; elastic and plastic behaviour; normal and shear stresses; normal and shear strains.</li> <li>• Stress-strain curves for ductile and brittle materials (qualitative); proportional limit, yield point, ultimate and failure.</li> <li>• Hooke’s law for uniaxial stress; elastic constants: E, G, K, <math>\nu</math> and their relationships (isotropic, homogeneous material).</li> <li>• Axially loaded members: bars of uniform and varying cross-section; stepped bars; temperature stresses (simple cases with/without constraints).</li> <li>• Factor of safety and working stress concept (introductory).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                |             |                            |
| <b>Linked COs: CO1, CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |             | <b>Number of Hours: 14</b> |
| <b>Module-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |             |                            |
| <b>Shear force, bending moment and stresses in beams:</b> <ul style="list-style-type: none"> <li>• Types of loads and supports; concept of shear force (SF) and bending moment (BM).</li> <li>• SF and BM diagrams for statically determinate beams: simply supported, cantilever and overhanging beams with point loads, UDL/UVL and simple combinations. Relationship between load, SF and BM diagrams.</li> <li>• Flexural (bending) stresses: assumptions of simple bending theory; flexure formula <math>\sigma = \frac{My}{I}</math> (statement and use); section modulus; bending stresses in rectangular, circular and I-sections (no built-up complex cases).</li> <li>• Shear stresses in beams: shear formula <math>\tau = \frac{VQ}{Ib}</math> (statement and use); shear stress distribution in rectangular and I-sections (qualitative curves + numericals).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                   |                                |             |                            |
| <b>Linked COs: CO2, CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |             | <b>Number of Hours:14</b>  |
| <b>Module-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |             |                            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|----------------------------|
| <b>Torsion and combined stresses:</b> <ul style="list-style-type: none"> <li>Torsion of circular shafts: assumptions; torsion formula <math>\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}</math> (statement and application); solid and hollow shafts, strength and stiffness comparisons.</li> <li>Power transmitted by shafts; design-style numericals (within course level).</li> <li>Combined axial and bending stresses in members (qualitative introduction + simple numericals).</li> <li>Introduction to thin cylindrical shells under internal pressure: hoop and longitudinal stresses (formulae and simple problems).</li> </ul> <b>Linked COs: CO2, CO3, CO6</b>                                                                                                                           |  | <b>Number of Hours:14</b>  |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                            |
| <b>Two-dimensional stress analysis and Mohr's circle:</b> <ul style="list-style-type: none"> <li>Plane stress at a point: normal and shear stresses on inclined planes; transformation equations (no full derivation needed at length).</li> <li>Principal planes and principal stresses; maximum shear stress; orientation of principal planes.</li> <li>Construction and use of Mohr's circle for plane stress – determination of principal stresses and maximum shear; interpretation in terms of material failure.</li> <li>Plane strain (basic idea); brief mention of 3D generalisation (qualitative).</li> </ul> <b>Linked COs: CO1, CO4, CO6</b>                                                                                                                                                  |  | <b>Number of Hours: 14</b> |
| <b>Module-5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                            |
| <b>Columns, buckling and strain energy:</b> <ul style="list-style-type: none"> <li>Columns and struts: classifications; slenderness ratio; Euler's buckling theory for ideal columns (pinned-pinned, fixed-free, fixed-pinned, fixed-fixed).</li> <li>Critical load, effective length and factor of safety in compression members; limitations of Euler theory.</li> <li>Introduction to empirical/Rankine or IS-based formula (statement and awareness).</li> <li>Strain energy: concept of energy stored in axially loaded members and in members under bending and torsion (formulae and simple numericals).</li> <li>Qualitative use of strain-energy methods for deflection and impact (no lengthy derivations); link to stiffness and serviceability checks.</li> </ul> <b>Linked COs: CO5, CO6</b> |  | <b>Number of Hours:14</b>  |
| <b>Suggested Learning Resources</b><br><b>Text books:</b> <ol style="list-style-type: none"> <li>Beer, F. P., Johnston, E. R., DeWolf, J. T., &amp; Mazurek, D. F. <i>Mechanics of Materials</i>. McGraw-Hill Education. Latest edition.</li> <li>Hibbeler, R. C. <i>Mechanics of Materials</i>. Pearson. Latest edition.</li> <li>Punmia, B. C., Jain, A. K., &amp; Jain, A. K. <i>Strength of Materials</i>. Laxmi Publications.</li> </ol> <b>Reference books / Manuals:</b> <ol style="list-style-type: none"> <li>Ramamrutham, S. <i>Strength of Materials</i>. Dhanpat Rai Publishing.</li> <li>Gere, J. M., &amp; Goodno, B. J. <i>Mechanics of Materials</i>. Cengage.</li> <li>Timoshenko, S., &amp; Young, D. H. <i>Elements of Strength of Materials</i>.</li> </ol>                           |  |                            |
| <b>Web links and Video Lectures (e-Resources):</b> <ol style="list-style-type: none"> <li>NPTEL (IITs): "Strength of Materials", "Mechanics of Materials", "Solid Mechanics" – full lecture series, worked examples and assignments aligned to Indian civil curricula.</li> <li>MIT OCW / other MOOCs: Open course materials on "Solid Mechanics" and "Mechanics of Materials" for additional concept explanation and problem practice.</li> </ol>                                                                                                                                                                                                                                                                                                                                                        |  |                            |

**Teaching-Learning Process (Innovative Delivery Methods):**

Suggested Innovative Delivery Methods may include (but are not limited to) in addition to chalk and talk .

- 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 visualisation of stress states, real civil-engineering examples (beams, columns, slabs) and frequent micro-questions.
2. Regular tutorial/problem-solving sessions focusing on typical exam and design-style numericals.
3. Short case snippets (e.g., beam cracking, column buckling) to connect theory with practice and safety.
4. Encouraging use of spreadsheets/graphing tools to explore parameter sensitivity (Industry 5.0 orientation and NEP 2020 self-learning spirit).

**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 learning activities 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.

| <b>Term Work (TW) and Self Learning (SL) components in<br/>Number of Hours per semester</b>                      |                                                                                                                                                                                                                                                          |                            |
|------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 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 – Beam SF–BM and stress study (CO2, CO3, CO6):<br>Students model a simple beam (e.g., corridor beam) with assumed loads, construct SF–BM diagrams and estimate max bending and shear stresses, short reflection on safety and serviceability. | 25                         |
| 2.                                                                                                               | Activity B – Column buckling mini-case (CO5, CO6):<br>Group exercise: given dimensions/material of a column, estimate Euler load for various end conditions and discuss practical limitations and safety margins.                                        | 25                         |
| 3.                                                                                                               | Activity C – Mohr's circle concept card (CO4):<br>Students prepare a one-page "Mohr's circle card" with step-by-step procedure and one worked example, share and critique peers' versions.                                                               | 25                         |
| SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.                                    |                                                                                                                                                                                                                                                          |                            |
| Sl. No.                                                                                                          | Self-Learning (SL) Activity                                                                                                                                                                                                                              | Number of Hours / Semester |
| 1.                                                                                                               | NPTEL (IITs): "Strength of Materials", "Mechanics of Materials", "Solid Mechanics" – full lecture series, worked examples and assignments aligned to Indian civil curricula..                                                                            | 25                         |
| 2.                                                                                                               | MIT OCW / other MOOCs: Open course materials on "Solid Mechanics" and "Mechanics of Materials" for additional concept explanation and problem practice                                                                                                   | 25                         |

**Rubrics for Learning Activity (TW) (example – Activity A: Beam SF–BM and stress study)**

| Criteria                                       | 4 – Excellent                                                      | 3 – Good                                       | 2 – Fair                                        | 1 – Needs Improvement                             |
|------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------|-------------------------------------------------|---------------------------------------------------|
| Problem understanding (CO2)                    | Beam, loads and boundary conditions clearly and correctly defined. | Mostly correct; minor omissions.               | Basic attempt; some incorrect assumptions.      | Beam/problem not clearly defined.                 |
| SF–BM diagrams (CO3)                           | Correct, neat diagrams with key values and shapes accurate.        | Largely correct; minor errors in values/shape. | Partially correct; several mistakes.            | Incorrect or missing diagrams.                    |
| Stress calculation & interpretation (CO3, CO6) | Correct stresses; clear comment on safety/serviceability.          | Mostly correct; limited commentary.            | Some correct calculations; interpretation weak. | Wrong calculations; no meaningful interpretation. |
| Presentation & clarity (CO6)                   | Well-organised, neat, easy to follow.                              | Generally clear; some issues in layout.        | Understandable but untidy.                      | Very unclear or incomplete.                       |

**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 MATERIALS AND CONSTRUCTION METHODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                |                           |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------------------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1BCV304                        | Scheme                    | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Professional Core Course (PCC) | Semester                  | III  |
| 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   |
| <b>Course outcome (Course Skill Set)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |                           |      |
| At the end of the course, the student will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |                           |      |
| <div><div></div><div>1. CO1 (L2 – Understand): Explain the properties, classification, specifications, and uses of common building materials used in civil engineering works.</div><div>2. CO2 (L3 – Apply): Select suitable building materials for specific construction applications based on performance, durability, economy, and sustainability.</div><div>3. CO3 (L3 – Apply): Describe and interpret standard construction practices for foundations, masonry, walls, floors, roofs, doors, windows, plastering, and finishing works.</div><div>4. CO4 (L4 – Analyze): Analyse construction details and identify appropriate methods, tools, and precautions for safe and durable execution of building components.</div><div>5. CO5 (L3 – Apply): Apply principles of quality control, construction sequencing, and safety measures in building construction activities.</div><div>6. CO6 (L4 – Analyze/Evaluate): Evaluate building material choices and construction practices with respect to sustainability, economy, maintainability, and serviceability.</div></div> |                                |                           |      |
| <b>Module-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |                           |      |
| <b>Introduction to building materials and their properties:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |                           |      |
| <div><div></div><div><div></div><div>• Introduction to building materials; classification as natural, manufactured, conventional, and modern materials.</div><div>• Physical, mechanical, thermal, chemical, and durability properties of building materials.</div><div>• Requirements of a good building material: strength, durability, workability, fire resistance, weather resistance, availability, and economy.</div><div>• Overview of material selection criteria for civil engineering applications.</div><div>• Basic concepts of sustainability in construction materials and embodied energy.</div></div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                |                           |      |
| <b>Linked COs: CO1, CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                | <b>Number of Hours: 8</b> |      |
| <b>Module-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |                           |      |
| <b>Stones, bricks, blocks, cement, lime, mortar and Concrete:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                |                           |      |
| <div><div></div><div><div></div><div>• Stones: types, properties, quarrying, dressing, uses, and defects.</div><div>• Bricks: manufacturing process, classification, tests, properties, and uses.</div><div>• Concrete blocks, hollow blocks, fly ash bricks, and compressed stabilized earth blocks.</div><div>• Cement: ingredients, manufacturing process, types, properties, storage, and tests.</div><div>• Lime: types, properties, and uses.</div><div>• Mortar: ingredients, proportions, types, properties, and applications.</div></div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |                           |      |
| <b>Linked COs: CO1, CO2, CO5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                | <b>Number of Hours: 9</b> |      |
| <b>Module-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |                           |      |
| <b>Timber, metals, glass, paints, and protective materials:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |                           |      |
| <div><div></div><div><div></div><div>• Timber: classification, defects, seasoning, preservation, plywood, veneers, particle boards, and fibre boards.</div><div>• Metals used in building construction: steel, aluminium, and their common applications.</div><div>• Glass: types, properties, and uses in buildings.</div><div>• Paints, varnishes, distempers, and polishes: types, ingredients, application, and defects.</div><div>• Corrosion protection, waterproofing materials, and damp-proofing materials.</div></div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |                           |      |
| <b>Linked COs: CO1, CO2, CO6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                | <b>Number of Hours: 9</b> |      |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |                           |      |

**Building components and construction practices:**

- Foundations: types, functions, and general construction principles.
- Masonry construction: stone masonry and brick masonry, types, bond patterns, and defects.
- Walls and partitions: load-bearing walls, partition walls, cavity walls, and retaining walls.
- Floors and roofs: ground floors, upper floors, flat roofs, sloping roofs, and basic roof coverings.
- Doors, windows, lintels, sunshades, staircases, parapets, and coping.
- Basic construction details for slabs, beams, and column interfaces in buildings.

**Linked COs: CO3, CO4, CO5****Number of Hours: 8****Module-5****Construction methods, finishing, quality control, and sustainability:**

- Plastering, pointing, cladding, flooring, and finishing works.
- Scaffolding, centering, shoring, and formwork: purpose and general types.
- Construction tools and equipment used in building works.
- Quality control in construction: workmanship, inspection, defects, and remedial measures.
- Basic construction safety practices and housekeeping at site.
- Green building concepts, sustainable construction practices, reuse, recycling, and life-cycle thinking.

**Linked COs: CO4, CO5, CO6****Number of Hours: 8****Suggested Learning Resources****Text books:**

1. S. C. Rangwala, Engineering Materials. Charotar Publishing House. Latest edition.
2. P. C. Varghese, Building Materials. Prentice Hall India / PHI Learning. Latest edition.
3. B. C. Punmia, Building Construction. Laxmi Publications. Latest edition.

**Reference books / Manuals:**

1. Gurucharan Singh, Building Construction. Standard Publishers.
2. R. S. Khurmi and J. K. Gupta, Building Construction. S. Chand.
3. National Building Code of India, latest edition, relevant parts.

**Web links and Video Lectures (e-Resources):**

1. NPTEL (IITs): Building Materials, Building Construction, and Construction Practices lecture series.
2. MoUs/MOOCs and open educational resources on sustainable building materials and construction methods.

**Teaching-Learning Process (Innovative Delivery Methods):**

Suggested Innovative Delivery Methods may include, but are not limited in addition to calk and talk.

- Flipped Classroom.
- Problem-Based Learning (PBL).
- Case-Based Teaching.
- Site Visit / Industrial Visit.
- ICT-Enabled Teaching.
- Simulation and Virtual Demonstration.
- Role Play.
- Mini project and material survey exercises.

The following sample strategies may be adopted to enhance teaching-learning effectiveness and support course outcome attainment:

1. Use real samples, photographs, and videos of construction materials and building components.
2. Encourage comparison of traditional and modern materials through case-based discussions.
3. Conduct field/site observations of masonry, formwork, finishing, and roof systems.
4. Use charts, specimen collections, and simple testing demonstrations to connect theory with practice.

**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 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 activities 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.

| <b>Term Work (TW) and Self Learning (SL) components in<br/>Number of Hours per semester</b>                      |                                                                                                                                                                                                                             |                                   |
|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.) |                                                                                                                                                                                                                             |                                   |
| <b>Sl. No.</b>                                                                                                   | <b>Term Work (TW) Activity</b>                                                                                                                                                                                              | <b>Number of Hours / Semester</b> |
| 1.                                                                                                               | Activity A – Building material selection case study (CO1, CO2, CO6): Students compare two or more materials for a chosen building element and justify selection based on strength, durability, economy, and sustainability. | 24                                |

|                                                                               |                                                                                                                                                                                                                                 |                            |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 2.                                                                            | Activity B – Construction component observation report (CO3, CO4, CO5): Students document building elements observed in a site visit or through case photos and explain construction sequence, precautions, and quality issues. | 24                         |
| SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc. |                                                                                                                                                                                                                                 |                            |
| Sl. No.                                                                       | <b>Self-Learning (SL) Activity</b>                                                                                                                                                                                              | Number of Hours / Semester |
| 1.                                                                            | NPTEL or MOOC modules on building materials, construction technology, and sustainable construction.                                                                                                                             | 24                         |
| 2.                                                                            | Preparation of material comparison charts, short notes, and digital portfolio of building components                                                                                                                            | 24                         |

**Rubrics for Evaluation of Term Work (TW) Activities:**

| Criteria                           | 4 – Excellent                                              | 3 – Good                                                     | 2 – Fair                                                  | 1 – Needs Improvement                          |
|------------------------------------|------------------------------------------------------------|--------------------------------------------------------------|-----------------------------------------------------------|------------------------------------------------|
| <b>Problem Understanding</b>       | Clearly defines materials/techniques with sound reasoning. | Mostly accurate with minor omissions in selection.           | Basic attempt; some incorrect material/technique choices. | Concept not clearly defined.                   |
| <b>Construction/Design Details</b> | Sketches/details are accurate, neat, and professional.     | Largely correct with minor layout errors.                    | Partially correct; several technical mistakes.            | Incorrect or missing diagrams/details.         |
| <b>Safety &amp; Sustainability</b> | Insightful analysis of safety, durability, and eco-impact. | Generally covers safety with limited sustainability comment. | Weak analysis; mostly mechanical application of theory.   | No meaningful interpretation of safety/impact. |
| <b>Presentation &amp; Clarity</b>  | Well-organized, easy to follow, and high-quality report.   | Generally clear; some minor layout/formatting issues.        | Understandable but somewhat untidy.                       | Very unclear or incomplete submission.         |

**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)

| ENGINEERING GEOLOGY FOR INFRASTRUCTURE PROJECTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                |                                      |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--------------------------------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1BCV305                        | Scheme                               | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Professional Core Course (PCC) | Semester                             | III  |
| 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   |
| <b>Course outcome (Course Skill Set)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                |                                      |      |
| At the end of the course, the student will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                |                                      |      |
| <ol style="list-style-type: none"><li><b>CO1 (L2 – Understand):</b> Explain the origin, classification and properties of rocks and soils relevant to civil engineering infrastructure.</li><li><b>CO2 (L3 – Apply):</b> Interpret geological maps, structures and subsurface information for siting and planning of foundations, tunnels, dams and highways.</li><li><b>CO3 (L3 – Apply):</b> Identify and describe engineering significance of geological structures such as joints, faults, folds and unconformities.</li><li><b>CO4 (L4 – Analyze):</b> Analyse unstable slopes and mass-movement conditions qualitatively and suggest suitable stabilisation and drainage measures.</li><li><b>CO5 (L3 – Apply):</b> Apply basic principles of groundwater occurrence and movement in planning wells, dewatering and seepage control measures.</li><li><b>CO6 (L4 – Analyze/Evaluate):</b> Assess geological hazards and geo-environmental issues, and relate them to resilient and sustainable infrastructure in line with SDG 6, SDG 9, SDG 11 and SDG 13.</li></ol> |                                |                                      |      |
| <b>Module-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                |                                      |      |
| <b>Introduction, minerals and rocks:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                |                                      |      |
| <ul style="list-style-type: none"><li>• Scope of engineering geology in planning, design and construction of infrastructure.</li><li>• Internal structure of the earth and rock cycle (qualitative).</li><li>• Minerals – physical properties of important rock-forming minerals (quartz, feldspar, mica, calcite etc.).</li><li>• Rocks – classification into igneous, sedimentary and metamorphic; textures and structures; engineering significance of common rock types (granite, basalt, sandstone, limestone, shale, gneiss, schist).</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                |                                      |      |
| <b>Linked COs: CO1, partial CO2, CO6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                | <b>Number of Hours (CI) = 8 hrs</b>  |      |
| <b>Module-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                |                                      |      |
| <b>Geological Structures and Engineering significance:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |                                      |      |
| <ul style="list-style-type: none"><li>• Primary and secondary structures; bedding, laminations and joints – types, spacing, infilling and their effect on strength and permeability.</li><li>• Folds – terminology, classification based on attitude; impact on tunnels, slopes and foundations.</li><li>• Faults – elements, types and recognition in field and maps; engineering problems due to faults.</li><li>• Unconformities and their recognition; importance in site selection and groundwater.</li><li>• Interpretation of simple geological maps and sections (qualitative).</li><li>• Joints: Types of joints and engineering significance</li><li>• Rock Quality Determination (RQD) for infrastructures projects, Study of engineering geological conditions for site selection.</li><li>• Detailed Core logging (Hardness, Dip, Strike, Fold, Fault, Joint, Unconformities) and its importance in foundations.</li></ul>                                                                                                                                    |                                |                                      |      |
| <b>Linked COs: CO2, CO3, CO6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                | <b>Number of Hours (CI)= 8 hrs</b>   |      |
| <b>Module-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                |                                      |      |
| <b>Weathering, soil profile and site investigation:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                |                                      |      |
| <ul style="list-style-type: none"><li>• Soil formation and soil profile and engineering importance.</li><li>• Weathering of rocks – physical, chemical and biological processes; residual and transported soils; engineering implications.</li><li>• Soil profile, laterites and black cotton soils – occurrence and problems for foundations (qualitative).</li><li>• Concept of bearing strata, overburden, rock mass quality (awareness of RQD).</li><li>• Role of engineering geologist in reconnaissance and detailed site investigations.</li><li>• Reconnaissance survey and detailed site investigations</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |                                      |      |
| <b>Linked COs: CO1, CO2, CO4, CO6.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                | <b>Number of Hours (CI) = 8 hrs.</b> |      |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                |                                      |      |

**Hydrogeology and Geomorphology:**

- Groundwater occurrence in different terrains ; Igneous Rocks, Sedimentary Rocks and Metamorphic rocks
- Water Bearing Formations, aquifers, aquitard, water table and piezometric surface.
- Concept of porosity, permeability and Transmissivity at qualitative level.
- Springs, wells and boreholes; influence of geological formations on groundwater yield.
- Seepage and leakage issues in foundations, underground structures and slopes; basic drainage and grouting concepts (qualitative).
- Seepage and leakage issues in foundations, underground structures and slopes; basic drainage and grouting concepts (qualitative).
- Geophysical exploration, Hydrological cycle. Vertical distribution of groundwater, artesian groundwater in soil and rock. Artificial recharge structure, Rain water harvesting
- Groundwater Pollution. Floods and its control, Cyclone and its effects. Landforms, different drainage pattern and types.

**Linked COs: CO2, CO5, CO6.****Number of Hours (CI) = 8 hrs.****Module-5****Geo-Hazards, Landslides, GIS and Remote Sensing**

- Natural slopes in rock and soil, factors affecting stability – material, structure, groundwater and external loading.
- Landslides – types, causes, warning signs and basic preventive measures (drainage, retaining structures, bioengineering – qualitative).
- Geological considerations in dam and reservoir sites – suitable and unsuitable conditions, seepage and uplift issues.
- Tunnels and underground constructions – influence of rock type, joints, faults and water; concept of rock support systems (awareness). Earthquakes, seismic zoning (India – awareness), geotechnical amplification and resilient infrastructure; linkage to SDG 11 and SDG 13.
- Engineering problems related to Earthquakes, Tsunami causes and effects, Volcanic Eruptions. Remote Sensing – Concept, Application and its Limitations; Natural Disasters and their mitigation.
- Geographic Information System (GIS) and Global Positioning System (GPS) and its applications in Civil Engineering Projects.
- Remote Sensing concept and its Applications in Natural Resource Management.
- Aerial Photography, LISS 4 data, Sentinel-2 and LANDSAT Imagery in urban planning.

**Linked COs: CO2, CO4, CO5, CO6.****Number of Hours (CI) = 10 hrs..****Suggested Learning Resources****Text books:**

1. Parbin Singh, *Engineering and General Geology*. S.K. Kataria & Sons. 8th Edition (2018 or latest).
2. Chenna Kesavulu N., *Textbook of Engineering Geology*. Macmillan Publishers India Ltd. 2nd Edition (2019 or latest).
3. K. V. G. K. Gokhale, *Principles of Engineering Geology*. B.S. Publications. 2nd Edition (2017 or latest).

**Reference Books/Manuals:**

1. F.G.H. Blyth and M.H. de Freitas, *Geology for Engineers*. Butterworth-Heinemann. 7th Edition (2017).
2. Bureau of Indian Standards, National Building Code of India (NBC) 2016, Vol. 1, Part 6 (Structural Design - Section 2: Soils and Foundations), 2016.

**Web links and Video Lectures (e-Resources):**

1. NPTEL courses on Engineering Geology and Rock Engineering.

**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.
- Site Visit / Industrial Visit.
- ICT-Enabled Teaching.
- Simulation and Virtual Demonstration.
- Role Play.
- Mini project and material survey exercises.

The following sample strategies may be adopted to enhance teaching-learning effectiveness and support course outcome attainment:

1. Flipped classroom for structural geology concepts, case-based teaching for dam/tunnel failure analysis, and virtual demonstrations of geophysical testing.
2. Use of geological maps/sections, field/site observations (if applicable), and integration of real-world infrastructure disaster case studies.

**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. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below.

| <b>Term Work (TW) and Self Learning (SL) components in<br/>Number of Hours per semester</b>                      |                                                                                                                                                                         |                                   |
|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.) |                                                                                                                                                                         |                                   |
| <b>Sl. No.</b>                                                                                                   | <b>Term Work (TW) Activity</b>                                                                                                                                          | <b>Number of Hours / Semester</b> |
| 1.                                                                                                               | <b>Activity A – Geological Site Analysis:</b> Students interpret borehole/map data for a proposed infrastructure site and recommend stability measures (CO2, CO4, CO5). | 24                                |
| 2.                                                                                                               | <b>Activity B – Case Study Presentation:</b> Document a major civil project failure caused by geological factors; analyze remedial measures (CO4, CO6).                 | 24                                |
| SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.                                    |                                                                                                                                                                         |                                   |
| <b>Sl. No.</b>                                                                                                   | <b>Self-Learning (SL) Activity</b>                                                                                                                                      | <b>Number of Hours / Semester</b> |
| 1.                                                                                                               | NPTEL/MOOC modules on Engineering Geology, Rock Mechanics, or Geotechnical Exploration.                                                                                 | 24                                |
| 2.                                                                                                               | Preparation of geological profile charts and digital portfolio of common rock/mineral specimens.                                                                        | 24                                |

**Rubrics for Evaluation of Term Work (TW) Activities:**

| <b>Criteria</b>                   | <b>4 – Excellent</b>                                                | <b>3 – Good</b>                                               | <b>2 – Fair</b>                                       | <b>1 – Needs Improvement</b>     |
|-----------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------|-------------------------------------------------------|----------------------------------|
| <b>Problem Understanding</b>      | Clearly links geology to project stability with sound reasoning.    | Mostly accurate with minor gaps in geological interpretation. | Basic attempt; some incorrect geological assumptions. | Concept not defined.             |
| <b>Analysis/Interpretation</b>    | Insightful analysis of rock data/site reports.                      | Correct analysis with some implicit assumptions.              | Limited analysis; mainly descriptive.                 | No analysis; irrelevant content. |
| <b>Presentation &amp; Clarity</b> | Well-organized, professional reports and clear geological sketches. | Generally clear; minor formatting issues.                     | Understandable but somewhat untidy.                   | Incomplete submission.           |

**Continuous Internal Evaluation (CIE):**

3. 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.
4. 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.
5. 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.
6. 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 CAD AND 3D MODELLING LAB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |               | Scheme      | 2025 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1BCVL306      | Semester    | III  |
| Teaching Hours/Week (L:T:P)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 28 (0:0:2)    | CIE Marks   | 50   |
| Total Hours of Pedagogy<br>CI(L:T):LI(P):SL/TW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 30 (0:0:28:2) | SEE Marks   | 50   |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1             | Total Marks | 100  |
| Examination type (SEE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Practical     | Exam Hours  | 03   |
| <b>Course outcome (Course Skill Set)</b><br>At the end of the course, the student will be able to: <ol style="list-style-type: none"> <li>CO1: Describe CAD interface, units, layers, snaps, and aids for building drafting. (L2)</li> <li>CO2: Create detailed 2D plans, elevations, sections of institutional buildings using layers, hatches, dimensions. (L3)</li> <li>CO3: Develop 3D models of buildings, generate multi-views, and apply basic rendering. (L3)</li> <li>CO4 : Organize complex drawings with blocks, XREFs, layouts for collaboration and standards compliance. (L4)</li> <li>CO5: Export models for estimation, BIM intro, presentations; reflect on civil applications. (L3)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |             |      |
| <b>Note:</b> <ol style="list-style-type: none"> <li>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.</li> <li>Both PART-A and PART-B are considered for CIE and SEE.</li> <li>Students have answer 1(one) question from PART-A and 1(one) question from PART-B.               <ol style="list-style-type: none"> <li>The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for <b>70 marks</b> out of the maximum 100 marks.</li> <li>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 <b>30 marks</b>.</li> </ol> </li> <li>For Continuous Internal Evaluation (CIE) during the semester, classwork shall typically include open-ended questions from <b>Part-B</b>, along with other similar questions designed to enhance the students' skills.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |               |             |      |
| PART – A<br>FIXED SET OF EXPERIMENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |             |      |
| Students shall perform practical exercises related to: <ol style="list-style-type: none"> <li>CAD basics: Interface setup, units (metric), limits, layers (walls, doors, dimensions), OSNAPs, modify commands; draw simple room shapes, annotate.</li> <li>Residential plan: Detailed plan with rooms, doors/windows (standard sizes: doors 900x2100mm, windows 1200x1200mm), furniture blocks, dimensions 1:100 scale.</li> <li>Residential elevation/section: Matching elevation, cross-section with hatching (walls 230mm brick, slab 150mm), stairs, roof.</li> <li>School building plan: Ground +1 floor plan (classrooms 7x8m, staff room, hall 20x10m, toilets, corridors), doors/windows, ramps for accessibility, grid lines, 1:100 scale.</li> <li>School elevation/sections: Front/side elevations, longitudinal section showing plinth (750mm), parapet, solar panels; hatches for materials.</li> <li>Office building plan: G+2 commercial office (reception, cabins 4x4m, open workstations, conference 10x6m, parking layout), lifts, services ducts, 1:100.</li> <li>Office elevations/sections: Multi-level elevations, sections with column grids (6x6m bay), beam details, glazing.</li> <li>Primary health center (PHC) plan: OPD rooms, waiting area, lab, pharmacy, wards (4 beds), admin, generator backup, circulation for patients, 1:100 scale.</li> <li>PHC elevations/sections: Elevations with ramps (1:12), sections showing ventilation, septic tank stub, green features.</li> </ol> |               |             |      |

**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. Complete working drawings (plan, 2 elevations, 2 sections) for school/office/PHC variant; advanced layers, dynamic blocks, title block with BOM.
2. 3D modeling: Extrude school/office/PHC plans to full model (floors, roof, doors/windows), UCS views, section planes, basic materials/rendering (Revit/AutoCAD 3D).
3. Collaborative set: XREF plans/elevations/3D from peers, assemble layout sheets, plot PDFs; BIM export intro (IFC format).
4. Quantity takeoff: Area/volume from 3D model (floors, walls), Excel link; sustainability check (green area >20%)

**Suggested Learning Resources:**

**Text books:**

1. MG Shah, CM Kale, SY Patki, "Building Drawing with an Integrated Approach to Built Environment Drawing", Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. S.S. Bhavikatti and M.V. Chitawadagi, "Building Planning and Drawing", I K International Publishing House Pvt. Ltd., New Delhi.
3. Gurucharan Singh, "Building Construction", Standard Publishers & Distributors, New Delhi.
4. RS Malik and GS Meo, "Civil Engineering Drawing", Asian Publishers / Computech Publications Pvt. Ltd., New Delhi.
5. Sham Tickoo. AutoCAD 2024 for Engineers and Designers (or latest edition) – 2D drafting and 3D modelling with civil/architectural examples.
6. Munir Hamad. AutoCAD for Architectural Drawing and Design – building plans, elevations and basic 3D for buildings.
7. Elise Moss. Introducing AutoCAD Civil 3D – site, road and basic infrastructure modelling using Civil 3D.

**Reference books / Manuals:**

1. Dodge F.W., "Time Saver Standards for Building Types", F.W. Dodge Corp., New York.
2. IS: 962 – 1989 – "Code of Practice for Architectural and Building Drawing", BIS, New Delhi.
3. "National Building Code of India", BIS, New Delhi.
4. Prof. Anil A. Patil. Computer Aided Building Drawing
5. Louisa Jahn, Dustin Manning. Mastering Autodesk Civil 3D – advanced corridor, grading and infrastructure workflows.

**Web links and Video Lectures (e-Resources):**

1. NPTEL: Computer Aided Design – Introductory CAD concepts and 3D modelling (lecture series by IIT Delhi / IITs).
2. NPTEL / IIT Hyderabad: Computer Aided Engineering Drawing and Design – 2D/3D CAD, drafting standards, projections useful before AutoCAD practice.
3. NPTEL / BIM-related courses: Building Information Modeling (BIM) – conceptual and workflow understanding for 3D model-based building/infrastructure projects (IITM Pravartak / similar)

**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**.
- 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**

| <b>Performance Indicators</b>        | <b>Excellent</b>                                                                                                                                           | <b>Very Good</b>                                                                                                        | <b>Good</b>                                                                                          | <b>Satisfactory</b>                                                               |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 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)       |

| MATLAB & SPREADSHEET APPLICATIONS FOR CIVIL ENGINEERING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                         |             |      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1BCVL307A                               | Scheme      | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Ability Enhancement Course (Laboratory) | Semester    | III  |
| 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   |
| <b>Course outcome (Course Skill Set):</b><br><b>At the end of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li><b>C01 (L3 – Apply):</b> Apply MATLAB and spreadsheet tools to perform basic numerical computations and data presentation for civil engineering problems.</li> <li><b>C02 (L3 – Apply):</b> Implement mathematical and engineering calculations using scripts, formulas, and built-in functions in MATLAB and spreadsheets.</li> <li><b>C03 (L4 – Analyze):</b> Analyze civil engineering datasets using charts, trendlines, interpolation, regression, and statistical summaries.</li> <li><b>C04 (L3 – Apply):</b> Develop spreadsheet models for quantity estimation, rate analysis, and simple design calculations relevant to civil engineering.</li> <li><b>C05 (L4 – Analyze):</b> Interpret outputs from MATLAB and spreadsheet simulations to support engineering decisions and report preparation.</li> <li><b>C06 (L5 – Evaluate):</b> Evaluate the suitability of computational results for civil engineering applications and communicate findings in a professional report aligned with sustainability and digital engineering practices.</li> </ol>          |                                         |             |      |
| <b>SET OF EXPERIMENTS (LI =28 hours)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                         |             |      |
| Students shall perform practical exercises related to: <ol style="list-style-type: none"> <li>Introduction to MATLAB environment, command window, variables, matrices, and basic plotting.</li> <li>Arithmetic operations, unit conversions, and engineering calculator using MATLAB.</li> <li>Solution of simultaneous equations relevant to structural and water resources problems.</li> <li>Plotting of load–deflection, stress–strain, and discharge–head graphs using MATLAB.</li> <li>Interpolation and curve fitting for civil engineering data.</li> <li>Numerical differentiation and integration for engineering applications.</li> <li>Spreadsheet creation for civil engineering calculations using formulas and cell referencing.</li> <li>Preparation of quantity estimation sheet for a simple building component.</li> <li>Rate analysis sheet for common civil engineering items.</li> <li>Data entry, sorting, filtering, and conditional formatting for field/lab data in spreadsheets.</li> <li>Statistical analysis of test data using spreadsheet functions, averages, standard deviation, and charts.</li> <li>Regression analysis and trendline-based prediction using spreadsheet tools.</li> </ol> |                                         |             |      |
| <b>Suggested Learning Resources</b><br><b>Text Books</b> <ol style="list-style-type: none"> <li>Chapra, S. C. Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill Education, 4th Edition, 2018.</li> <li>Attaway, S. MATLAB: A Practical Introduction to Programming and Problem Solving, Butterworth-Heinemann, 4th Edition, 2019.</li> <li>Bansal, R. K. A Textbook of Engineering Mechanics and Spreadsheet Applications, Laxmi Publications, 1st Edition, 2020.</li> <li>Dhanpat Rai &amp; Company MS Excel for Engineers and Analysts, Dhanpat Rai Publications, 2nd Edition, 2021.</li> <li>Borah, D. Computational Methods in Civil Engineering Using MATLAB, Khanna Publishers, 1st Edition, 2022.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                         |             |      |

**Reference Books**

1. Rao, S. S. Numerical Methods for Engineers, Elsevier, 7th Edition, 2018.
2. Kreyszig, E. Advanced Engineering Mathematics, Wiley, 10th Edition, 2011.
3. Dewri, H. Spreadsheet Modeling for Civil and Structural Engineering, McGraw-Hill, 1st Edition, 2020.
4. Chapra, S. C., and Canale, R. P. Numerical Methods for Engineers, McGraw-Hill Education, 8th Edition, 2016.
5. Perry, L. Excel Applications for Engineers, Pearson, 2nd Edition, 201

**Web links and Video Lectures (e-Resources):**

1. [MATLAB Documentation](#)
2. [MATLAB Onramp](#)
3. [Spreadsheet functions reference](#)
4. [NPTEL engineering computation 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 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 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<br>(5)<br>(PO4) | Student is able to run the program on various cases and compare the result with proper analysis.<br>(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.<br>(3)                    | Student will be able to run the program but not able to analyze the output. (1-2) |
| Demonstration<br>(8)<br>(PO9)     | The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth.<br>(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.<br>(1-2)    |

| GRAPHIC STATICS LABORATORY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                         |             |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1BCV307B                                | Scheme      | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Ability Enhancement Course (Laboratory) | Semester    | III  |
| 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   |
| <b>Course outcome (Course Skill Set)</b><br><b>At the end of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li><b>C01 (L3 – Apply):</b> Apply graphical methods to represent forces, vectors, and structural actions in civil engineering systems.</li> <li><b>C02 (L3 – Apply):</b> Construct force and funicular polygons for given load systems using accurate graphical procedures.</li> <li><b>C03 (L4 – Analyze):</b> Analyze reactions, member forces, and equilibrium conditions of simple structural systems through graphic statics.</li> <li><b>C04 (L3 – Apply):</b> Develop graphical solutions for beams, trusses, and cable systems relevant to civil engineering applications.</li> <li><b>C05 (L4 – Analyze):</b> Interpret graphical results to assess load paths, stability, and force distribution in structures.</li> <li><b>C06 (L5 – Evaluate):</b> Evaluate the suitability of graphical methods for civil engineering problems and communicate results in a professional report aligned with engineering practice.</li> </ol>                                                                                                           |                                         |             |      |
| <b>SET OF EXPERIMENTS (LI =28 hours)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                         |             |      |
| Students shall perform practical exercises related to: <ol style="list-style-type: none"> <li>Introduction to graphic statics, scaling, instruments, and construction of force vectors.</li> <li>Resolution and composition of forces using force polygons.</li> <li>Determination of resultant of concurrent force systems by graphical method.</li> <li>Analysis of coplanar force systems and equilibrium of a rigid body using force polygon.</li> <li>Construction of funicular polygon for a system of parallel forces.</li> <li>Determination of reactions of simply supported beams using graphical statics.</li> <li>Graphical analysis of beams with point loads and uniformly distributed loads.</li> <li>Construction of load line and link polygon for structural force distribution.</li> <li>Analysis of simple trusses using method of joints through graphical representation.</li> <li>Determination of member forces in statically determinate trusses by graphic method.</li> <li>Graphical study of cable structures and suspension systems.</li> <li>Analysis of funicular shapes for given loading conditions.</li> </ol>                                                   |                                         |             |      |
| <b>Suggested Learning Resources</b><br><b>Text books:</b> <ol style="list-style-type: none"> <li><b>Text Books</b></li> <li>Hibbeler, R. C. <i>Engineering Mechanics: Statics</i>, Pearson, latest edition.</li> <li>Hartsuijker, C. <i>Graphic Statics</i>, Springer, latest edition.</li> <li>Zienkiewicz, O. C. <i>Mechanics of Structures</i>, Elsevier, latest edition.</li> <li>Bansal, R. K. <i>Engineering Mechanics</i>, Laxmi Publications, latest edition.</li> <li>Negi, L. S. <i>Structural Analysis</i>, McGraw-Hill Education, latest edition.</li> </ol> <b>Reference Books</b> <ol style="list-style-type: none"> <li>Bow, R. H. <i>Engineering Mechanics of Statics</i>, Wiley, latest edition.</li> <li>Weaver, W., and Gere, J. M. <i>Matrix Analysis of Framed Structures</i>, CBS Publishers, latest edition.</li> <li>Timoshenko, S. P., and Young, D. H. <i>Theory of Structures</i>, McGraw-Hill, latest edition.</li> <li>Ghali, A., Neville, A. M., and Brown, T. G. <i>Structural Analysis: A Unified Classical and Matrix Approach</i>, CRC Press, latest edition.</li> <li>Hulse, R., and Cain, J. <i>Structural Mechanics</i>, Palgrave, latest edition.</li> </ol> |                                         |             |      |

**Web links and Video Lectures (e-Resources):**

1. NPTEL Structural Analysis resources
2. Engineering Mechanics and Statics video lectures
3. Graphic statics tutorials and demonstrations
4. Online structural analysis learning modules

**Assessment Structure:**

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- 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 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 demerits (3)           | Student is capable of explaining the design (1-2)                                 |
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| 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) |

| PYTHON PROGRAMMING LAB FOR CIVIL ENGINEERS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                         |             |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1BCV307C                                | Scheme      | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Ability Enhancement Course (Laboratory) | Semester    | III  |
| 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   |
| <b>Course outcome (Course Skill Set)</b><br><b>At the end of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>1. CO1 (L3 – Apply): Apply Python programming basics to solve civil engineering-related numerical and logical problems.</li> <li>2. CO2 (L3 – Apply): Implement conditional statements, loops, functions, and arrays for engineering computations.</li> <li>3. CO3 (L4 – Analyze): Analyze civil engineering data using Python libraries and interpret computational results.</li> <li>4. CO4 (L3 – Apply): Develop Python scripts for structural, transportation, environmental, and geotechnical engineering applications.</li> <li>5. CO5 (L4 – Analyze): Interpret outputs from Python-based solutions to support engineering decision-making.</li> <li>6. CO6 (L5 – Evaluate): Evaluate the suitability of Python as a computational tool and communicate results in a professional report aligned with engineering practice.</li> </ol>                                                                                                                                                                                                 |                                         |             |      |
| <b>SET OF EXPERIMENTS (LI =28 hours)</b> <ol style="list-style-type: none"> <li>1. Introduction to Python, installation, IDE usage, and basic syntax.</li> <li>2. Input, output, data types, operators, and simple engineering calculations.</li> <li>3. Conditional statements and looping constructs for civil engineering problem solving.</li> <li>4. Functions and modular programming for reusable engineering computations.</li> <li>5. Arrays, lists, tuples, and dictionaries for data handling.</li> <li>6. Plotting using Python libraries for basic civil engineering data visualization.</li> <li>7. Solution of simultaneous equations relevant to structural or water resources problems.</li> <li>8. Computation of area, volume, centroid, and moment of inertia for standard sections.</li> <li>9. Program for slope, deflection, or load calculation in simple structural members.</li> <li>10. Program for beam reactions under point loads and uniformly distributed loads.</li> <li>11. Data analysis of survey, rainfall, traffic, or material test data using Python.</li> <li>12. Application of Python in design-oriented civil engineering case studies.</li> </ol> |                                         |             |      |
| <b>Suggested Learning Resources:</b><br><b>Textbooks:</b> <ol style="list-style-type: none"> <li>1. Hibbeler, R. C., <i>Engineering Mechanics: Statics</i>, Pearson, latest edition.</li> <li>2. Hartsuijker, C., <i>Graphic Statics</i>, Springer, latest edition.</li> <li>3. Zienkiewicz, O. C., <i>Mechanics of Structures</i>, Elsevier, latest edition.</li> <li>4. Ramalho, M., and co-authors, <i>Programming with Python for Engineers</i>, Springer, latest edition.</li> <li>5. Downey, A. B., <i>Think Python: How to Think Like a Computer Scientist</i>, O'Reilly, latest edition.</li> <li>6. Bansal, R. K., <i>Engineering Mechanics</i>, Laxmi Publications, latest edition.</li> </ol> <b>Reference Books:</b> <ol style="list-style-type: none"> <li>1. Severance, C. R., <i>Python for Everybody</i>, Exploring Data Using Python 3, Open book version / equivalent publisher edition.</li> <li>2. Lutz, M., <i>Learning Python</i>, O'Reilly, latest edition.</li> <li>3. Gaddis, T., <i>Starting Out with Python</i>, Pearson, latest edition.</li> <li>4. Necaie, R., <i>Data Structures and Algorithms Using Python</i>, Wiley, latest edition.</li> </ol>             |                                         |             |      |

5. Langtangen, H. P., *A Primer on Scientific Programming with Python*, Springer, latest edition.

**Web links and Video Lectures (e-Resources):**

1. NPTEL Python programming resources.
2. Python tutorials for engineers and scientific computing.
3. Python file handling and data visualization video lectures.
4. Online practice modules for Python programming in engineering applications.

**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) (P01)      | 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) (P02 & P03) | 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 demerits (3)           | Student is capable of explaining the design (1-2)    |
| Implementation (8) (P03 & P08)       | 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)<br>(P04) | 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)<br>(P09)     | 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)       |

| ENGINEERING GEOLOGY AND SOIL IDENTIFICATIONS LAB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                         |             |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1BCV307D                                | Scheme      | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Ability Enhancement Course (Laboratory) | Semester    | III  |
| 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   |
| <b>Course outcome (Course Skill Set)</b><br><b>At the end of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>1. CO1 (L3 – Apply): Identify and classify common rock-forming minerals and rocks based on physical properties, textures, and structures relevant to civil engineering applications.</li> <li>2. CO2 (L3 – Apply): Perform standard laboratory tests to determine physical and index properties of soils including moisture content, specific gravity, grain size distribution, and Atterberg limits.</li> <li>3. CO3 (L4 – Analyze): Analyze soil classification using Unified Soil Classification System (USCS) and Indian Standard Classification (IS) based on laboratory test results and plasticity characteristics.</li> <li>4. CO4 (L3 – Apply): Use geological instruments (clinometer compass, Brunton compass) to measure dip and strike of geological formations and interpret geological maps and cross- sections.</li> <li>5. CO5 (L4 – Analyze): Evaluate engineering properties of rocks (specific gravity, porosity, water absorption) and assess their suitability for construction materials and infrastructure projects.</li> <li>6. CO6 (L5 – Evaluate): Assess geological and geotechnical site conditions, relate laboratory findings to field observations, and recommend suitable foundation types and construction practices aligned with SDG 9 (Industry, Innovation and Infrastructure) and SDG 11 (Sustainable Cities and Communities).</li> </ol> |                                         |             |      |
| <b>SET OF EXPERIMENTS (LI =28 hours)</b> <ol style="list-style-type: none"> <li>1. Study of geological maps and symbols.</li> <li>2. Identification of common rock-forming minerals by physical properties.</li> <li>3. Identification and description of igneous rocks/sedimentary rocks/metamorphic rocks.</li> <li>4. Study of structural features of rocks such as folds, faults, joints, and bedding planes.</li> <li>5. Study of topographical maps and contour interpretation.</li> <li>6. Interpretation of geological sections and rock strata.</li> <li>7. Study of aerial photographs / stereoscopic photo interpretation.</li> <li>8. Study of engineering geological conditions for site selection.</li> <li>9. Visual manual identification and description of soil samples.</li> <li>10. Field identification of coarse and fine -grained soils.</li> <li>11. Geophysical survey to determine subsurface strata characteristics for foundations.</li> <li>12. Field exposure to identify topography, rocks, minerals and soil and suitable dam selection area.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                         |             |      |
| <b>Suggested Learning Resources</b><br><b>Text books:</b> <ol style="list-style-type: none"> <li>1. Parbin Singh. Engineering and General Geology. Katson Publishing House.</li> <li>2. Venkat Reddy, D. Engineering Geology for Civil Engineers. Oxford &amp; IBH Publishing.</li> <li>3. Murthy, V. N. S. Soil Mechanics and Foundation Engineering (7th Edition). CBS Publishers.</li> <li>4. Punmia, B. C., Jain, A. K., &amp; Jain, A. K. Soil Mechanics and Foundations (17th Edition). Laxmi Publications.</li> </ol> <b>Reference books:</b> <ol style="list-style-type: none"> <li>1. Krynine, D. P., &amp; Judd, W. R. Principles of Engineering Geology and Geotechnics. McGraw-Hill.</li> <li>2. Goodman, R. E. Engineering Geology – Rock in Engineering Construction. Wiley.</li> <li>3. IS 2720 (Parts I to XXII) – Methods of Test for Soils – Indian Standard Code of Practice.</li> <li>4. Rahn, P. H. Engineering Geology: An Environmental Approach (2nd Edition). Prentice Hall.</li> <li>5. Das, B. M. Principles of Geotechnical Engineering (9th Edition). Cengage Learning</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                   |                                         |             |      |

**Web links and Video Lectures (e-Resources):**

1. NPTEL courses on Engineering Geology (IIT Roorkee, IIT Kharagpur).
2. NPTEL courses on Soil Mechanics and Foundation Engineering (IIT Delhi, IIT Bombay).
3. Virtual Labs – Geotechnical Engineering Virtual Lab (IIT Kanpur): <https://vlab.co.in>
4. Geological Survey of India (GSI) – Maps, reports, and publications: <https://www.gsi.gov.in>
5. YouTube channels: Civil Engineering Essentials, The Engineering Classroom (soil mechanics experiments).
6. American Society of Civil Engineers (ASCE) – Geotechnical resources and standards

**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) (P01)      | 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) (P02 & P03) | 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)       |

| COMMUNITY PROJECT / SOCIETAL PROJECT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |               |             |      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1BCP308       | Scheme      | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | SDC           | Semester    | III  |
| Teaching Hours/Week (L :T : P)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 30 (0:0:30)   | CIE Marks   | 50   |
| Total Hours of Pedagogy CI( L :T):LI(P):SL:TW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 30 (0:0:30:0) | SEE Marks   | 50   |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1             | Total Marks | 100  |
| Type of Examination                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Practical     | Exam Hours  | 02   |
| <p><b>Course objective:</b><br/>Rapid urbanisation, population growth, environmental concerns, energy demand, water scarcity, waste management, transportation issues and rural development challenges have created practical problems affecting communities and public welfare. This course aims to integrate technical knowledge, field exposure and societal engagement so that students identify real community issues, frame problem statements and attempt appropriate, feasible and sustainable engineering responses within the scope of a one-semester project.</p> <p><b>Course outcome (Course Skill Set):</b><br/><b>At the end of the course, the student will be able to:</b></p> <ol style="list-style-type: none"> <li>1. <b>CO1 (L2 – Understand):</b> Identify and analyse societal problems through field interaction and technical assessment.</li> <li>2. <b>CO2 (L3 – Apply):</b> Develop skills in project planning, field survey, data collection, implementation, documentation and reporting.</li> <li>3. <b>CO3 (L4 – Analyze):</b> Formulate feasible engineering problem statements and solutions considering practical constraints and sustainability aspects.</li> <li>4. <b>CO4 (L3 – Apply):</b> Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.</li> <li>5. <b>CO5 (L4 – Analyze):</b> Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.</li> <li>6. <b>CO6 (L5 – Evaluate):</b> Demonstrate teamwork and communication skills while interacting with technical and non-technical stakeholders and reflect on project impact on society.</li> </ol> <p><b>Restrictions and professional conduct:</b><br/>Community / Societal Projects shall remain <b>academic, socially responsible, technically focused, and politically neutral</b>. Students and faculty shall maintain professionalism, ethical conduct, public respect and institutional integrity while interacting with communities, public groups, organisations and stakeholders.<br/>Students and faculty <b>shall avoid</b> the following during project execution:</p> <ul style="list-style-type: none"> <li>• Association with political party activities, campaigns or propaganda.</li> <li>• Participation in activities that may disturb communal harmony, public order or institutional reputation.</li> <li>• Use of the project platform for personal, political, ideological or commercial promotion.</li> <li>• Disrespectful, discriminatory or unethical interaction with community members or stakeholders.</li> </ul> <p>Projects must also recognise constraints related to <b>cost, resources, environment and safety, and stakeholder behaviour/cooperation/acceptance</b> when planning and implementing activities.</p> |               |             |      |
| SET OF PROJECT ACTIVITIES (TW/SL = 30 HOURS)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |             |      |
| <p><b>Methods for project identification:</b><br/>Students may identify the project topic using one or more of the following methods:</p> <ul style="list-style-type: none"> <li>• Interaction with local rural or urban stakeholders such as local leaders, corporation/municipality personnel, NGOs, panchayat representatives, etc.</li> <li>• Review of issues highlighted in print and electronic media, and social networks (WhatsApp,</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |             |      |

Facebook, X, Instagram, etc.).

- After selecting a broad topic, students shall collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and then 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                                                      | PO2, PO6, PO7, PO8, PO9, PO10  | SDG 2, SDG 3, SDG 11         |

|    |                                                 |                                                                                                                                      |                                |                        |
|----|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|------------------------|
|    |                                                 | adoption of healthier practices.                                                                                                     |                                |                        |
| 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 | Youth mentoring programmes                      | Deliver a structured mentoring activity and measure participation, engagement, and skill/awareness improvement.                      | PO6, PO8, PO9, PO10, PO11      | SDG 4, SDG 10, SDG 17  |
| 18 | Adult education                                 | Conduct learner-needs assessment, prepare instructional content, and measure improvement in basic literacy or numeracy indicators.   | PO6, PO8, PO9, PO10, PO11      | SDG 4, SDG 10, SDG 17  |
| 19 | 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   |
| 20 | Human rights awareness with legal systems       | Prepare and deliver an awareness module and assess increase in legal awareness and access-to-rights understanding.                   | PO6, PO7, PO8, PO9, PO10       | SDG 5, SDG 10, SDG 16  |
| 21 | House tax collection through digital media      | Develop a simple digital workflow or awareness support and measure improvement in compliance, convenience, or response time.         | PO2, PO3, PO4, PO5, PO10, PO11 | SDG 9, SDG 11, SDG 16  |
| 22 | Use of application / application program        | Build or demonstrate a useful community app and measure usability, adoption, or efficiency improvement.                              | PO1, PO3, PO4, PO5, PO9, PO10  | SDG 9, SDG 11, SDG 17  |

|    |                               |                                                                                                           |                           |                               |
|----|-------------------------------|-----------------------------------------------------------------------------------------------------------|---------------------------|-------------------------------|
| 23 | Creation of Panchayat library | Plan the library model, catalogue resources, and measure usage, accessibility, or participation outcomes. | PO6, PO8, PO9, PO10, PO11 | SDG 4, SDG 10, SDG 11, SDG 17 |
|----|-------------------------------|-----------------------------------------------------------------------------------------------------------|---------------------------|-------------------------------|

**Suggested Learning Resources:****Textbooks:**

1. **Phadke, N. D.** Community Engagement and Social Innovation. 1st ed., Oxford University Press, New Delhi.
2. **Garg, N. R.** Project-Based Learning in Engineering Education. 1st ed., Pearson India Education Services, Noida.
3. **Gupta, A. and P. Singh.** Service Learning and Community Projects. 1st ed., McGraw-Hill Education (India), New Delhi.
4. **Wilson, G.** Practical Guide to Community Development Projects. 2nd ed., 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: <https://sdgs.un.org>
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 (IIT Roorkee, IIT Kharagpur).
2. NPTEL courses on Soil Mechanics and Foundation Engineering (IIT Delhi, IIT Bombay).
3. Virtual Labs – Geotechnical Engineering Virtual Lab (IIT Kanpur): <https://vlab.co.in>
4. Geological Survey of India (GSI) – Maps, reports, and publications: <https://www.gsi.gov.in>
5. YouTube channels: Civil Engineering Essentials, The Engineering Classroom (soil mechanics 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                                           | Review and refine problem statement                             | Prepare problem statement, scope, and                    | Approved problem statement     |

|    |                                                           |                                                           |                                                          |                                           |
|----|-----------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------|-------------------------------------------|
|    | formulation                                               |                                                           | objectives                                               |                                           |
| 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  $\geq 40$ ; 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/industry/community               | 8              | Problem is clearly identified with strong evidence of societal relevance and well-defined scope. | Problem is relevant and scope is clear with adequate supporting evidence. | Problem defined but justification or evidence is weak.          | Problem unclear or not relevant; little/no supporting evidence.  |
| Formation of problem statement; Engineering approach, innovation & feasibility | 10             | Problem statement is precise; approach is sound, innovative and clearly feasible.                | Problem statement adequate; approach feasible with minor gaps.            | Problem statement partial; approach feasibility is marginal.    | Problem statement missing or approach not feasible.              |
| Interaction with stakeholders; Data collection, analysis & interpretation      | 8              | Thorough stakeholder engagement; data collection is comprehensive; analysis is well-interpreted  | Good engagement; data and analysis adequate with minor gaps.              | Limited engagement; data incomplete and analysis superficial.   | Little/no stakeholder contact; insufficient or no data/analysis. |
| Project documentation; Clarity, organization & problem-solving demonstrated    | 10             | Documentation is complete, well-organized, analytical, and shows strong problem-solving          | Documentation complete and clear with some analytical content.            | Documentation on basic with omissions; problem-solving limited. | Documentation missing/poorly organized; no clear problem-solving |

|                                                            |   |                                                                                            |                                                                |                                                                          |                                                                       |
|------------------------------------------------------------|---|--------------------------------------------------------------------------------------------|----------------------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------|
| Communication & Presentation skills                        | 6 | Presentation is confident, structured, and answers queries fully; visuals effective.       | Presentation clear and satisfactory; responds to most queries. | Presentation acceptable but lacks clarity or confidence; weak responses. | Presentation poor or absent; unable to respond.                       |
| Contribution & Benefit to society (impact, sustainability) | 8 | Clear, demonstrable societal benefit and sustainability; realistic path to implementation. | Benefit plausible; sustainability considered with minor gaps.  | Limited or unclear societal benefit; sustainability not well addressed.  | No evident benefit or sustainability; project not community-oriented. |

**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/industry/community               | 16             | Problem and relevance are articulated clearly with strong evidence and context.                 | Problem relevance clear with reasonable evidence.                  | Problem stated but evidence/context weak.                        | Problem poorly defined or irrelevant.                 |
| Formation of problem statement; Engineering approach, innovation & feasibility | 20             | Problem statement is precise; approach demonstrates engineering depth, novelty and feasibility. | Approach is technically sound and feasible with minor limitations. | Approach basic; limited technical depth or feasibility concerns. | No viable engineering approach or infeasible plan.    |
| Interaction with stakeholders; Data collection, analysis & interpretation      | 16             | Excellent stakeholder 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             | Report is comprehensive, technically rigorous, and demonstrates systematic problem-solving.     | Report is complete and technically correct with minor gaps.        | Report lacks technical depth or has notable omissions.           | Report missing key elements or technically incorrect. |

|                                                                       |    |                                                                                                    |                                                                         |                                                                     |                                                      |
|-----------------------------------------------------------------------|----|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------|------------------------------------------------------|
| Communication, Presentation & Viva-voce responses                     | 12 | Candidate presents expertly, defends work persuasively and answers all queries correctly.          | Good presentation and satisfactory answers to most queries.             | Presentation 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 assessment of social impact and sustainability with scaling recommendations. | Reasonable impact 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)  $\geq 40$ . 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.

| SURVEYING AND GEOSPATIAL TECHNIQUES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |                           |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1BCV401                      | 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   |
| <b>Course outcome (Course Skill Set)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |                           |      |
| At the end of the course, the student will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                              |                           |      |
| <div>1. CO1 (L2 – Understand): Explain the basic principles, classifications, and instrumentation of surveying and geospatial techniques used in civil engineering projects.</div> <div>2. CO2 (L3 – Apply): Carry out chain, compass, levelling, theodolite, and tacheometric surveys, record field data systematically, and compute areas, reduced levels, and coordinates.</div> <div>3. CO3 (L3 – Apply): Operate modern surveying instruments such as total station and GNSS/GPS receivers for data acquisition, setting out, and topographic mapping.</div> <div>4. CO4 (L4 – Analyze): Analyze and adjust traverse and levelling data, generate contour plans, and perform volume and alignment computations for engineering works.</div> <div>5. CO5 (L3 – Apply): Interpret aerial photographs, satellite imagery, and basic remote sensing products for terrain evaluation and planning of civil engineering projects.</div> <div>6. CO6 (L4 – Analyze/Evaluate): Integrate GIS with surveying and remote sensing data for spatial analysis, decision-making, and management of civil infrastructure assets.</div> |                              |                           |      |
| Module-1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |                           |      |
| <b>Fundamentals of Surveying and Linear Measurements:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |                           |      |
| <div><div>• Introduction to surveying – definition, objectives, principles (working from whole to part, location by measurements); classification of surveying (plane, geodetic; chain, compass, leveling, theodolite).</div><div>• Linear measurements – direct and indirect methods; instruments (chains, tapes, ranging rods, arrows, pegs); chain surveying principles and field procedures.</div><div>• Measurement of distances on level ground, sloping ground (slope and horizontal distance corrections); errors in chaining and their elimination.</div><div>• Ranging – direct ranging, indirect ranging; obstacles to ranging and chaining; methods of overcoming obstacles.</div><div>• Compass surveying – principles, magnetic meridian, true meridian; bearing systems (whole circle bearing, quadrantal bearing, reduced bearing), Plane Table Surveying.</div><div>• Prismatic compass – construction, temporary adjustments; measurement of bearings; local attraction and its detection and elimination.</div></div>                                                                                     |                              |                           |      |
| Linked COs: CO1,CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              | Number of Hours = 8 hours |      |
| Module-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |                           |      |
| <b>Leveling, Contouring and Theodolite Surveying:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |                           |      |
| <div><div>• Principles of leveling – definitions (level surface, horizontal plane, vertical line, datum, bench mark, reduced level); types of leveling (direct, indirect).</div><div>• Leveling instruments – dumpy level, tilting level, automatic level; components (telescope, bubble tube, leveling head, tripod, Leveling staff,); temporary adjustments.</div><div>• Differential leveling, fly leveling, profile leveling, cross-sectioning; errors in leveling and precautions; curvature and refraction corrections.</div><div>• Contouring – definition, characteristics and uses of contours; contour interval; methods of contouring (direct, indirect); interpolation of contours.</div><div>• Uses of contour maps – determination of indivisibility, gradient, catchment area, capacity of reservoir (qualitative); applications in highway and railway alignment.</div><div>• Theodolite – types (transit, non-transit); parts and functions; temporary adjustments (leveling, centering, elimination of parallax).</div></div>                                                                              |                              |                           |      |
| Linked COs: CO1, CO2, CO6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              | Number of Hours = 9 hours |      |

| <b>Module-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| <b>Total Station, EDM and Curves:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                   |
| <ul style="list-style-type: none"> <li>Electronic Distance Measurement (EDM) – principles of electromagnetic distance measurement; types (microwave, infrared, laser); accuracy and range.</li> <li>Total Station – components and features; integration of electronic theodolite and EDM; coordinate measurement system.</li> <li>Total Station operations – setup and orientation, measurement of coordinates, distance and angles; data recording and download; applications in infrastructure projects.</li> <li>Coordinate systems – local coordinates, grid coordinates; coordinate transformation; azimuth and bearing computations.</li> <li>Curves setting for infrastructure – horizontal curves (simple circular curves); elements of curves; setting curves by offsets, deflection angle method using Total Station.</li> <li>Vertical curves – types (crest, sag); elements; computation of elevations along vertical curves for highway and railway alignment.</li> <li>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.</li> </ul>                                                                                                                                                         |                                   |
| <b>Linked COs: CO2, CO3, CO6.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Number of Hours = 8 hours.</b> |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                   |
| <b>GIS and Remote Sensing:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                   |
| <ul style="list-style-type: none"> <li>Introduction to Geographic Information Systems (GIS) – definition, components (hardware, software, data, people, procedures); spatial and attribute data.</li> <li>GIS data models – vector data (points, lines, polygons), raster data (grid cells, pixels); topology; data structures and formats (shape files, geo databases).</li> <li>Spatial data acquisition – primary sources (field surveys, GPS), secondary sources (maps, aerial photos, satellite imagery); digitization and geo referencing.</li> <li>GIS applications in civil infrastructure – site selection, route optimization for highways/pipelines, urban planning, utility mapping, disaster management.</li> <li><b>Remote sensing fundamentals</b> – electromagnetic spectrum, passive and active remote sensing; platforms (satellite, airborne, UAV).</li> <li>Satellite remote sensing systems – optical sensors (Landsat, Sentinel, Cart sat), radar sensors (SAR); spatial, spectral, temporal, radiometric resolution.</li> <li>Image interpretation and analysis – visual interpretation elements (tone, texture, pattern, shape, size, association); digital image processing (enhancement, classification).</li> <li>Applications of remote sensing in civil engineering – land use/land cover mapping, terrain analysis, infrastructure monitoring, natural resource assessment.</li> </ul> |                                   |
| <b>Linked COs: CO2, CO5, CO6.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Number of Hours = 9 hours.</b> |
| <b>Module-5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                   |
| <b>Advanced Geospatial Technologies for Infrastructure:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                   |
| <ul style="list-style-type: none"> <li>LiDAR (Light Detection and Ranging) technology – principles, components (laser scanner, GPS, IMU); airborne LiDAR, terrestrial LiDAR, mobile LiDAR.</li> <li>LiDAR data products – point clouds, intensity images, Digital Terrain Model (DTM), Digital Surface Model (DSM); classification of point clouds.</li> <li>Applications of LiDAR – corridor mapping for highways/railways, powerline surveys, flood modeling, volume computation, as-built documentation.</li> <li>Integration with Building Information Modeling (BIM) – scan-to-BIM workflows; clash detection between design and as-built; facility management applications.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                   |

- 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:**

#### **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:**

- 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/>

### **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 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 framework (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 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.      | 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                         |

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

**Field Surveying Project / GIS Analysis – Rubric**

| Criterion                                         | Exemplary (3)                                                                                                                                                                                                             | Proficient (2)                                                                                                 | Basic (1)                                                                                                             | Weight |
|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|--------|
| Field data collection And procedure (C01,C02,C03) | 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 (C02,C03,C0)     | 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 (C02, C04)             | 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):**

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.

1. 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.
2. 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.
3. 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:**

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. 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.
3. If the total (CIE + SEE) is less than 40 marks, the student

| <b>WATER SUPPLY AND SANITARY ENGINEERING</b> |                                             |             |      |
|----------------------------------------------|---------------------------------------------|-------------|------|
| Course Code                                  | 1BCV402                                     | Scheme      | 2025 |
| Type of course                               | Integrated Professional Core Courses (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. **C01 (L2 – Understand):** Explain water demand estimation, sources, quality parameters and basic planning considerations for water supply schemes in urban and rural contexts.
2. **C02 (L3 – Apply):** Apply principles of water treatment unit operations (sedimentation, filtration, disinfection) and design simple treatment units for potable water production.
3. **C03 (L4 – Analyze):** Analyse water distribution networks using pipe flow principles, Hardy–Cross method and software tools (EPANET), and evaluate pressure adequacy and losses.
4. **C04 (L3 – Apply):** Apply sanitary engineering principles to design house drainage, sewerage systems and simple sewage pumping and conveyance facilities.
5. **C05 (L4 – Analyze):** Analyse wastewater treatment processes (primary, secondary and tertiary) and their role in environmental protection and public health.
6. **C06 (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: C01, partial C06

Number of Hours: 8 Hrs

### 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:

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| <ul style="list-style-type: none"> <li>Slow sand filters – construction, working, maintenance, advantages and limitations.</li> <li>Rapid gravity filters – media specifications, filter runs, backwashing, head loss considerations;</li> <li>Pressure filters and multi-media filters (overview).</li> </ul> <p><b>Disinfection:</b></p> <ul style="list-style-type: none"> <li>Methods of disinfection – chlorination, ozonation, UV irradiation (qualitative comparison).</li> <li>Chlorination – breakpoint chlorination, chlorine demand, residual chlorine; dosage calculations.</li> <li>Storage and handling of chlorine; safety considerations.</li> </ul> <p><b>Linked COs: CO2, partial CO6</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Number of Hours: 8 Hrs</b> |
| <b>Module-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |
| <p><b>Water Distribution Systems and Network Analysis:</b></p> <p><b>Water Distribution System Layout:</b></p> <ul style="list-style-type: none"> <li>Types of distribution systems – gravity, pumping and combined systems.</li> <li>Layout patterns – tree/branch, grid-iron, ring/loop and radial systems; comparative advantages.</li> <li>Service reservoirs – location, capacity determination (balancing and fire storage).</li> </ul> <p><b>Pipe Materials and Appurtenances:</b></p> <ul style="list-style-type: none"> <li>Pipe materials – CI, DI, HDPE, PVC, GI; selection criteria.</li> <li>Valves – gate, sluice, non-return, air and scour valves; hydrants and service connections.</li> </ul> <p><b>Hydraulic Analysis of Distribution Networks:</b></p> <ul style="list-style-type: none"> <li>Pipe flow fundamentals – Hazen-Williams and Darcy-Weisbach equations; head loss calculations.</li> <li>Pipes in series and parallel – equivalent pipe concept.</li> <li>Looped network analysis – Hardy-Cross method (iterative procedure for simple networks); nodal and loop formulation.</li> </ul> <p><b>CO linkage: CO3, partial CO6</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Number of Hours: 8 Hrs</b> |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |
| <p><b>Sanitary Engineering: House Drainage and Sewerage:</b></p> <p><b>House Drainage and Plumbing:</b></p> <ul style="list-style-type: none"> <li>Objectives and principles of house drainage; sanitary fixtures and traps – water seal, types of traps.</li> <li>Inspection chambers and septic tanks – construction, working and maintenance (qualitative).</li> </ul> <p><b>Sewerage Systems:</b></p> <ul style="list-style-type: none"> <li>Definitions – sewage, sullage, storm water; characteristics of sewage (physical, chemical and biological).</li> <li>Systems of sewerage – separate, combined and partially separate systems; suitability and comparison.</li> <li>Estimation of sewage flow – domestic, commercial, industrial and infiltration contributions; design flow calculations.</li> </ul> <p><b>Sewer Design:</b></p> <ul style="list-style-type: none"> <li>Hydraulic design of sewers – Manning's formula for gravity sewers; minimum and maximum velocities; self-cleansing velocity concept.</li> <li>Design procedure for sanitary sewers – discharge, diameter, slope and velocity determination; worked examples.</li> <li>Sewer appurtenances – manholes, drop manholes, inverted siphons, catch basins, flushing tanks and grease traps (qualitative).</li> </ul> <p><b>Sewage Pumping and Conveyance</b></p> <ul style="list-style-type: none"> <li>Necessity of pumping stations; types, layout and capacity estimation (awareness level).</li> <li>Force mains and rising mains – design considerations.</li> </ul> <p><b>CO linkage: CO4, partial CO6</b></p> | <b>Number of Hours: 9 Hrs</b> |
| <b>Module-5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |
| <p><b>Wastewater Treatment and Sustainable Sanitation</b></p> <p><b>Introduction to Wastewater Treatment</b></p> <ul style="list-style-type: none"> <li>Objectives of wastewater treatment; BOD, COD, suspended solids and nutrients – significance and permissible discharge limits.</li> <li>Treatment stages – preliminary, primary, secondary and tertiary.</li> </ul> <p><b>Preliminary and Primary Treatment</b></p> <ul style="list-style-type: none"> <li>Screening – bar screens, comminutors, grit chambers (types and design considerations).</li> <li>Primary sedimentation tanks – design parameters, detention period, surface overflow rate; scum and sludge removal.</li> </ul> <p><b>Secondary (Biological) Treatment</b></p> <ul style="list-style-type: none"> <li>Principles of biological treatment – aerobic and anaerobic processes.</li> <li>Activated sludge process (ASP) – process description, aeration tank, return sludge, excess sludge; BOD</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                               |

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| <p>removal efficiency (qualitative).</p> <ul style="list-style-type: none"> <li>• Trickling filters – construction, working, dosing and recirculation (overview).</li> <li>• Oxidation ponds and waste stabilisation ponds (awareness level).</li> <li>• Principles of biological treatment – aerobic and anaerobic processes.</li> <li>• Activated sludge process (ASP) – process description, aeration tank, return sludge, excess sludge; BOD removal efficiency (qualitative).</li> <li>• Trickling filters – construction, working, dosing and recirculation (overview).</li> <li>• Oxidation ponds and waste stabilisation ponds (awareness level).</li> </ul> <p><b>Tertiary Treatment and Disinfection</b></p> <ul style="list-style-type: none"> <li>• Nutrient removal – nitrogen and phosphorus removal processes (qualitative).</li> <li>• Disinfection of treated effluent – chlorination and UV methods.</li> </ul> <p><b>Sludge Treatment and Disposal</b></p> <ul style="list-style-type: none"> <li>• Sludge characteristics, thickening, digestion (aerobic and anaerobic), dewatering and drying.</li> </ul> <p><b>Sustainable and Climate-Resilient Sanitation</b></p> <ul style="list-style-type: none"> <li>• Decentralized wastewater treatment systems – community-scale and household treatment.</li> <li>• Nature-based solutions – constructed wetlands, phytoremediation.</li> <li>• Water reuse and resource recovery – nutrient recovery, biogas generation, circular economy principles.</li> <li>• Climate adaptation in sanitation – flood-resilient systems, drought management, linkage to SDG 6, SDG 11 and SDG 13.</li> </ul> <p><b>CO linkage: CO5, CO6</b></p> <p style="text-align: right;"><b>Number of Hours: 9 Hrs</b></p>                                                                                                                                                                          |
| <p><b>PRACTICAL COMPONENTS OF IPCC</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <p><b>FIXED SET OF EXPERIMENTS (LI-28 Hrs)</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ol style="list-style-type: none"> <li>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).</li> <li>2. Measurement of turbidity by nephelometer – comparison with BIS turbidity limits (1 NTU acceptable, 5 NTU permissible).</li> <li>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).</li> <li>4. Determination of total, calcium and magnesium hardness – EDTA titration, linked to BIS hardness limits (200–600 mg/L as CaCO<sub>3</sub>).</li> <li>5. Determination of chlorides in water – argentometric titration, compared with BIS limits (250–1000 mg/L).</li> <li>6. Determination of sulphates and nitrates – spectrophotometric methods, checked against BIS limits (SO<sub>4</sub> 200–400 mg/L, NO<sub>3</sub> 45 mg/L).</li> <li>7. Determination of dissolved oxygen (DO) – Winkler’s iodometric method; foundation for BOD and treatment process design.</li> <li>8. Determination of 5 day BOD of treated/untreated water – incubator method at 20 °C, checking organic pollution relevant to supply from surface sources.</li> <li>9. Jar test for determination of optimum alum (or other coagulant) dose – studying coagulation– flocculation and turbidity removal for conventional treatment plants.</li> <li>10. Determination of percentage of available chlorine in bleaching powder – iodometric titration, to design disinfection dosage.</li> <li>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.</li> <li>12. Breakpoint chlorination and chlorine demand study – preparation of chlorine–residual curve to identify breakpoint dosage for safe disinfection</li> </ol> |
| <p><b>Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):</b></p> <p><b>Textbooks:</b></p> <ol style="list-style-type: none"> <li>1. Birdie, G. S., Birdie, J. S. Water Supply and Sanitary Engineering. Dhanpat Rai Publishing.</li> <li>2. Punmia, B. C., Jain, A. K., Jain, A. K. Water Supply Engineering. Laxmi Publications.</li> <li>3. Garg, S. K. Water Supply Engineering. Khanna Publishers.</li> <li>4. Metcalf &amp; Eddy. Wastewater Engineering: Treatment and Resource Recovery. McGraw-Hill.</li> </ol> <p><b>Reference books / Manuals:</b></p> <ol style="list-style-type: none"> <li>1. Modi, P. N. Water Supply Engineering. Standard Book House.</li> <li>2. Srinivasa Raghavan, Gupta, Environmental Engineering (Vol. I &amp; II). PHI Learning.</li> <li>3. BIS Standards – IS 10500 (Drinking Water), IS 456 (Water for Construction), CPHEEO Manual on Water Supply and Treatment.</li> <li>4. WHO Guidelines for Drinking-water Quality.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

**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 Organization) 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 framework (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Self 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.

**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.                                                                            | <b>MOOC +GATE/Open- Book Track.:</b> Complete selected FM MOOC modules and GATE-style tests, plus at least one integrated open-book exam on conceptual/design problems.                                                                                                      | 25                         |
| 2.                                                                            | <b>Case Study &amp; Literature Portfolio:</b> 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, C06)    | 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 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)      |

**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**

| <b>Component</b>                                 | <b>Description</b>                                                                                                      | <b>Marks</b> |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Allotment of marks for regular class work</b> |                                                                                                                         |              |
| 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     |
| <b>Subtotal</b>                                  |                                                                                                                         | <b>15</b>    |
| <b>Allotment of marks for CIE practical test</b> |                                                                                                                         |              |
| 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      |
| <b>Subtotal</b>                                  |                                                                                                                         | <b>10</b>    |
| <b>Total</b>                                     |                                                                                                                         | <b>25</b>    |
|                                                  |                                                                                                                         |              |

| ANALYSIS OF STRUCTURES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                |                           |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------------------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1BCV403                        | 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   |
| <b>Course outcome (Course Skill Set):</b><br>At the end of the course, the student will be able to:<br><div><div>1.</div><div>CO1 (L2 – Understand): Explain concepts of static determinacy/indeterminacy, stability, and behaviour of beams, trusses and frames under various loadings.</div></div> <div><div>2.</div><div>CO2 (L3 – Apply): Analyse determinate beams, trusses and arches for internal forces, reactions and influence lines using classical methods.</div></div> <div><div>3.</div><div>CO3 (L3 – Apply): Compute deflections of beams and frames using energy methods, moment–area, conjugate beam and unit load methods.</div></div> <div><div>4.</div><div>CO4 (L4 – Analyze): Analyse indeterminate structures using slope–deflection, moment distribution and related classical stiffness concepts.</div></div> <div><div>5.</div><div>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.</div></div> |                                |                           |      |
| Module-1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |                           |      |
| <b>Fundamentals of Structural Analysis:</b><br><div><div>•</div><div>Concept of structure, idealisation of structures; types of structures (beams, trusses, frames, arches), loads and load paths; engineering assumptions.</div></div> <div><div>•</div><div>Stability, static determinacy and indeterminacy; degree of freedom (DOF) and degree of static/kinematic indeterminacy for beams, trusses and frames (simple numerical examples).</div></div> <div><div>•</div><div>Support conditions and their idealisation; load types (point, UDL, UVL, temperature, settlement, lack-of-fit) and load combinations as per typical codes.</div></div> <div><div>•</div><div>Review of basic statics: equilibrium equations, free body diagrams (FBDs), reaction calculations for determinate structures.</div></div> <div><div>•</div><div>Shear force and bending moment diagrams for determinate beams and frames; relation between load, shear and bending moment; concept of points of contraflexure.</div></div>                           |                                |                           |      |
| Linked COs: CO1, CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | Number of Hours: 14 hours |      |
| <b>Analysis of Determinate Structures:</b><br><div><div>•</div><div>Analysis of plane trusses by method of joints and method of sections; zero force members; simple civil examples such as roof and bridge trusses.</div></div> <div><div>•</div><div>Compound and continuous trusses: introduction and illustrative problems.</div></div> <div><div>•</div><div>Three-hinged arches: types (parabolic, circular); determination of reactions; normal thrust, radial shear and bending moment; influence of temperature and support settlement (qualitative).</div></div> <div><div>•</div><div>Influence lines for reactions, shear force and bending moment for determinate beams; Muller–Breslau principle (qualitative and simple numerical examples).</div></div> <div><div>•</div><div>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.</div></div>                                                                        |                                |                           |      |
| Linked COs: CO1, CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | Number of Hours: 14 hours |      |
| Module-3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |                           |      |
| <b>Deflection of Beams and Frames:</b><br><div><div>•</div><div>Differential equation of the elastic curve for beams (concept); relation between bending moment, slope and deflection.</div></div> <div><div>•</div><div>Moment–area theorems: derivation (statement and proof) and application to computation of slope and deflection of simply supported, cantilever and overhanging beams.</div></div> <div><div>•</div><div>Conjugate beam method: concept of conjugate beam, fixed and free ends; application to standard beam configurations.</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                |                           |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| <ul style="list-style-type: none"> <li>Energy methods: strain energy in axial, flexural and torsional members; Castigliano's theorems (statement only) and use for deflection of beams and pin-jointed trusses.</li> <li>Unit load (dummy load) method for deflection of determinate beams and simple frames (single displacement).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                   |
| <b>Linked COs: CO2, CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Number of Hours : 14 hours</b> |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                   |
| <b>Analysis of Indeterminate Structures (Classical Methods):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                   |
| <ul style="list-style-type: none"> <li>Concept of indeterminacy; review of compatibility conditions and force/displacement relations; introduction to flexibility and stiffness.</li> <li>Clapeyron's theorem of three moments and its application to continuous beams (with and without support settlements).</li> <li>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).</li> <li>Moment distribution method: basic idea, carry-over and distribution factors; analysis of continuous beams and simple portal frames, including sway (numerical examples).</li> <li>Qualitative discussion of side-sway, drift and stiffness concepts in multi-storey frames; relation to modern computer-based analysis (no detailed numericals).</li> </ul> |                                   |
| <b>Linked COs: CO3, CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Number of Hours : 14 hours</b> |
| <b>Module-5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                   |
| <b>Matrix Methods of Structural Analysis:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                   |
| <ul style="list-style-type: none"> <li>Basic matrix operations required in structural analysis: vectors and matrices, transposition, partitioning, assembly idea (no rigorous linear algebra).</li> <li>Element stiffness matrix for axially loaded bar and prismatic beam elements in local coordinates; nodal DOFs, nodal forces and nodal displacements.</li> <li>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.</li> <li>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).</li> </ul>                                                                                          |                                   |
| <b>Linked COs: CO4, CO5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Number of Hours : 14 hours</b> |
| <b>Suggested Learning Resources</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                   |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |
| <ol style="list-style-type: none"> <li>Ghali, A., Neville, A. M., &amp; Brown, T. G., "Structural Analysis – A Unified Classical and Matrix Approach", Latest edition.</li> <li>Reddy, C. S., "Basic Structural Analysis", Tata McGraw-Hill.</li> <li>Bhavikatti, S. S., "Structural Analysis – Vol. 1 and Vol. 2", New Age / Vikas.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                   |
| <b>Reference Books / Manuals</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                   |
| <ol style="list-style-type: none"> <li>Hibbeler, R. C., "Structural Analysis", Pearson.</li> <li>Wang, C. K., "Intermediate Structural Analysis", McGraw-Hill.</li> <li>Gere, J. M. &amp; Weaver, W., "Matrix Analysis of Framed Structures", Cengage / CBS.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                   |
| <b>Web links and Video Lectures (e Resources)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                   |
| <ol style="list-style-type: none"> <li>NPTEL: "Structural Analysis I", "Structural Analysis II", "Advanced Structural Analysis" – lecture series with examples and assignments aligned to Indian civil engineering curricula.</li> <li>Other MOOCs / OCW: "Structural Analysis", "Matrix Methods of Structural Analysis" for additional concept explanation, computational labs and problem practice.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                   |

**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.

| <b>Term Work (TW) and Self Learning (SL) components in<br/>Number of Hours per semester</b>                      |                                                                                                                                                                                                                                                                                                                                                  |                            |
|------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 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.                                                                                                               | <b>Activity A – Influence Line and Moving Load Study (CO2, CO3):</b> 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.                                                                                                               | <b>Activity B – Portal Frame Behaviour Mini-Project (CO3, CO4):</b> 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.                                                                                                               | <b>Activity C – Matrix Analysis Workbook (CO4, CO5):</b> 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                         |

**Sample Rubrics for a Learning Activity (e.g., Activity A: Influence Line and Moving Load Study)**

| Criterion                                   | Level 4 – Excellent                                                        | Level 3 – Good                      | Level 2 – Fair                                  | Level 1 – Needs Improvement                       |
|---------------------------------------------|----------------------------------------------------------------------------|-------------------------------------|-------------------------------------------------|---------------------------------------------------|
| Problem understanding (CO2)                 | Beam, supports and load cases clearly and correctly defined.               | Mostly correct; minor omissions.    | Basic attempt; some incorrect assumptions.      | Beam/problem not clearly defined.                 |
| Influence lines (CO2, CO3)                  | Correct and neat influence lines with key ordinates accurate.              | Largely correct; minor errors.      | Partially correct; several mistakes.            | Incorrect or missing diagrams.                    |
| Response envelopes and interpretation (CO3) | Correct determination of maximum effects with clear comments on structural | Mostly correct; limited commentary. | Some correct calculations; interpretation weak. | Wrong calculations; no meaningful interpretation. |

| Criterion                                                             | Level 4 – Excellent                                                                                                                         | Level 3 – Good                                                                                  | Level 2 – Satisfactory                                                                   | Level 1 – Needs Improvement                                                          |
|-----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Conceptual understanding of structural behaviour (C01, C02, C03)      | Accurately explains determinacy, stability, internal forces, deflection concepts and matrix basics; uses correct terminology and relations. | Mostly correct concepts; minor gaps or imprecise terms that do not affect the main reasoning.   | Partial understanding; some key ideas (e.g., sway, ILD, stiffness) unclear or mixed up.  | Significant misconceptions about basic concepts, equilibrium or structural response. |
| Problem-solving method and procedure (C02, C03, C04, C05)             | Chooses appropriate method (classical/matrix), follows a logical sequence with correct equations and assumptions, reaches correct solution. | Uses appropriate method with mostly correct steps; a few slips but approach is clearly valid.   | Method partially correct; several errors or missing steps, but some progress evident.    | Wrong or no method; random substitutions or solutions unrelated to the question.     |
| Representation (diagrams, ILDs, FBDs and sign conventions) (C02, C03) | Draws clear, well-labelled FBDs, SFD/BMD, influence lines and deformation sketches with correct sign conventions and scales.                | Diagrams mostly correct and legible; minor mistakes in labels, scales or sign convention.       | Diagrams present but with multiple inaccuracies; understanding only partly visible.      | Diagrams missing, very untidy or fundamentally incorrect; hinders understanding.     |
| Interpretation of results and structural insight (C03, C04, C05)      | Correctly interprets reactions, internal forces, deflections and member forces; comments on safety, serviceability and modelling limits.    | Interpretation generally correct with minor omissions in commenting on behavior or limitations. | Limited interpretation; mainly presents numbers without connecting to structural action. | No meaningful interpretation; comments incorrect or absent.                          |
| Organization, clarity and presentation (P010, C05)                    | Solution is well-structured, neat and easy to follow; symbols and steps are consistently used and highlighted.                              | Generally, organized and readable; minor jumps in steps or inconsistent notation.               | Understandable but poorly formatted or untidy; some difficulty in following the logic.   | Disorganized, hard to read, or incomplete; key steps missing or illegible.           |

**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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1BCV404                        | 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):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)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                |             |                     |
| <ol style="list-style-type: none"> <li>At the end of the course, the student will be able to:</li> <li>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.</li> <li>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.</li> <li>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.</li> <li>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.</li> <li>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.</li> <li>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.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |             |                     |
| Module-1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |             |                     |
| <b>BIM Fundamentals, Roles, Stakeholders and Responsible Use:</b> <ul style="list-style-type: none"> <li>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.</li> <li>Built-asset lifecycle: stages include strategic definition, briefing, design, coordination, procurement, construction, commissioning, handover, operation, and renewal.</li> <li>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.</li> <li>Stakeholder engagement in BIM: roles of owner/client, consultant, designer, engineer, quantity surveyor, planner, contractor, subcontractor, supplier, facility manager, and public authority.</li> <li>BIM uses across stages: visualization, coordination, quantity take-off, 4D/5D planning, logistics, safety, fabrication, handover, facility management, sustainability, and digital twin readiness.</li> <li>Software and hardware selection: based on BIM use, data needs, interoperability, exchange formats, project scale, accessibility, cost, and suitability for teaching.</li> <li>Indian BIM context: influenced by BIS/IBC/CPWD; challenges include fragmented delivery, weak information requirements, unclear roles, CDE misuse, handover gaps, and uneven maturity.</li> <li>Benefits, limitations, and responsible use: avoid over-reliance on software, BIM washing, false model certainty, overmodelling, and superficial template-based compliance.</li> <li>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.</li> </ul> |                                |             |                     |
| Linked COs: CO1, CO5, CO6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |             | Number of Hours: 08 |
| Module-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                |             |                     |
| <b>Information Modelling, BIM Model Structure and Model Generation:</b> <ul style="list-style-type: none"> <li>Information modelling types: object-based, spatial, attribute/property, relationship, classification, workflow/process, requirement-based, exchange-based, database/query-based, geospatial, and time-cost modelling.</li> <li>BIM model structure: hierarchy includes project, site, facility/building, storey/level, zone, space, system, element, type, asset, and associated documents.</li> <li>Graphical and non-graphical data: geometry along with properties, quantities, materials, specifications, asset tags, cost codes, maintenance data, and document links.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                |             |                     |

- 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****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****Module-4****OpenBIM, IFC, MVD, CDE, Interoperability, Coordination and Validation:**

- OpenBIM 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: C04, C05, C06****Number of Hours: 09****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: C01, C05, C06****Number of Hours: 09****Suggested Learning Resources:**

Text books / core references:

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.

**Indian and standards-oriented references:**

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. buildingSMART International resources on IFC, BCF, IDS, bSDD, openBIM and professional learning outcomes.
6. buildingSMART Global IFC Mandates and public openBIM case studies.
1. 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. buildingSMART 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.
2. 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 inspection      | BIMvision, Open IFC Viewer, usBIM.viewer, IFC.js/web-ifc viewers; standard lab PCs                        | Open, inspect and review IFC models; 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.
- 9. Use reflective activities on BIM risks, software dependence, overmodelling, false model certainty and handover failures.

#### **Assessment Structure (both CIE and SEE) :**

The weightage assigned to Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) shall be 50% each. A student shall secure a minimum of 50% of the maximum marks prescribed for CIE and a minimum of 40% of the maximum marks prescribed for SEE to be eligible for a pass in the course.

A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject /course only if he/she secures not less than 50% of the aggregate marks obtained in CIE and SEE taken together.

#### **Continuous Internal Evaluation (CIE):**

(i) The CIE marks shall be decided based on internal tests and 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 and the second 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 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 SEE.

#### **Passing requirement in SEE:**

(i) For a pass in the SEE, a student shall secure a minimum of 35 marks out of 100 before scaling, or as prescribed by VTU rules applicable to the scheme.

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

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

#### **Students activities for TW/SL under NCrF: Samples only**

As per NCrF, students shall spend 90 hours for a 3-credit course, including course instruction and term work/self-learning. The following indicative activities may be used as CCA components and evaluated using rubrics.

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

| Sl. No. | Term Work (TW) Activity - module-wise practical work                                                                                                                        | Hours |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1       | Module 1 practical: stakeholder-role map, BIM-use map, RACI/RASCI awareness and software/hardware suitability note for a small project.                                     | 25    |
| 2       | Module 2 practical: inspect a sample model/IFC and context dataset; identify information modelling type, generation method, hierarchy, properties and reliability gaps.     | 25    |
| 3       | Module 3 practical: create or update a simple model, generate drawings/schedules/quantities, export/inspect IFC and record lab software/hardware setup.                     | 25    |
| 4       | Module 4 practical: interoperability exercise using IFC/MVD awareness, property checks, BCF-style issue log, CDE status/revision workflow and validation note.              | 25    |
| 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. | 25    |
| Sl. No. | Self-Learning (SL) Activity                                                                                                                                                 | Hours |
| 1       | Complete online/tutorial exposure on BIM fundamentals, openBIM, IFC viewing, Bonsai/BlenderBIM, FreeCAD BIM, IfcOpenShell basics, QGIS and CDE workflow.                    | 25    |

|   |                                                                                                                                                                    |    |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 2 | Prepare a short comparative note on BIM software and hardware selection for viewing, authoring, coordination, reality capture, VDC/IDD and handover use cases.     | 25 |
| 3 | Review IFC/MVD/BCF/IDS/COBie/bSDD concepts using buildingSMART and open-source documentation and prepare a simple interoperability checklist.                      | 25 |
| 4 | Case-study review of Indian and international BIM/digital-construction implementation, including stakeholder benefits, risks, data security and handover failures. | 25 |

#### Rubrics for Student Learning Activities - TW/SL (Sample)

| Criterion                                                                   | Exemplary (3)                                                                                                                                                                      | Proficient (2)                                                                                    | Basic (1)                                                                          | Weight |
|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|--------|
| BIM role, stakeholder, use-case and tool-selection logic (C01, C06)         | 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 (C02, C03)      | 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 (C04, C05) | 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 (C03, C05, C06)              | 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 organization and communication                                    | 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%    |

| <b>SURVEYING AND GEOSPATIAL ENGINEERING LABORATORY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  | Scheme      | 2025 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>1BCVL405</b>  | 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)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Practical</b> | Exam Hours  | 03   |
| <b>Course outcome (Course Skill Set)</b><br>At the end of the course, the student will be able to: <ol style="list-style-type: none"> <li>CO1: Use basic surveying instruments and perform field observations for linear and angular measurements. (L3)</li> <li>CO2: Determine elevations, contours, and site features using leveling and tacheometric methods. (L3)</li> <li>CO3: Conduct topographic and route surveys using modern surveying techniques. (L3)</li> <li>CO4: Process survey data and prepare plans, sections, and geospatial outputs. (L4)</li> <li>CO5: Apply geospatial tools, GPS/GNSS, and digital mapping concepts for civil engineering applications. (L3)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                  |             |      |
| <b>Note:</b> <ol style="list-style-type: none"> <li>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.</li> <li>Both PART-A and PART-B are considered for CIE and SEE.</li> <li>Students have answer 1(one) question from PART-A and 1(one) question from PART-B.               <ol style="list-style-type: none"> <li>The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for <b>70 marks</b> out of the maximum 100 marks.</li> <li>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 <b>30 marks</b>.</li> </ol> </li> <li>For Continuous Internal Evaluation (CIE) during the semester, classwork shall typically include open-ended questions from <b>Part-B</b>, along with other similar questions designed to enhance the students' skills.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |             |      |
| <b>PART – A<br/>FIXED SET OF EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |             |      |
| <ol style="list-style-type: none"> <li><b>Chain surveying.</b> <ul style="list-style-type: none"> <li>Measurement of a simple field by chain and tape, including offsets and sketch preparation.</li> </ul> </li> <li><b>Compass surveying.</b> <ul style="list-style-type: none"> <li>Traversing with compass, observation of bearings, and computation of included angles.</li> </ul> </li> <li><b>Levelling.</b> <ul style="list-style-type: none"> <li>Fly levelling and check levelling using dumpy or automatic level; reduction of levels by H.I. or rise and fall method.</li> </ul> </li> <li><b>Theodolite experiment.</b> <ul style="list-style-type: none"> <li>Measurement of horizontal and vertical angles using theodolite.</li> </ul> </li> <li><b>Tacheometry Experiment</b> <ul style="list-style-type: none"> <li>To determine horizontal distances and elevations of points by tacheometric methods</li> </ul> </li> <li><b>Study of Total Station.</b> <ul style="list-style-type: none"> <li>Identification of parts, temporary adjustments, setting up, centring, levelling, and instrument operation.</li> </ul> </li> <li><b>Traverse using Total Station.</b> <ul style="list-style-type: none"> <li>Observation of angles and distances, computation of coordinates, and checking traverse closure.</li> </ul> </li> <li><b>Remote height and distance using Total Station.</b> <ul style="list-style-type: none"> <li>Determination of inaccessible height/distance of a point, building, or object.</li> </ul> </li> <li><b>GPS survey.</b> <ul style="list-style-type: none"> <li>Recording coordinates of survey points using GPS and understanding absolute/differential positioning.</li> </ul> </li> </ol> |                  |             |      |
| <b>PART – B<br/>OPEN ENDED EXPERIMENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |             |      |

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) (P01)                       | 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) (P02 & P03)                  | 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) (P03 & P08)                        | 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) (P04)                           | 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) (P09)                               | 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 INFORMATION MODELING (BIM) LAB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                            |             |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1BCVL406A                                  | Scheme      | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Ability Enhancement Course<br>(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   |
| <b>Course outcome (Course Skill Set):</b><br><b>At the end of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>CO1 (L3 – Apply): Apply BIM software tools to create and modify 3D building models.</li> <li>CO2 (L3 – Apply): Develop architectural, structural, and service models using standard BIM workflows.</li> <li>CO3 (L4 – Analyze): Analyze model elements, coordination issues, and clashes using BIM tools.</li> <li>CO4 (L3 – Apply): Generate drawings, schedules, quantities, and basic reports from BIM models.</li> <li>CO5 (L4 – Analyze): Interpret BIM outputs for planning, coordination, and construction documentation.</li> <li>CO6 (L5 – Evaluate): Evaluate BIM-based digital workflows for integrated project delivery and professional communication.</li> </ol>                                                                                                                                                                                                                                                                                                                                                             |                                            |             |      |
| <b>SET OF EXPERIMENTS (LI =28 hours)</b> <ol style="list-style-type: none"> <li>Introduction to BIM environment, interface, templates, and project setup.</li> <li>Creation of levels, grids, and basic building elements in BIM software.</li> <li>Development of 3D architectural model for a simple residential building.</li> <li>Modeling of walls, doors, windows, floors, roofs, and stairs.</li> <li>Creation of structural model with columns, beams, slabs, and foundations.</li> <li>Preparation of basic MEP/service layout and coordination with architectural model.</li> <li>Generation of floor plans, elevations, sections, and working drawings.</li> <li>Development of material schedules, door-window schedules, and room schedules.</li> <li>Extraction of quantities and basic BOQ from the BIM model.</li> <li>Detection and resolution of clashes among architectural, structural, and service components.</li> <li>Application of annotations, tags, dimensions, and sheet preparation.</li> <li>Visualization through walkthroughs, render views, and presentation sheets.</li> <li>Preparation of a simple BIM-based project report and presentation.</li> </ol> |                                            |             |      |
| <b>Suggested Learning Resources:</b><br><b>Textbooks:</b> <ol style="list-style-type: none"> <li>Eastman, C., Teicholz, P., Sacks, R., and Liston, K., <i>BIM Handbook: A Guide to Building Information Modeling</i>, Wiley.</li> <li>McPhee, A., <i>Building Information Modeling for Dummies</i>, Wiley.</li> <li>Sacks, R., Eastman, C., Lee, G., and Teicholz, P., <i>BIM Handbook</i>, Wiley.</li> <li>Brad Hardin, <i>BIM and Construction Management</i>, Wiley.</li> <li>Krygiel, E. and Nies, B., <i>Green BIM: Successful Sustainable Design with Building Information Modeling</i>, Wiley.</li> </ol> <b>Reference Books</b> <ol style="list-style-type: none"> <li>Smith, P., and Tardif, M., <i>Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers</i>, Wiley.</li> <li>Shelden, D., <i>BIM: Design, Construction and Operations</i>, various editions.</li> <li>Lu, Y., and Korman, T., <i>BIM and Integrated Design</i>, Routledge.</li> <li>Chuck Eastman et al., <i>BIM Handbook</i>, Wiley.</li> <li>Related manuals of Revit / Archicad / Tekla / Navisworks.</li> </ol>             |                                            |             |      |

**Web links and Video Lectures (e-Resources):**

1. Autodesk Revit official documentation.
2. BIM forums and professional tutorials.
3. NPTEL resources on BIM and digital construction.
4. National and international BIM standards and workflow guides.

**Software Tools:**

**A. Commercial BIM Software**

| Software                        | Best For                                                                                                 | Key Features                                                                                                    | Education Access                                          |
|---------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Autodesk Revit                  | Industry standard for large commercial projects, MEP coordination, construction documentation Snap Trude | Dominant platform in North America & developed markets; deepest ecosystem with AEC Collection bundle snap Trude | Free student license (up to 3 years)                      |
| Graphisoft ArchiCAD             | Design-focused mid-scale commercial work, Mac-based studios                                              | Strong design workflow; native Mac support; Open BIM interoperability Snap Trude                                | Free ArchiCAD EDU license for non-commercial academic use |
| Bentley Open Buildings Designer | Large infrastructure & complex assets                                                                    | Scale and infrastructure depth for major projects                                                               | Educational licenses available                            |

**B. Open-Source BIM Software**

| Software              | Best For                                                         | Key Features                                                                                     | License               |
|-----------------------|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------|
| Blender BIM (Bonsai)  | Native IFC authoring, Open BIM workflows                         | Only tool with native IFC modeling; add-on for Blender; IFC/BCF/IDS support                      | GNU GPL (free)        |
| FreeCAD BIM Workbench | Beginner-friendly parametric CAD, BIM modeling                   | BIM workbench matured significantly since 2022; open-source parametric platform                  | GPL-2.0 (free)        |
| BIMserver.org         | BIM collaboration & project management cloudsmallbusinessservice | Open-source BIM server for dynamic AEC collaboration; supports IFC/BCF cloudsmallbusinessservice | GNU Affero GPL (free) |

**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)      |

| WATER DISTRIBUTION NETWORK MODELLING WITH EPANET LAB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                         |             |      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1BCVL406B                               | 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   |
| <b>Course outcome (Course Skill Set)</b><br><b>At the end of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>CO1 (L3 – Apply): Use EPANET to create and edit water distribution network models, define junctions, pipes, reservoirs, pumps and demands.</li> <li>CO2 (L3 – Apply): Run hydraulic and water quality simulations and extract node/pipe results (pressure, flow, head, quality).</li> <li>CO3 (L4 – Analyze): Analyze simulation outputs to identify low pressure zones, bottlenecks, and mass balance issues.</li> <li>CO4 (L4 – Analyze): Calibrate a simple distribution network model using field data and demand patterns.</li> <li>CO5 (L3 – Apply): Develop scenario analyses (pipe closure, pump scheduling, demand growth) and compare results.</li> <li>CO6 (L5 – Evaluate): Evaluate operational strategies (leak detection prioritization, pressure management, emergency response) and prepare a professional lab report with recommendations.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                         |             |      |
| <b>SET OF EXPERIMENTS (LI =28 hours)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                         |             |      |
| <ol style="list-style-type: none"> <li>EPANET introduction, software interface, creating a new project, units and network elements (junctions, pipes, tanks, reservoirs, pumps, valves).</li> <li>Create a small example network (5–10 nodes), assign demands and run steady state hydraulic analysis; interpret node pressures and pipe flows.</li> <li>Visualizing results: contours, pipe flow arrows, node reports and time series plots for hydraulic variables.</li> <li>Demo: reservoir/tank modeling and extended period simulation (EPS) basics (demand patterns, time steps).</li> <li>Pump curves and patterns: modeling variable speed pumps and simple pump scheduling.</li> <li>Valves (PRV, PSV) and their effects on network hydraulics; pressure control scenarios.</li> <li>Water quality simulation basics: constituent setup, reaction coefficients, and tracing a conservative tracer.</li> <li>Leak / closed pipe scenario: simulate pipe closure and identify alternate flows and critical links.</li> <li>Pipe roughness, Hazen Williams coefficient sensitivity study and its effect on pressures and flows.</li> <li>Demand estimation: create/modify diurnal demand patterns and analyze peak vs base conditions.</li> <li>Model calibration exercise: compare simulated vs provided field pressures/flows, adjust demands or roughness to improve fit.</li> <li>Scenario analysis: demand growth or fire flow requirement simulation and identify required upgrades.</li> </ol> |                                         |             |      |
| <b>Suggested Learning Resources:</b><br><b>Textbooks:</b> <ol style="list-style-type: none"> <li>Rossman, L. A. <i>EPANET 2 Users Manual</i> / EPANET technical documentation. This is the core reference for hydraulic and water quality modelling in EPANET.</li> <li>Walski, T. M., et al. <i>Advanced Water Distribution Modeling and Management</i>. A useful reference for network analysis, calibration, and operational studies.</li> <li>Mays, L. W. <i>Water Distribution Systems Handbook</i>. Helpful for design principles, pressure management, and system planning.</li> <li>AWWA manuals and selected civil engineering water supply texts for distribution network fundamentals and practical design guidance.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                         |             |      |

**Reference Books**

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.

**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.

**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) (P01)      | 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) (P02 & P03) | 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) (P03 & P08)       | 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<br>(5) (P04) | 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)<br>(P09)     | 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)      |

| DRONE-BASED PHOTOGRAMMETRY LAB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                         |             |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1BCVL406C                               | 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   |
| <b>Course outcome (Course Skill Set)</b><br><b>At the end of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>CO1 (L3 – Apply): Apply unmanned aerial vehicle (UAV) flight planning and image acquisition procedures for photogrammetric data collection in civil engineering contexts.</li> <li>CO2 (L3 – Apply): Implement image pre-processing, geotagging, and basic control point workflows using photogrammetry software and spreadsheets.</li> <li>CO3 (L4 – Analyze): Analyze image overlap, ground control placement, and processing parameters to produce orthophotos and digital surface models (DSMs).</li> <li>CO4 (L3 – Apply): Develop simple quantity extraction and area/volume estimation sheets from orthomosaics using GIS/spreadsheet tools.</li> <li>CO5 (L4 – Analyze): Interpret outputs (orthomosaic, DSM, point cloud) to assess accuracy, detect errors, and suggest corrective actions for engineering decisions.</li> <li>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.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                         |             |      |
| <b>SET OF EXPERIMENTS (LI =28 hours)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                         |             |      |
| <ol style="list-style-type: none"> <li>Introduction to UAV systems and payloads, safety, regulatory considerations, and basic mission planning for photogrammetry.</li> <li>Flight planning exercise: defining ground sampling distance (GSD), image overlap, flight altitude, and camera settings using mission-planning software.</li> <li>Ground control points (GCP) procedure: marking, surveying (use of total station/GNSS demo), and recording coordinates for photogrammetric control.</li> <li>Conducting a supervised field flight (simulated or live depending on approvals) to collect nadir imagery for a small test site.</li> <li>Image pre-processing: geotagging, image quality checks, deblurring, and organizing datasets using folder/spreadsheet records.</li> <li>Image alignment and sparse/dense point cloud generation in photogrammetry software; interpretation of tie-point distribution and alignment reports.</li> <li>Generating orthomosaic and digital surface model (DSM) products and understanding projection/coordinate systems.</li> <li>Accuracy assessment: using GCPs and check-points to compute RMSE and prepare a short accuracy summary in a spreadsheet.</li> <li>Extraction of planimetric features (contours, roads, boundaries) from orthomosaics and basic vectorization.</li> <li>Volume/area estimation: calculate cut/fill and stockpile volumes from DSMs and capture results in a quantity-estimation spreadsheet.</li> <li>Creating a simple inspection report: measuring cracks, roof areas, or drainage features from orthophotos and preparing annotated figures.</li> <li>Integration exercise: combine photogrammetric outputs with existing GIS layers and produce a comparative thematic map.</li> <li>Preparation and presentation of a final lab report/portfolio that includes datasets, processing steps, spreadsheets (quantity &amp; accuracy sheets), orthomosaics, DSMs, and interpretation.</li> </ol> |                                         |             |      |

**Suggested Learning Resources:****Textbooks:**

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 and e-Resources :**

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.**

**Suggested rubrics for Practical continuous assessment:**

| Performance Indicator                | Excellent                                                                                                                                                  | Very Good                                                                                                               | Good                                                                                      | Satisfactory                                         |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------------------------------------------|
| Fundamental Knowledge (4) (P01)      | 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) (P02 & P03) | 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) (P03 & P08)       | 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<br>(5) (P04) | 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<br>(8)<br>(P09)  | The lab record is well-organized, with clear sections (e.g., Introduction, Method, Results, Conclusion). Transitions between sections are smooth.<br>(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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1BCVL406D                               | 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   |
| <b>Course outcome (Course Skill Set)</b><br><b>At the end of the course, the student will be able to:</b> <ol style="list-style-type: none"> <li>CO1 (L3 – Apply): Perform standard tests on bricks, timber, cement, fine aggregate, and coarse aggregate using relevant procedures and equipment.</li> <li>CO2 (L3 – Apply): Determine physical properties and strength characteristics of building materials and compute required test results accurately.</li> <li>CO3 (L4 – Analyze): Interpret test data to assess suitability of materials for construction applications.</li> <li>CO4 (L4 – Analyze): Compare material properties with relevant specifications and identify defects or deviations.</li> <li>CO5 (L5 – Evaluate): Recommend appropriate materials for specific construction uses based on test outcomes and field observations.</li> <li>CO6 (L5 – Evaluate): Prepare a professional laboratory record with observations, calculations, conclusions, and viva voce responses.</li> </ol>                                                               |                                         |             |      |
| <b>SET OF EXPERIMENTS (LI =28 hours)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                         |             |      |
| <ol style="list-style-type: none"> <li>Water absorption and compression test on bricks.</li> <li>Bulking of sand.</li> <li>Sieve analysis of fine aggregate.</li> <li>Specific gravity and moisture content test on fine aggregate.</li> <li>Impact strength test on coarse aggregate.</li> <li>Crushing test on coarse aggregate.</li> <li>Standard consistency test on cement.</li> <li>Fineness test on cement.</li> <li>Initial and final setting time test on cement.</li> <li>Compressive strength test on cement mortar and concrete cubes.</li> <li>Flexural test on timber.</li> <li>Tensile test on steel</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                         |             |      |
| <b>Suggested Learning Resources:</b><br><b>Textbooks:</b> <ol style="list-style-type: none"> <li>M. L. Gambhir and Neha Jamwal, <i>Building and Construction Materials: Testing and Quality Control</i>, McGraw Hill Education (India) Pvt. Ltd..</li> <li>Davis, Troxell and Hawk, <i>Testing of Engineering Materials</i>, McGraw Hill Book Co..</li> <li>C. B. Kukreja, K. Kishore and Ravi Chawla, <i>Material Testing Laboratory Manual</i>, Standard Publishers &amp; Distributors..</li> <li>A. K. Suryanarayana, <i>Testing of Metallic Materials</i>, Prentice Hall of India Pvt. Ltd..</li> <li>K. A. Holes, <i>Experimental Strength of Materials</i>, English Universities Press Ltd..</li> <li>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</li> <li>Laboratory Manual on Testing of Engineering Materials by H. S. Sood, Standard technical publication, ISBN: 9788180140990</li> </ol> |                                         |             |      |

**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.

**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)<br>(P09) | 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) |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|

| BIOLOGY FOR CIVIL ENGINEERS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                            |                      |      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------|------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1BCV407                    | Scheme               | 2025 |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Basic Science Course (BSC) | Semester             | III  |
| Teaching Hours/Week (L:T:P)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 70(3:2:0)                  | CIE Marks            | 50   |
| Total Hours of Pedagogy per semester<br>CI (L /T) :LI(P):SL&TW:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 120(42:28:0:50)            | SEE Marks            | 50   |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 4                          | Total Marks          | 100  |
| Examination type (SEE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Theory                     | Exam Hours           | 03   |
| <div>1. CO1 (L2): Explain fundamental biological concepts relevant to civil engineering (microbial ecology, plant-soil interactions, ecosystem services).</div> <div>2. CO2 (L3): Apply biological principles to classify and select suitable biological treatments and green infrastructure options for water, soil and waste management.</div> <div>3. CO3 (L3): Apply methods for basic site biological characterization (microbial indicators, soil biology, vegetation surveys) and interpret simple results.</div> <div>4. CO4 (L4): Analyse performance and limitations of biological systems (constructed wetlands, phytoremediation, bioreactors) under field-relevant conditions.</div> <div>5. CO5 (L5): Evaluate sustainability, regulatory and safety aspects and propose biologically informed solutions for simple civil engineering case studies.</div> |                            |                      |      |
| Module-1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |                      |      |
| Fundamentals of Biology for Civil Engineers:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                            |                      |      |
| <div><div>• Topics: Cells, microbes and communities; basics of microbial metabolism and catabolic pathways; plant physiology relevant to phytoremediation; soil biology and ecosystem services.</div><div>• Learning focus: key terms, concepts and relevance to infrastructure and environmental systems.</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                            |                      |      |
| Linked COs: CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                            | Number of Hours: 06  |      |
| Module-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |                      |      |
| Biological Processes in Water and Waste Treatment:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                            |                      |      |
| <div><div>• Topics: Microbial processes for wastewater treatment (aerobic/anaerobic digestion, biofilms, nitrification/denitrification), natural and engineered treatment wetlands, biofilm reactors and basic reactor concepts.</div><div>• Learning focus: process mechanisms, design parameters (DO, retention time, SRT), simple performance indicators.</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |                      |      |
| Linked COs: CO2, CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            | Number of Hours: 06  |      |
| Module-3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |                      |      |
| Soil, Groundwater and Solid Waste Biology:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |                      |      |
| <div><div>• 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.</div><div>• Learning focus: when biology can remediate vs when engineering controls are needed.</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                            |                      |      |
| Linked COs: CO2, CO3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                            | Number of Hours: 06. |      |
| Module-4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |                      |      |
| Field Characterization, Monitoring and Data Interpretation:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                            |                      |      |
| <div><div>• 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.</div><div>• Learning focus: sampling design, data interpretation and uncertainty.</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                            |                      |      |
| Linked COs: CO3, CO4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                            | Number of Hours: 05. |      |
| Module-5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |                      |      |
| Field Characterization, Monitoring and Data Interpretation:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                            |                      |      |
| <div><div>• 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.</div><div>• Learning focus: sampling design, data interpretation and uncertainty.</div></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                            |                      |      |
| Linked COs: CO3, CO4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                            | Number of Hours: 05  |      |

**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/ Self 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.                                                                                                               | <b>Group mini-project — Pilot design of a small biological treatment/green solution (CO<sub>2</sub>, CO<sub>3</sub>, CO<sub>5</sub>):</b> Students form teams (3–4) to design a pilot constructed wetland, phytoremediation bed or small bioreactor for a given site/problem<br><b>Task:</b> site description, selection of biological method, process flow diagram, basic sizing/retention time estimate, monitoring plan, short cost & sustainability note. | 16                         |
| 2.                                                                                                               | <b>Field visit and structured report:</b> Visit a local wastewater treatment plant, constructed wetland, landfill or composting facility to observe biological processes in practice.<br><b>Task:</b> 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.                                                                                                               | <b>Tool / software exploration assignment:</b> 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 team members is evident.                                       | Minor imbalance in contribution.                       | Uneven participation with limited evidence.              | Poor teamwork or little contribution.          |

**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                                                 | <b>1BEP408</b>                    | Scheme      | <b>2025</b> |
| Type of Course                                              | Societal Development Course (SDC) | Semester    | IV          |
| Teaching Hours/Week (L:T:P)                                 | 28 (0:0:2)                        | CIE Marks   | 50          |
| Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL | 30 (0:0:28:2)                     | SEE Marks   | 50          |
| Credits                                                     | <b>1</b>                          | Total Marks | 100         |
| Examination type (SEE)                                      | <b>Theory</b>                     | 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. **C01 (L2 – Understand):** Identify and analyse environmental problems through field interaction and technical assessment.
2. **C02 (L3 – Apply):** Develop skills in project planning, field survey, data collection, implementation, documentation and reporting.
3. **C03 (L4 – Analyze):** Formulate feasible environmental problem statements and solutions considering practical constraints and sustainability aspects.
4. **C04 (L3 – Apply):** Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.
5. **C05 (L4 – Analyze):** Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.
6. **C06 (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                                  | <ol style="list-style-type: none"> <li>1. Phadke, N. D., <i>Community Engagement and Social Innovation</i>, Oxford University Press, New Delhi.</li> <li>2. Garg, N. R., <i>Project-Based Learning in Engineering Education</i>, Pearson India Education Services, Noida.</li> <li>3. Gupta, A. and P. Singh, <i>Service Learning and Community Projects</i>, McGraw-Hill Education (India), New Delhi.</li> <li>4. Wilson, G., <i>Practical Guide to Community Development Projects</i>, Routledge, London.</li> </ol>                                         |
| Reference books                            | <ol style="list-style-type: none"> <li>1. NPTEL courses on Project-Based Learning and Social Innovation.</li> <li>2. SWAYAM courses on community engagement and sustainability.</li> <li>3. UN Sustainable Development Goals portal.</li> <li>4. MyGov India and local civic body portals for community initiatives.</li> <li>5. YouTube resources on design thinking, social innovation, and community service learning.</li> <li>6. NGO and government field-action case studies related to sanitation, water, health, education, and environment.</li> </ol> |
| Web links and Video Lectures (e-Resources) | <ol style="list-style-type: none"> <li>1. NPTEL courses on Engineering Geology.</li> <li>2. NPTEL courses on Soil Mechanics and Foundation Engineering.</li> <li>3. Virtual Labs – Geotechnical Engineering Virtual Lab.</li> <li>4. Geological Survey of India.</li> <li>5. YouTube channels on civil engineering experiments.</li> <li>6. American Society of Civil Engineers (ASCE) – Geotechnical resources and standards.</li> </ol>                                                                                                                       |

### 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  $\geq 40$ ; 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 | 16             | Clearly articulated with | Clear with reasonable evidence. | Problem stated but | Poorly defined or irrelevant. |

| society/environment                                                            |    | strong evidence and context.                                                    |                                                                 | evidence/context weak.                                  |                                                     |
|--------------------------------------------------------------------------------|----|---------------------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|
| 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)  $\geq 40$ . 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 parameters and analysis | 20         | Correctly analyzes key physical, chemical, and microbiological parameters and interprets results. | Analyzes most parameters correctly with minor interpretation gaps. | Some parameters analyzed, but interpretation is weak. | Minimal or incorrect analysis.         |

| Criterion                                 | Weight (%) | 4 - Excellent                                                                          | 3 - Good                                           | 2 - Satisfactory                                          | 1 - Needs improvement                     |
|-------------------------------------------|------------|----------------------------------------------------------------------------------------|----------------------------------------------------|-----------------------------------------------------------|-------------------------------------------|
| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>1BCV409</b>                | Scheme      | <b>2025</b>                |
| 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                         |
| 6. CO1: Relate material characteristics (cement, aggregates, water, admixtures and supplementary cementitious materials) to the microstructure and basic properties of concrete.<br>7. CO2: Distinguish fresh concrete behavior based on workability, segregation, bleeding and setting characteristics, and identify suitable measurement and control methods.<br>8. CO3: Evaluate hardened concrete strength, elasticity, creep, shrinkage and durability under different exposure conditions using appropriate test methods and standards.<br>9. CO4: Proportion concrete mixes (including high-strength and special concretes) using IS 10262 and other codal provisions, meeting specified performance requirements and sustainability considerations.<br>10. CO5: Select and justify suitable concrete types (RMC, SCC, fibre-reinforced, geopolymers, high-performance and other special concretes) and site practices for given structural and durability demands.<br>11. CO6: Demonstrate familiarity with modern quality assurance, non-destructive testing, and sustainability frameworks applicable to concrete production and construction.                                                                                                                                                             |                               |             |                            |
| Module-1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                               |             |                            |
| <b>Concrete Ingredients and Sustainability:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |             |                            |
| <ul style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>Fine Aggregates: Functions, grading requirements, properties; alternatives to river sand; manufactured sand (M-sand) – production, properties, codal provisions and environmental implications.</li> <li>Coarse Aggregates: Size, shape, texture, strength and durability; grading and blending; recycled aggregates; acceptance criteria and tests.</li> <li>Water: Quality requirements for mixing and curing water; impact on concrete properties.</li> </ul>                                                                                                                                                                                                                                                                                           |                               |             |                            |
| <b>Linked COs: CO1, CO4, CO5.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                               |             | <b>Number of Hours: 08</b> |
| Module-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                               |             |                            |
| <b>Fresh Concrete – Production, Workability and Site Practices:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                               |             |                            |
| <ul style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>Fresh concrete phenomena: Segregation, bleeding, setting and early-age cracking; control measures and good site practices.</li> <li>Chemical admixtures: Plasticizers, superplasticizers, accelerators, retarders, air-entraining agents and viscosity-modifying agents – properties, dosage and typical applications.</li> <li>Mineral admixtures/SCMs and blended systems: Performance-based selection of SCMs and admixtures for durability and sustainability.</li> <li>Curing: Methods and technologies – water curing, membrane curing, steam curing, accelerated curing, self-curing agents; curing regimes for different structural and durability needs.</li> <li>Ready-Mixed Concrete (RMC): Plant layout, batching accuracy, transportation, pumping, placing and quality</li> </ul> |                               |             |                            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| control; relevant Indian codes and QCI RMPCPS guidelines.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |
| <ul style="list-style-type: none"> <li>• Concreting in hot and cold weather, mass concreting and temperature control measures.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                            |
| <b>Linked COs: CO2, CO4, CO5.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Number of Hours:08</b>  |
| <b>Module-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |
| <b>Hardened Concrete –Properties, Durability and Testing</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                            |
| <ul style="list-style-type: none"> <li>• 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.</li> <li>• Mechanical properties: Modulus of elasticity, Poisson's ratio, fatigue, impact, fracture behavior; relevance to structural design.</li> <li>• Time-dependent deformations: Creep and shrinkage (plastic and drying), influencing factors and mitigation strategies.</li> <li>• 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.</li> <li>• Special exposure conditions and service life considerations, including marine, industrial and aggressive environments; basic introduction to performance-based durability design.</li> <li>• 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.</li> </ul> |                            |
| <b>Linked COs: CO3, CO6.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Number of Hours: 08</b> |
| <b>Module-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |
| <b>Concrete Mix Proportioning and Quality Assurance:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                            |
| <ul style="list-style-type: none"> <li>• Mix proportioning concepts: Parameters influencing mix design (strength grade, workability, exposure conditions, aggregate properties, SCMs and admixtures); statistical basis for strength and quality control.</li> <li>• 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.</li> <li>• High-strength and high-performance concrete mix design considerations: Aggregate packing, low w/c ratio, high-range admixtures, curing and quality control requirements.</li> <li>• 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.</li> <li>• 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).</li> </ul>                                                                                                                                                                                    |                            |
| <b>Linked COs: CO4, CO6.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Number of Hours: 09</b> |
| <b>Module-5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |
| <b>Special Concretes and Sustainable Practices:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                            |
| <ul style="list-style-type: none"> <li>• <b>SCC:</b> Concept, materials, EFNARC-based mix approach; tests (slump flow, <math>T_{50}</math>, L-box, V-funnel); use in congested reinforcement and precast.</li> <li>• <b>FRC:</b> Fibre types; improved toughness, crack control, impact resistance; applications in pavements and precast.</li> <li>• <b>Lightweight Concrete:</b> Types (LWA, foamed, AAC); low density, insulation; applications in buildings.</li> <li>• <b>Geopolymer Concrete:</b> Fly ash/GGBS-based; alkali activation; low <math>CO_2</math>; good durability.</li> <li>• <b>High-Performance Concrete:</b> High strength, low w/c; used in high-rise and bridges.</li> <li>• <b>Sustainability:</b> Use of industrial waste, recycled aggregates; life-cycle approach; green ratings (LEED, GRIHA).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                      |                            |
| <b>Linked COs: CO5, CO6.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Number of Hours: 07</b> |

**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:**

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

**Web links and e-Resources:**

- NPTEL/SWAYAM courses on Concrete Technology, Durability of Concrete, Advanced Concrete Construction and related topics.
- BIS standards portal and QCI RMCPCS documentation for updated codes and guidelines.
- 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 activities 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.

| <b>Term Work (TW) and Self Learning (SL) components in Number of Hours per semester</b>                          |                                                                                                                                                                                                                                                                                            |                                   |
|------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.) |                                                                                                                                                                                                                                                                                            |                                   |
| <b>Sl. No.</b>                                                                                                   | <b>Term Work (TW) Activity</b>                                                                                                                                                                                                                                                             | <b>Number of Hours / Semester</b> |
| 1                                                                                                                | <b>TW1 – Concrete Materials Profiling Exercise:</b> 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                                                                                                                | <b>TW2 – Site Workability and Quality Assessment:</b> 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                                |
|                                                                                                                  | <b>TW3 – Durability and NDT Case Study:</b> 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.                                                     |                                   |
| SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.                                    |                                                                                                                                                                                                                                                                                            |                                   |
| <b>Sl. No.</b>                                                                                                   | <b>Self-Learning (SL) Activity</b>                                                                                                                                                                                                                                                         | <b>Number of Hours / Semester</b> |
| 1                                                                                                                | <b>SL1 – Policy/Guideline Review :</b> 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                                                                                                                | <b>SL2 – RMC Plant / Special Concrete Technology Review (24 hours):</b> Review one RMC plant's quality system or a special concrete technology (SCC, geopolymers, HPC) via online resources and summarize its advantages, limitations and implementation challenges. Linked COs: CO5, CO6. | 24                                |

|  |                                                                                                                                                                                                                  |    |
|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
|  | <b>SL3 – MOOC/Video Module on Concrete Durability and Sustainability :</b> Complete a MOOC or video module on durability, corrosion or sustainable concrete and submit a learning note.<br>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.            |