| PROBABILITY AND STATISTICS | | | |
|---|---|---|---|
| Course Code | 1BMATMN301 | 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 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 |

CO1: Understand and explain basic statistical concepts, descriptive measures, and data visualization.
CO2: Apply probability rules, random variables, and common probability distributions to engineering problems.
CO3: Use sampling distributions, estimation, and hypothesis testing to draw statistical inferences.
CO4: Interpret statistical results, discuss assumptions and limitations, and relate them to engineering practice.
CO5: Analyze relationships between variables using correlation and regression models.

**Module-1**

**DESCRIPTIVE STATISTICS:** 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.

**(RBT Levels: LI, L2 and L3)** **Number of Hours: 14**

**Module-2**

**PROBABILITY AND RANDOM VARIABLES Review:** on sample space, events, axioms of probability, conditional probability, independence of events, total probability theorem, and Bayes theorem. Random variables, discrete and continuous types, probability mass function, probability density function, cumulative distribution function. Expectation and variance. Joint distributions for two discrete variables.

**(RBT Levels: LI, L2 and L3)** **Number of Hours: 14**

**Module-3**

**PROBABILITY DISTRIBUTIONS:** Discrete distributions: Binomial, Geometric, and Poisson - definitions, mean, and variance. Continuous distributions: Uniform, exponential, and normal - definitions, mean, and variance and related problems.

**(RBT Levels: LI, L2 and L3)**

**Linked COs: CO2, CO3, CO5** **Number of Hours: 14**

**Module-4**

**SAMPLING AND ESTIMATION:** 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. 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.

**(RBT Levels: LI, L2 and L3)** **Number of Hours: 14**

Module-5:

**CORRELATION, REGRESSION**: 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.

**(RBT Levels: LI, L2 and L3)** **Number of Hours: 14**

**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/ Selfe learning (TW/Sl-50 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. | **Analysis of engineering data using descriptive statistics.**: 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. | **Mini Project**: 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. | **Programming & Tools Workbook:** Develop a digital workbook in Excel/R/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 question; data source and limitations documented. | Mostly clear; minor gaps in context or data description. | Vague question 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 modelling (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% |

| APPLIED GEOLOGY FOR MINING ENGINEERING | | | |
|---|---|---|---|
| Course Code | 1BMN302 | Scheme | 2025 |
| Type of course | IPCC | Semester | III |
| Teaching Hours/Week (L:T:P) | 70 (3:0:2) | CIE Marks | 50 |
| Total Hours of Pedagogy L:T:P:SL:TW | 120(42:0:28:50) | SEE Marks | 50 |
| Credits | **4** | Total Marks | 100 |
| Type of Examination (IPCC): | Theory- CIE +SEE, and Lab- CIE only | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

1. CO1 (L2): Understand the principles of structural geology, geological maps, topographic interpretation, folds, faults, joints and unconformities.
2. CO2 (L3): Apply the knowledge of rock forming minerals, ore forming minerals and rock mass characterization to identify and evaluate minerals, rocks, coal types and engineering properties of geological materials.
3. CO3 (L4): Analyse geological mapping data, geophysical surveys, geochemical investigations, drilling records, and stereographic projections for mineral prospecting and subsurface exploration.
4. CO4 (L5): Evaluate mineral deposits and ore reserves using conventional and geostatistical estimation methods along with UNFC resource classification systems.
5. CO5 (L5): Design suitable hydrogeological and environmental management solutions for mine water control, slope stability, acid mine drainage mitigation, tailing dam safety, and land reclamation in mining projects.

**Module-1**

**Structural Geology**

- Study of topographic maps; Attitude of planar and linear structures; Effects of topography on outcrops.
- Structural aspects of rocks like Outcrop, Dip and strike, Folds, Faults, Joints, Unconformities and their influence on Engineering Projects/structures like dam, tunnels, slope treatment; ground improvement, recognition of the structures in field and their types/classification.
- Folds – terminology, classification based on attitude; impact on tunnels, slopes and foundations.
- Faults – Elements, types and recognition in field and maps; engineering problems due to faults.
- Joints: Types of joints and engineering significance
- Unconformities: Types and its importance in site selection and groundwater. Interpretation of simple geological maps and sections (qualitative). Rock Quality Determination (RQD).
- Effects of folds and fractures on strata/orebodies and their importance in mining operations.
- Principles of stereographic projections of linear and planar features of rocks. Geological site characterization: Dam foundations and rock Foundation treatment for dams and Reservoirs heavy structures by grouting and rock reinforcement.

**CO linkage: CO1, CO3** **Number of Hours : 8 hours**:

**Module-2**

**Mineralogy & Petrology for Engineers**

- **Ore-Forming and Rock Minerals:** Physical and optical properties of major oxides, sulfides, and silicate minerals. Minerals – Physical properties of important rock-forming minerals (quartz, feldspar, mica, calcite etc.).
- Mineral properties, composition and their use in the manufacture of construction materials – Quartz Group (Glass); Feldspar Group (Ceramic wares and Flooring tiles); Kaolin (Paper, paint and textile); Asbestos (AC sheets); Carbonate Group ( Cement); Gypsum (POP, gypsum sheets, cement); Mica Group (Electrical industries); Ore minerals - Iron ores (Steel); Chromite (Alloy); Bauxite (aluminum); Igneous rocks-Types of Granite, Dolerite, Basalt, Pumice, Granite Porphyry as building materials.
- Sedimentary. Sandstone, Limestone, Shale, Conglomerate as building materials.
- Metamorphic Rocks: Gneiss, Slate, Muscovite & Biotite schist, Marble, Quartzite. Rock weathering types and their effects on Civil Engineering Projects. Chalcopyrite (copper).

- **Rock Mass Characterization:** Detailed study of Igneous, Sedimentary, and Metamorphic rocks with emphasis on their mechanical strength and weathering properties.
- **Coal & Petroleum Geology:** Origin, rank, and lithotypes of coal; migration and entrapment of hydrocarbons.

**CO linkage: CO2, CO4** **Number of Hours (CI ): 8 hours**:

**Mineralogy & Petrology for Engineers**

- **Ore-Forming and Rock Minerals:** Physical and optical properties of major oxides, sulfides, and silicate minerals. Minerals – Physical properties of important rock-forming minerals (quartz, feldspar, mica, calcite etc.).
- Mineral properties, composition and their use in the manufacture of construction materials – Quartz Group (Glass); Feldspar Group (Ceramic wares and Flooring tiles); Kaolin (Paper, paint and textile); Asbestos (AC sheets); Carbonate Group ( Cement); Gypsum (POP, gypsum sheets, cement); Mica Group (Electrical industries); Ore minerals - Iron ores (Steel); Chromite (Alloy); Bauxite (aluminum); Igneous rocks-Types of Granite, Dolerite, Basalt, Pumice, Granite Porphyry as building materials.
- Sedimentary. Sandstone, Limestone, Shale, Conglomerate as building materials.
- Metamorphic Rocks: Gneiss, Slate, Muscovite & Biotite schist, Marble, Quartzite. Rock weathering types and their effects on Civil Engineering Projects. Chalcopyrite (copper).
- **Rock Mass Characterization:** Detailed study of Igneous, Sedimentary, and Metamorphic rocks with emphasis on their mechanical strength and weathering properties.
- **Coal & Petroleum Geology:** Origin, rank, and lithotypes of coal; migration and entrapment of hydrocarbons.

**CO linkage: CO2, CO4** **Number of Hours: 8 hours**:

**Module-3**

**Prospecting and Exploration Techniques**

- **Geological Mapping:** Surface and underground mapping techniques; use of Total Station and GPS in geological surveys.
- **Geophysical Prospecting:** Principles of Magnetic, Gravity, Seismic, and Electrical Resistivity methods for subsurface imaging.
- **Geochemical Exploration:** Soil, water, and stream sediment sampling; identifying anomalies.
- **Drilling:** Core logging, RQD (Rock Quality Designation) calculation, and borehole sampling protocols.

**CO linkage: CO3, CO4** **Number of Hours (CI ): 8 hours**:

**Module-4**

**Economic Geology & Resource Estimation**

- **Ore Genesis:** Hydrothermal, magmatic, sedimentary, and metamorphic processes of ore formation.
- **Indian Mineral Deposits:** Distribution of Iron, Manganese, Copper, Gold, and Lead-Zinc in India.
- **UNFC Classification:** United Nations Framework Classification for reserves and resources.
- **Estimation Methods:** Conventional methods such as Area of Influence and Cross-Section Method. Introduction to Geostatistical methods including Kriging for ore reserve estimation.

**CO linkage: CO4** **Number of Hours : 8 hours**:

**Module-5**

**Hydrogeology & Environmental Geology**

- **Groundwater Dynamics:** Hydrologic cycle, occurrence and movement of groundwater, porosity, permeability, aquifers, aquitards, confined and unconfined aquifers, and Darcy's Law.
- **Groundwater Exploration**: Groundwater Exploration methods like pumping tests, recharge estimation, and hydrogeological mapping for mining and civil engineering projects.
- **Mine Water Management:** Estimation of mine water inflow, groundwater control measures, dewatering techniques, drainage systems, and the influence of groundwater on slope stability and underground excavations.
- **Environmental Impact:** Management of Acid Mine Drainage (AMD), tailing dam stability, and land reclamation strategies.
- **Sustainable Mining Practices:**

Environmental monitoring, groundwater conservation, eco-restoration techniques, environmental impact assessment (EIA), and sustainable mine closure practices.

**CO linkage: CO5** **Number of Hours : 8 hours**:

**PRACTICAL COMPONENTS OF IPCC (LI-28 Hrs)**

**SET OF EXPERIMENTS**

1. Interpretation & description of structural geological maps – Contour maps, Dipping strata, Folded & Faulted strata and unconformities.
2. Megascopic identification of rock-forming minerals and various types of coal
3. Megascopic identification of ore-forming minerals.
4. Megascopic identification of igneous, sedimentary and metamorphic rock types.
5. Interpretation & description of topographic maps and Geological maps
6. Bore Hole problems (Three point problems): On ground level
7. Thickness problems (4 Types)
8. Dip and Strike Problems (2 Types)

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

**Text books:**

1. *Engineering & General Geology*. Parbin Singh. Publisher, S.K. Kataria & Sons. Edition, 8th 2008.
2. *Mining Geology, R.N.P. Arogyaswamy ; Publisher, Oxford & IBH Publishing Company, 1973*.

**Reference books / Manuals:**

1. Hefferan, K. and O'Brien, J., 2010. Earth Materials, Wiley-Blackwell, Sussex; 670 p..
2. Van der Pluijm, B.A., Marshak, S., 2004. Earth Structure – An Introduction to Structural Geology and Tectonics, W.W. Norton & Company, New York; 656 p.

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

https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ce107

. 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 (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**.

**Continuous Internal Evaluation (CIE):**

**i. 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.

**ii. 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.

iii. 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.

**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).

**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 each from both Part A and Part B.

**Table – ICs/IPCCs 1 Distribution of marks**

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

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

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

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

| Sl. No. | Term Work (TW) Activity | Number of Hours / Semester |
|---|---|---|
| 1. | Activity A – Field mapping and report (map + cross-section + interpretation) | 25 |
| 2. | Activity B – Mine visit / exploration case study report | 25 |
| **3.** | Open Book Team Challenge: Solving advanced complex 3-point borehole problems under varying ground levels to locate deep stratigraphic horizons. | 25 |

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

| Sl. No. | Self-Learning (SL) Activity | Number of Hours / Semester |
|---|---|---|
| 1 | MOOCs / Online Certification: Completion of designated video lecture segments from NPTEL / SWAYAM related to "Geological Mapping" or "Subsurface Exploration". | 25 |
| 2 | Tool & Software Exploration: Self-paced tutorials on open-source digital geology applications (such as QGIS) for processing topography and mineral distribution layers. | 25 |
| 3 | Competitive Aptitude Practice: Solving previous years' GATE-based engineering geology problems related to structural geology, stereographic projections, and Darcy's Law. | 25 |

**Suggested rubrics for Practical continuous assessment:**

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

| SOLID MECHANICS | | | |
|---|---|---|---|
| Course Code | 1BMN303 | Scheme | **2025** |
| Type of Course | Professional Core Course (PCC) | Semester | III |
| Teaching Hours/Week (L:T:P) | 70 (42:28:0) | CIE Marks | 50 |
| Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL | 120(42:28:0:50) | SEE Marks | 50 |
| Credits | **4** | Total Marks | 100 |
| Examination type (SEE) | **Theory** | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

1. CO1 (L2 – Understand): Explain fundamental concepts of stress, strain, elastic constants and factor of safety for common civil engineering materials.
2. CO2 (L3 – Apply): Apply equilibrium and deformation relations to determine stresses and elongations in axially loaded members and circular shafts under torsion.
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.
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.
5. CO5 (L3 – Apply): Apply column buckling concepts to estimate critical loads and assess the stability of compression members under idealised end conditions.
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.

**Module-1**

**Introduction, stress–strain and axial members:**

- Concepts of rigid and deformable bodies; elastic and plastic behaviour; normal and shear stresses; normal and shear strains.
- Stress–strain curves for ductile and brittle materials (qualitative); proportional limit, yield point, ultimate and failure.
- Hooke's law for uniaxial stress; elastic constants: E, G, K, ν and their relationships (isotropic, homogeneous material).
- Axially loaded members: bars of uniform and varying cross-section; stepped bars; temperature stresses (simple cases with/without constraints).
- Factor of safety and working stress concept (introductory).

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

**Module-2**

**Shear force, bending moment and stresses in beams:**

- Types of loads and supports; concept of shear force (SF) and bending moment (BM).
- 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.
- Flexural (bending) stresses: assumptions of simple bending theory; flexure formula $\sigma = \frac{My}{I}$ (statement and use); section modulus; bending stresses in rectangular, circular and I-sections (no built-up complex cases).
- Shear stresses in beams: shear formula $\tau = \frac{VQ}{Ib}$ (statement and use); shear stress distribution in rectangular and I-sections (qualitative curves + numericals).

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

**Module-3**

**Torsion and combined stresses:**

- Torsion of circular shafts: assumptions; torsion formula $\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$ (statement and application); solid and hollow shafts, strength and stiffness comparisons.
- Power transmitted by shafts; design-style numericals (within course level).
- Combined axial and bending stresses in members (qualitative introduction + simple numericals).
- Introduction to thin cylindrical shells under internal pressure: hoop and longitudinal stresses (formulae and simple problems).

**Linked COs: CO2, CO3, CO6** **Number of Hours:14**

**Module-4**

**Two-dimensional stress analysis and Mohr's circle:**

- Plane stress at a point: normal and shear stresses on inclined planes; transformation equations (no full derivation needed at length).
- Principal planes and principal stresses; maximum shear stress; orientation of principal planes.
- Construction and use of Mohr's circle for plane stress – determination of principal stresses and maximum shear; interpretation in terms of material failure.
- Plane strain (basic idea); brief mention of 3D generalisation (qualitative).

**Linked COs: CO1, CO4, CO6** **Number of Hours:14**

**Module-5**

**Columns, buckling and strain energy:**

- Columns and struts: classifications; slenderness ratio; Euler's buckling theory for ideal columns (pinned–pinned, fixed–free, fixed–pinned, fixed–fixed).
- Critical load, effective length and factor of safety in compression members; limitations of Euler theory.
- Introduction to empirical/Rankine or IS-based formula (statement and awareness).
- Strain energy: concept of energy stored in axially loaded members and in members under bending and torsion (formulae and simple numericals).
- Qualitative use of strain-energy methods for deflection and impact (no lengthy derivations); link to stiffness and serviceability checks.

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

**Suggested Learning Resources**

**Text books:**

1. Beer, F. P., Johnston, E. R., DeWolf, J. T., & Mazurek, D. F. *Mechanics of Materials*. McGraw-Hill Education. Latest edition.
2. Hibbeler, R. C. *Mechanics of Materials*. Pearson. Latest edition.
3. Punmia, B. C., Jain, A. K., & Jain, A. K. *Strength of Materials*. Laxmi Publications.

**Reference books / Manuals:**

1. Ramamrutham, S. *Strength of Materials*. Dhanpat Rai Publishing.
2. Gere, J. M., & Goodno, B. J. *Mechanics of Materials*. Cengage.
3. Timoshenko, S., & Young, D. H. *Elements of Strength of Materials*.

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

1. NPTEL (IITs): "Strength of Materials", "Mechanics of Materials", "Solid Mechanics" – full lecture series, worked examples and assignments aligned to Indian civil curricula.
2. MIT OCW / other MOOCs: Open course materials on "Solid Mechanics" and "Mechanics of Materials" for additional concept explanation and problem practice.

**Teaching-Learning Process (Innovative Delivery Methods):**
Suggested Innovative Delivery Methods may include (but are not limited to):

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

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

1. Concept-driven lectures using 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 farmwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-52 hour) and Teamwork/ Selfe learning (TW/Sl-64 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 | Activity A – Beam SF–BM and stress study (CO2, CO3, CO6): 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): 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): 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 (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 | 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).

| ELEMENTS OF MINING ENGINEERING | | | |
|---|---|---|---|
| Course Code | **1BMN304** | Scheme | **2025** |
| Type of 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 |

**Course outcome (Course Skill Set)**

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

1. CO1 (L2): Explain the fundamentals of mining engineering, mine life cycle and classification of mining methods.
2. CO2 (L3): Select suitable Mine Entry based on geo-technical conditions.
3. CO3 (L3): select suitable shaft sinking process and drivage process of incline/decline based on geo-technical conditions.
4. CO4 (L2): Illustrate unit operations of underground mine and Layouts along with its applicability conditions.
5. CO5 (L2): describe types of surface mines, its applicability conditions, unit operations along with equipments selections.

**Module-1**

**Introduction to Mining Engineering:** Significance to mining industry in national economy and infrastructure building, basic mining terminologies, stages in mine life cycle, geo-technical investigations, classification of mining methods and their selection criteria.

**Linked COs: CO1** **Number of Hours: 8**

**Module-2**

**Opening-up of Deposits:** Choice of mode of entry - adit, shaft, incline, decline and combined mode, their applicability, number and disposition. **Inclines/Declines:** methods of incline/decline drivage. Box cut- types and location.

**Linked COs: CO2** **Number of Hours: 08**

**Module-3**

**Vertical/Inclined Shafts:** Location, shape, size, and organisation of shaft sinking, sinking methods, construction of shaft collar, shaft inset, shaft fittings.

**Numerical Problems:** related to shaft sinking and calculation of OMS

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

**Module-4**

**Overview of underground mining:** Different coal mining methods and their applicability & limitations; Different metal mining methods and their applicability & limitations; Basic concepts of transportation, ventilation, illumination and support in underground mines.

**Linked COs: CO3, CO4, CO5** **Number of Hours: 09**

**Module-5**

**Overview of surface mining:** Types of surface mines, applicability & limitations; Bench formation, stripping ratio, slope stability, and haul roads, Drilling and blasting in surface mine and equipment selection, pit geometry and layout.

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

**Suggested Learning Resources:**

**Textbooks:**

1. B. S. Kharbanda, Elements of Mining Engineering, latest edition.
2. D. J. Deshmukh, Elements of Mining Technology, Vol. 1, Khanna Publishers, latest edition.
3. R. L. Singhal, Mining Engineering, Khanna Publishers, latest edition.

**Reference books / Manuals:**

4. H. L. Hartman and J. M. Mutmansky, Introductory Mining Engineering, Wiley, latest edition.
5. S. K. Das, Principles and Practices of Mining Engineering, latest edition.
6. Directorate General of Mines Safety (DGMS) guidelines, relevant rules and regulations.
7. Indian Bureau of Mines (IBM) publications and manuals, 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 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. Use real samples, photographs, maps, and videos of mines, equipment, and mineral processing units.
2. ii. Encourage comparison of surface and underground mining methods through case-based discussions.
3. iii. Conduct field/site observations of mine layouts, drilling, blasting, ventilation, and safety systems.
4. iv. Use charts, models, and simple demonstrations to connect theory with mining 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 EE** is at least **40 out of 100 marks**.

**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).

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

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

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

As per National credit farmwork (NCrF) students must spend 90 hours of study for 3 credit courses, which include Course instructions (CI-42 hour) and Teamwork/ Selfe learning (TW/Sl-48 hours). Hence, students must complete minimum of two actives as part of NCrF. These learning activities can be considered as CCA components of CCA. 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. | **Activity A – Mining method comparison case study** (CO1, CO2, CO6): Students compare two or more mining methods for a chosen mineral deposit and justify selection based on production, safety, economy, and environmental impact. | 24 |
| 2. | **Activity B – Mine safety and operation observation report** (CO3, CO4, CO5): Students document mining operations observed through site visit / case photos / video case study and explain excavation, support, ventilation, precautions, and safety issues. | 24 |
| SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc. | | |
| Sl. No. | **Self-Learning (SL) Activity** | Number of Hours / Semester |
| 1 | NPTEL or MOOC modules on mining engineering, mine safety, and mineral processing. | 24 |
| 2 | Preparation of mining method comparison charts, safety notes, and digital portfolio of mining operations. | 24 |

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

| Criteria | 4 – Excellent | 3 – Good | 2 – Fair | 1 – Needs Improvement |
|---|---|---|---|---|
| **Problem Understanding** | 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. |
| **Construction/Design Details** | Sketches/details are accurate, neat, and professional. | Largely correct with minor layout errors. | Partially correct; several technical mistakes. | Incorrect or missing diagrams/details. |
| **Safety & Sustainability** | 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. |
| **Presentation & Clarity** | Well-organized, easy to follow, and high-quality report. | Generally clear; some minor layout/formatti ng 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).

| DRILLING AND BLASTING TECHNOLOGY | | | |
|---|---|---|---|
| Course Code | **1BMN305** | Scheme | 2025 |
| Type of Course | **PCC** | Semester | III |
| Teaching Hours/Week (L:T:P) | 42(3:0:0 ) | CIE Marks | 50 |
| Total Hours of Pedagogy per semester L /T/P/SL&TW: | 90 (42:0:0:48) | SEE Marks | 50 |
| Credits | **3** | Total Marks | 100 |
| Examination type (SEE) | Theory | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

1. Understanding about the explosives and initiating systems used in rock breakage.
2. Blast hole drilling mechanism and selection of a drill for surface excavation.
3. Ability to design the surface blast round and predict the outcomes of the blast design.
4. Ability to design underground blast round and predict the outcomes of the blast design.
5. Understanding the basics of mechanized excavation techniques.

**Module-1**

**Explosives and Initiating Systems:** Types of explosives, their composition and properties, classification; Selection of explosives; Manufacture, transport, storage and handling of explosives; Testing of explosives; Types of initiating systems – Electrical Detonators, Detonating cord, Detonating Relays, NONEL, Electronic Detonators, Blasting accessories, exploders.

**Linked COs: CO1** **Number of Hours: 08**

**Module-2**

**Drilling in Surface Mines:** Blasthole drills – types, classification, applicability and limitations; Mechanics of drilling, performance parameters, drilling cost, drilling errors, Selection of drilling systems, organization of drilling.

**Linked COs: CO2** **Number of Hours: 08**

**Module-3**

**Blasting in Surface Mines:** Mechanics of rock fragmentation; Livingston theory of crater formation; factors affecting blast design, Blast design - estimation of burden and spacing, estimation of charge requirement; initiation patterns; secondary blasting techniques; problems associated with blasting and remedies, ground vibration and air over pressure, blast instrumentation; cast blasting.

**Linked COs: CO3** **Number of Hours: 09**

**Module-4**

**Drilling & Blasting in Underground Mines Coal mines:** Drilling systems and their applicability, blasting-off-solid, different blasting cuts, calculation of specific charge, specific drilling and detonator factor, initiation patterns.

**Drilling & Blasting in Underground Metal mines:** Drilling systems and their applicability, blast design for horizontal drivages, different blasting cuts, long hole blasting, vertical crater retreat blasting.

**Linked COs: CO4** **Number of Hours: 09**

**Module-5**

**Mechanised Cutting:** Ripping, Cutting using– surface and underground machinery, rock breakers.

**Blast design and analysis software.**

**Linked COs: CO5** **Number of Hours: 08**

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

**Text books:**

1 **"Explosives and Blasting Practices in Mines,"** S.K. Das, Lovely Prakashan, Dhanbad, 1993.

2 **"Explosives and Blasting Techniques,"** G.K. Pradhan, Minetech Publication, 1996.

**<u>Reference books / Manuals:</u>**

1. **"Surface Mining"**, G.B. Mishra, Module 1, Dhanbad Publishers, Dhanbad, 1978.
2. **"Rock Fragmentation by Blasting,"** B.Mohanty, Module 4, A.A. Balkema, Rotterdam, 1996.
3. **"Advances in Drilling and Blasting"** V.R. Sastry, Module 1 and 2, Allied Publishers Ltd., 1993.
4. **"Principles of Rock Drilling"** U.M. Rao Karanam and B.Mishra, Module 1 and 2 Oxford and IBH, 1998.

5. **"Drilling and Blasting of Rocks"**, Carlopez Jimeno, etal. Module 7, A.A. Balkema, Rotterdam, Brook fields, 1995.
6. **"Engineering Rock Blasting operations"**, Sushil Bhandari, Module 3 and 6, , A.A. Balkema, Rotterdam, Brook fields, 1997

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

- https://onlinecourses.nptel.ac.in/noc22_mm02/preview

**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.

**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 EE** is at least **40 out of 100 marks**.

**Continuous Internal Evaluation (CIE):**

(v) 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.

(vi) 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.

(vii) 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.

(viii) 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).

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

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

**Students' activities for TW/SL under NCrF:**

Samples only As per National credit farmwork (NCrF) students must spend 90 hours of study for 3 credit courses, which include Course instructions (CI-42 hour) and Teamwork/ Selfe learning (TW/Sl-48 hours). Hence, students must complete minimum of two actives as part of NCrF. These learning activities can be considered as CCA component of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The

**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. | **Micro-Project on Surface Blast Design:** Designing a bench blast round for an open-cast mine, including the estimation of burden, spacing, charge requirement per hole, and choosing an optimal initiation pattern. | 8 |
| 2. | **Industrial / Field Visit:** Visit to an operational mine site or a localized blasting project to observe explosive handling safety, transport systems, or blast-induced ground vibration monitoring. | 6 |
| 3. | **Seminar & Group Presentation:** Student group presentation focusing on the comparison, choice criteria, and field advantages of modern initiating systems | 4 |
| 4. | **Underground Mine Layout Assignment:** Drafting and calculating specific charge and drilling/detonator factors for a blasting-off-solid sequence or a wedge-cut pattern in underground coal/metal drivages. | 6 |
| SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc. | | |
| **Sl. No.** | **Self-Learning (SL) Activity** | **Number of Hours / Semester** |
| 1 | **Tool & Software Exploration:** Self-paced online learning and practice using open-source or academic Blast Design and Analysis Software to simulate rock fragmentation profiles. | 8 |
| 2 | **MOOCs / NPTEL Platform Learning:** Watching designated online video lecture sequences regarding modern "Drilling and Blasting Technology" or specialized mechanised excavation principles. | 8 |
| 3 | **Literature Review:** Independent analysis of engineering case studies concerning Livingston's theory of crater formation, cast blasting operations, or mitigation strategies for air overpressure. | 4 |
| 4 | **Competitive / GATE-Based Aptitude Practice:** Solving advanced numerical problems at RBL4 and RBL5 levels related | 4 |

| | | |
|---|---|---|
| | to rock fragmentation mechanics, drilling costs, and specific energy of mechanized machinery (ripping/rock breakers). | |

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

| Criteria | 4 – Excellent | 3 – Good | 2 – Fair | 1 – Needs Improvement |
|---|---|---|---|---|
| **Problem Understanding** | 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. |
| **Construction/Design Details** | Sketches/details are accurate, neat, and professional. | Largely correct with minor layout errors. | Partially correct; several technical mistakes. | Incorrect or missing diagrams/details. |
| **Safety & Sustainability** | 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. |
| **Presentation & Clarity** | Well-organized, easy to follow, and high-quality report. | Generally clear; some minor layout/formatti ng 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**

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

v. 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.

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

| COMPUTER AIDED MINE DESIGN AND DRAWING LABORATORY | | | |
|---|---|---|---|
| Course Code | **1BMNL306** | Scheme | 2025 |
| Type of Course | PCCL | Semester | III |
| Teaching Hours/Week (L:T:P) | 28 (0:0:2) | CIE Marks | 50 |
| Total Hours of Pedagogy L:T:P:SLTW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Examination type (SEE) | Practicle | Exam Hours | 03 |

**Course outcome (Course Skill Set):**
At the end of the course, the student will be able to:

1. CO1 – L3: Use CAD software tools to develop mine drawings as per standard drafting conventions.
2. CO2 – L3: Prepare geological, survey, and mining-related drawings from given field and borehole data using AutoCAD.
3. CO3 – L3: Develop surface and underground mine layouts including benches, haul roads, drill-hole patterns, shafts, drifts, and mine panels.
4. CO4 – L4: Analyze mining geometries and represent geological and mining features through appropriate plans, sections, and layouts.
5. CO5 – L5: Design and evaluate integrated mine drawings and layouts for specified mining conditions using computer-aided drafting tools.

**Note:**

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 6 - 8 conventional experiments, PART-B has 6 typical open-ended experiments. The maximum marks for the laboratory course are 100.
2. Both PART-A and PART-B are considered for CIE and SEE.
3. Students are required to answer 1(one) question from PART- A and 1(one) question from PART- B.
   a. The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for 70 marks out of the maximum 100 marks.
   b. The open-ended question set for SEE shall be any other open-ended question and not selected from the experiments under PART-A. It shall be evaluated for 30 marks out of the maximum 100 marks.

**PART – A**
**FIXED EXPERIMENTS**

1. Introduction to CAD interface, drawing tools, layers, units, limits, snaps, and plotting basics for mine drawings.
2. Drawing of line, polyline, circle, arc, offset, trim, extend, mirror, array, and hatch commands using simple mine-related exercises.
3. Preparation of Geological Cross-Section from Borehole Data.
4. Drawing of Surface Mine Bench Geometry with Berms and Haul Roads.
5. Preparation of Bench Blasting Layout Showing Drill Hole Pattern, Burden, and Spacing.
6. Drawing of Underground Mine Development Layout Including Shaft, Drift, Cross-Cut, and Raise.
7. Preparation of Bord-and-Pillar Panel Layout for a Coal Mine.
8. Drawing of Longwall Panel Layout Showing Gate Roads and Extraction Panel.

**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.

1. Design and Draft a Surface Mine Bench Layout for a Given Ore Deposit Geometry.
2. Develop an Underground Mine Access Layout for a Given Mineral Deposit.
3. Prepare a Geological Plan and Cross-Section from Borehole and Lithological Data.

4. Design a Mine Infrastructure Layout for a Small Mining Project.
5. Develop an Integrated Mine Plan Incorporating Geological Features, Excavation Layout, and Mining Infrastructure.
6. Create an Optimized Drill-Hole Pattern for a Specified Bench Blasting Scenario.

**Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):**

**Text books:**

1. Deshmukh, D. J., *Elements of Mining Technology*, Vol. 1 and 2, Wheeler Publishing.
2. B. A. Kennedy, *Surface Mining*, SME.
3. AutoCAD user guide or equivalent CAD software manual.

**Reference books / Manuals:**

1. Mines Act and relevant mine safety regulations.
2. DGMS circulars and standards relevant to mine layouts and safety.
3. Standard mine planning and drawing manuals.

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

1. NPTEL: Introduction to Mining Engineering and Mine Planning.
2. NPTEL / IIT courses on CAD drafting and technical drawing.
3. Online resources on mine planning, ventilation, and safety drawings

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

The following are the list of Innovative delivery methods adopted to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.

1. CAD live demonstrations and guided drafting.
2. Flipped laboratory sessions with pre-recorded CAD tutorials.
3. Problem-based and peer-reviewed mine planning exercises.

**Assessment Structure:**

The assessment for each of the Laboratory courses 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).

- To pass the **CIE**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 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**.

The CIE marks awarded shall be based on continuous assessments for 30 marks through rubrics and lab tests for 20 marks.

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. The summation of all the experiments marks to be scaled down to 30 marks.

The laboratory test at the end of the last week of the semester / after completion of all the experiments (whichever is early) shall be conducted for 100 marks and scaled down to 20 marks. For laboratory test and SEE, the student is required to conduct one experiment each from both Part A and Part B. Part A is assessed with a weightage of 70%, while Part B carries a weightage of 30%.

**Rubrics suggested for Practical continuous assessment**

| Performance Indicators | Excellent | Very Good | Good | Satisfactory |
|---|---|---|---|---|
| Fundamental Knowledge (4) (PO1) | The student has well depth knowledge of the topics related to the course (4) | Student has good knowledge of some of the topics related to course (3) | Student is capable of narrating the answer but not capable to show in depth knowledge (2) | Student has not understood the concepts clearly (1) |

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

| DATA AND OFFICE TOOLS LABORATORY FOR MINING ENGINEERING | | | |
|---|---|---|---|
| Course Code | **1BMNL307A** | 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 L :T:P:SL:TW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Type of Examination | Practical | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

1. **CO1 (2): Demonstrate** the use of basic computer operations and prepare documents, spreadsheets, make small presentations with audio, video and graphs and would be acquainted with internet.
2. **CO2 (3): Create and format** professional documents using word processing software by incorporating tables, headers, footers, graphics, spell checking, grammar checking, and mail merge features.
3. **CO3 (3): Develop and analyze** spreadsheets using formulas, functions, charts, and macros for data processing and management tasks.
4. **CO4 (3): Apply** office application software to perform routine administrative and workplace data management tasks efficiently.
5. **CO5 (3):** Utilize Google Suite for office data management tasks.

**SET OF EXPERIMENTS (LI =28 hours)**

1. To create professionally formatted documents using advanced text formatting, typography, nested lists, and table layouts in Microsoft Word.
2. To automate document preparation using styles, templates, formatting tools, document protection, and other advanced features in Microsoft Word.
3. To efficiently manage worksheets by navigating workbooks, organizing data, and applying data entry automation techniques in Microsoft Excel.
4. To perform data linking, worksheet management, freeze panes, and conditional formatting for efficient spreadsheet analysis in Microsoft Excel.
5. To create and customize charts from tabular data and integrate graphical representations across Microsoft Office applications.
6. To design interactive multimedia presentations using themes, layouts, animations, transitions, and embedded multimedia in Microsoft PowerPoint.
7. To design and create the structure of a relational database by defining tables, fields, keys, and relationships in Microsoft Access.
8. To perform database operations including data entry, modification, deletion, queries, forms, and reports using Microsoft Access.
9. To configure and manage an email client by creating user profiles, organizing mailboxes, and understanding email storage in Microsoft Outlook.
10. To organize emails, contacts, calendars, tasks, and offline data files for effective communication and information management using Microsoft Outlook.

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

**Text books:**

1. Sanjay Saxena, A First Course in Computers (Based on Windows 8 And MS Office 2013) Vikas Publishing 2015.
2. Jennifer fulton, Sherri Kinkoph, and Joe Kraynak, The Big Basics Book of Microsoft Office 1997, PHI, 1998.

**Reference books / Manuals:**

1. Laura Acklen et al, Microsoft Office 97 Professional Essentials,EEE Que E&T, PHI (1998).
2. Andy Channelle, Beginning OpenOffice 3, APress 2009.

| |
|---|
| **3.** R. Gabriel Gurley, A Conceptual Guide to OpenOffice.Org 2 for Windows and Linux |
| **Web links and Video Lectures (e-Resources):**<br><br>• Excel help & learning<br>• Word help & learning<br>• PowerPoint help & learning |

**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 (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) |

| PROGRAMMING IN C++ | | | |
|---|---|---|---|
| Course Code | **1BMNL307B** | 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 L :T:P:SL:TW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Type of Examination | Practical | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

1. **CO1 (3): Develop** programs to solve computational problems using object-oriented programming concepts such as classes and objects.
2. **CO2 (3): Implement** code reusability and extensibility using user-defined data types, operator overloading, and function overloading.
3. **CO3 (3): Construct** C++ programs employing inheritance and polymorphism to achieve code reusability and dynamic behavior.
4. **CO4 (4): Analyze and implement** input/output stream operations for efficient data handling and performance evaluation in C++ programs.
5. **CO5 (3): Develop** C++ applications using templates, exception handling, and file processing techniques to solve complex programming problems.

**SET OF EXPERIMENTS (LI =28 hours)**

1. Understand basic C++ syntax, input/output streams, and implement Function Overloading.
2. Learn the optimization utility of Inline Functions and flexibility of Default Arguments.
3. Master Call by Reference, Return by Reference, and the Scope Resolution Operator
4. Implement a real-world entity using Classes, Objects, Data Hiding (Encapsulation), and Abstraction.
5. Understand how Constructors and Destructors behave in derived classes.
6. Implement and differentiate between Multiple Inheritance and Hierarchical Inheritance.
7. Resolve the "Diamond Problem" in Hybrid Inheritance using virtual base classes.
8. Achieve runtime polymorphism using Virtual Functions and Abstract Classes.
9. Work with C++ File Streams to read and write both text and binary data.
10. Implement structured error handling using Try, Catch, and Throw blocks, including pre-defined exceptions.

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

**Text books:**

1. Bhushan Trivedi, “Programming with ANSI C++”, Oxford Press, Second Edition, 2012.
2. Balagurusamy E, Object Oriented Programming with C++, Tata McGraw Hill Education Pvt.Ltd , Fourth Edition 2010.
3. Bhave , “ Object Oriented Programming With C++”, Pearson Education , 2004.

**Reference books / Manuals:**

1. Ray Lischner, “Exploring C++ : The programmer’s introduction to C++” , apress, 2010
2. Bhave , “ Object Oriented Programming With C++”, Pearson Education , 2004

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

- Basics of C++ - https://www.youtube.com/watch?v=BClS40yzssA
- Functions of C++ - https://www.youtube.com/watch?v=p8ehAjZWjPw
  Tutorial Link:
- https://www.w3schools.com/cpp/cpp_intro.asp
- https://www.edx.org/course/introduction-to-c-3

**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 (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) |

| ROCK EXCAVATION AND SIMULATION LABORATORY | | | |
|---|---|---|---|
| Course Code | **1BMNL307C** | 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 L :T:P:SL:TW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Type of Examination | Practical | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

1. CO1 (2): Identify and explain the functions of rock excavation, drilling, and blasting equipment used in surface and underground mining operations.
2. CO2 (3): Determine drillability characteristics of rocks and evaluate drilling performance parameters such as penetration rate, specific energy, and bit efficiency.
3. CO3 (3): Design basic bench blasting patterns and calculate blasting parameters including burden, spacing, explosive charge, and powder factor.
4. CO4 (4): Analyze the effects of burden, spacing, delay timing, and explosive distribution on blast performance and rock fragmentation using simulation tools.
5. CO5 (5): Optimize drill-and-blast designs to achieve desired fragmentation and excavation efficiency through simulation-based evaluation.

**SET OF EXPERIMENTS (LI =28 hours)**

1. Study and Identification of Rock Excavation Equipment Used in Surface and Underground Mines.
2. Determination of Drillability Index of Different Rock Samples.
3. Measurement and Analysis of Drilling Parameters (Penetration Rate, Specific Energy, and Bit Performance).
4. Design of Basic Blast Patterns for Bench Blasting in Surface Mines.
5. Simulation of Burden and Spacing Effects on Blast Performance
6. Simulation of Rock Fragmentation and Analysis of Fragment Size Distribution Using Digital Tools.
7. Simulation of Delay Timing Sequences in Multi-hole Blasting
8. Study of Factors Affecting Rock Breakage through Controlled Blasting Simulation.
9. Drill pattern optimization using simulation tools.
10. Assessment of Explosive Charge Distribution and Powder Factor through Simulation.

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

Text books:

1. "Explosives and Blasting Practices in Mines," S.K. Das, Lovely Prakashan, Dhanbad, 1993.
2. "Explosives and Blasting Techniques," G.K. Pradhan, Minetech Publication, 1996.

Reference books / Manuals:

3. https://downloads.o-pitblast.com/files/manual/O-Pitblast%20Manual%20v.3.0.pdf

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

- https://www.o-pitblast.com/

**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 (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) |

| DATA VISUALIZATION WITH PYTHON | | | |
|---|---|---|---|
| Course Code | **1BMNL307D** | 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 L :T:P:SL:TW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Type of Examination | Practical | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

1. CO1 (3): Apply Python libraries to import, clean, transform, and structure datasets for analysis and visualization.
2. CO2 (3): Develop suitable 2D and 3D visualizations, including histograms, heatmaps, and contour maps, for effective representation of mining and geotechnical data.
3. CO3 (4): Design and analyze interactive dashboards and multi-plot visualizations using Plotly and Matplotlib for data-driven decision-making.

**SET OF EXPERIMENTS (LI=28 hrs)**

1. Learn basic line and scatter plots using Matplotlib.
2. Master bar charts and pie charts using Seaborn and Matplotlib.
3. Understand histograms and Box/Violin plots.
4. Create scatter plots with regression lines and correlation heatmaps.
5. Plotting time-dependent data and handling multiple axes.
6. Implement Pair Plots and Radar (Spider) Charts.
7. Render 3D scatter and surface plots.
8. Generate 2D contour lines and filled contour maps.
9. Build interactive, hoverable plots using Plotly.
10. Combine multiple plots into a single, cohesive dashboard layout.

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

**Text books:**

1. Python Data Science Handbook: Essential Tools for Working with Data" by Jake VanderPlas.
2. Interactive Data Visualization with Python" by Abha Belorkar, Sharath Chandra Chelugubala, and Bernardoip Vig.

**Reference books / Manuals:**

1. Geostatistical Reservoir Modeling" by Michael J. Pyrcz and Clayton V. Deutsch.
2. "Data Analysis in Geochemistry and Geophysics" by Edward C. Grimm.

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

- https://jakevdp.github.io/PythonDataScienceHandbook/

**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 (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) | 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 | 02 |

**Course objective:**

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.

**Course outcome (Course Skill Set):**

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

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

**Restrictions and professional conduct:**

Community / Societal Projects shall remain **academic, socially responsible, technically focused, and politically neutral**. Students and faculty shall maintain professionalism, ethical conduct, public respect and institutional integrity while interacting with communities, public groups, organisations and stakeholders.

Students and faculty **shall avoid** the following during project execution:

- Association with political party activities, campaigns or propaganda.
- Participation in activities that may disturb communal harmony, public order or institutional reputation.
- Use of the project platform for personal, political, ideological or commercial promotion.
- Disrespectful, discriminatory or unethical interaction with community members or stakeholders.

Projects must also recognise constraints related to **cost, resources, environment and safety, and stakeholder behaviour/cooperation/acceptance** when planning and implementing activities.

**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 (WhatsApp,

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 ≥ 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 discussion and sustainability considerations. | Limited evaluation of impact or sustainability. | No coherent assessment of impact or sustainability. |

**SEE pass rule:**

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

**Suggested implementation notes (for BoS / exam committees):**

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

| FLUID MECHANICS & THERMODYNAMICS | | | |
|---|---|---|---|
| Course Code | **1BMN401** | Scheme | **2025** |
| Type of Course | Professional Core Course (PCC) | Semester | IV |
| Teaching Hours/Week (L:T:P) | 42 (3:0:0) | CIE Marks | 50 |
| Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL | 90(42:0:0:48) | SEE Marks | 50 |
| Credits | 3 | Total Marks | 100 |
| Examination type (SEE) | Theory | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

- CO1 (L2): Explain the fundamental properties of fluids, fluid flow measurement techniques, and flow through pipes, orifices, and notches.
- CO2 (L3): Determine fluid pressures, hydrostatic forces on submerged surfaces, and analyze the stability of floating and submerged bodies.
- CO3 (L3): Apply Euler's and Bernoulli's equations to solve fluid flow problems and analyze energy distribution in flowing fluids.
- CO4 (L2): Describe thermodynamic systems, properties, processes, equilibrium conditions, and energy interactions.
- CO5 (L3): Apply thermodynamic laws and evaluate the performance parameters of reciprocating air compressors used in mining applications.

**Module-1**

**Fluid Mechanics:** Definition and properties of Fluids, ideal and real fluid units, systems of measurement. Fluid properties-density, specific weight, specific volume, specific gravity, viscosity, compressibility, surface tension and capillarity, vapour pressure and cavitation,

**Fluid flow measurements**: Venturimeter, Orifice meter. Flow through orifices and notches. Loss of head due to friction in pipes. Discharge measurements in pipes.

**Linked COs: CO1** **Number of Hours: 08**

**Module-2**

**Fluid Statistics:** pressure, atmospheric pressure, gauge and absolute pressure, measurement of pressure, piezometer tube, double column u-tube manometer, differential and inverted U-tube measurements, Bourdon's pressure gauge, diaphragm pressure gauge and dead weight pressure gauge. Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined planes, curved surface submerged in liquid.

**Buoyancy:** definition, center of buoyancy, metacenter and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of metacentric height experimentally and theoretically.

**Linked COs: CO2,** **Number of Hours:09**

**Module-3**

**Fluid Dynamics:** Introduction to equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation, assumptions, hydraulic gradient line and total energy line. Numerical Problems.

**Linked COs: CO3** **Number of Hours:08**

**Module-4**

**Basic concepts of Thermodynamics:** Thermodynamic system, classification of thermodynamic system. Thermodynamic property- extensive and intensive properties. Thermodynamic state, thermodynamic process. Reversible, irreversible process, Quasi-static process. Thermodynamic equilibrium, zeroth law of thermodynamics.

**Energy:** classification, stored energy and energy in motion. Work and heat-definition, work done at the moving boundary. Comparison between work and heat.

**Linked COs:CO4** **Number of Hours:08**

**Module-5**

**I and II Laws of Thermodynamics**: I and II Laws of thermodynamics: Statements, cyclic processes, numerical problems.

**Air Compressors**: Single stage and multistage reciprocating air compressors on surface and in underground mines. Expression for work done during single stage air compression with and without clearance volume. Volumetric efficiency. Simple numerical problems on single stage compressors only.

**Linked COs: CO5** **Number of Hours:09**:

**Suggested Learning Resources**

**Text books:**

1. **Engineering thermodynamics,** Nag P.K., Tata McGraw Hill publications., 2nd Ed. 2002.
2. **A** Text Book of Fluid Mechanics **and** Hydraulic Machines, R.K.Bansal, Laxmi publications. 2006.

**Reference books / Manuals:**

1. **Hydraulics and Fluid Mechanics,** Modi P.N. and Seth, S.M., Standard Publishers, New Delhi., 1999.

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

1. https://nptel.ac.in/courses/112104118
2. http://www.digimat.in/nptel/courses/video/112105218/L59.html
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_me76

**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 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

**Continuous Internal Evaluation (CIE):**

1. 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.
2. 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.
3. 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.
4. 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 shall be awarded the grade 'F' (Fail).

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

As per National credit farmwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-52 hour) and Teamwork/ Selfe learning (TW/Sl-64 hours). Hence, students must complete minimum of two actives as part of NCrF. These learning activities can 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 assignments, seminars, micro projects, industrial visits, any other student activities etc.) | | |
| Sl. No. | Term Work (TW) Activity | Number of Hours / Semester |
| 1. | **Micro-Project on Mine Drainage/Pumping Systems:** Evaluating head losses due to friction in mine pipelines and sizing an underground multi-stage centrifugal pump based on mine water inflow requirements. | 24 |
| 2. | **Seminar & Group Presentation:** Student group presentation focusing on the practical application and selection criteria of diverse fluid measurement tools (e.g., Venturimeter vs. Orifice meter) or pressure sensors. | 12 |
| 3. | **Thermodynamic Cycle Charting Assignment:** Solving numerical problems and plotting PV/TS operating loops for single-stage and multi-stage reciprocating air compressors used in mine pneumatic machinery. | 12 |
| SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc. | | |
| Sl. No. | Self-Learning (SL) Activity | Number of Hours / Semester |
| 1 | **MOOCs / NPTEL Platform Learning:** Watching designated online video lecture sequences regarding foundational "Fluid Mechanics" principles, fluid statics, or applied engineering thermodynamics. | 24 |
| 2 | **Competitive / GATE-Based Aptitude Practice:** Solving advanced numerical problems at RBL4 and RBL5 levels related to the First and Second Laws of Thermodynamics, non-flow work processes, and hydraulic pump efficiencies. | 24 |

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

| Criteria | 4 – Excellent | 3 – Good | 2 – Fair | 1 – Needs Improvement |
|---|---|---|---|---|
| **PI-1: Technical Knowledge and Conceptual Understanding (CO1, CO2 / PO1, PO2)** | Demonstrates comprehensive understanding of mine drainage, pumping systems, fluid measurement, and compressor cycles; concepts are applied accurately. | Demonstrates good understanding with minor conceptual errors. | Demonstrates satisfactory understanding but lacks depth. | Limited understanding with several conceptual errors. |
| **PI-2: Engineering Analysis and Problem Solving (CO2, CO3 / PO2, PO4)** | Performs calculations accurately, selects appropriate engineering methods/equipment, and justifies solutions using sound engineering principles. | Performs calculations with minor errors; justification is mostly appropriate. | Solves basic problems with moderate accuracy; limited justification. | Significant errors in analysis and equipment selection. |
| **PI-3: Teamwork and Collaboration (CO3 / PO9)** | Actively contributes, coordinates effectively, shares responsibilities equally, and supports team members throughout the activity. | Participates actively and completes assigned responsibilities. | Participates moderately with occasional contribution. | Limited participation; depends heavily on teammates. |
| **PI-4: Technical Report, Presentation and Communication (CO3 / PO10)** | Report and presentation are exceptionally organized, technically accurate, supported by diagrams/charts, and delivered confidently with effective responses to questions. | Well-organized report and presentation with minor shortcomings. | Adequate report and presentation with acceptable technical content. | Incomplete report or weak presentation with poor organization. |

| SOIL AND ROCK MECHANICS | | | |
|---|---|---|---|
| Course Code | 1BMN402 | Scheme | 2025 |
| Type of course | IPCC | Semester | IV |
| Teaching Hours/Week (L:T:P) | 70 (3:0:2) | CIE Marks | 50 |
| Total Hours of Pedagogy L:T:P:SL:TW | 120(42:0:28:50) | SEE Marks | 50 |
| Credits | **4** | Total Marks | 100 |
| Type of Examination (IPCC): | Theory- CIE +SEE, and Lab- CIE only | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

CO1 (L2): Explain the fundamental concepts of geotechnical engineering and characterize soils, rocks, and geological discontinuities relevant to mining engineering applications.

CO2 (L3): Determine the physical, mechanical, and hydraulic properties of soils, rocks, and rock masses using appropriate laboratory and field methods.

CO3 (L4): Analyze two-dimensional stress–strain conditions in rocks and apply Mohr's circle to evaluate stresses acting on planes of weakness.

CO4 (L5): Evaluate rock deformability, strength characteristics, and failure behavior using stress–strain relationships and established rock failure criteria.

CO5 (L5): Assess rock mass quality and engineering behavior using standard rock mass classification systems for mining and underground excavation applications.

**Module-1**

**Introduction to Geotechnical Engineering & Material Characterization**

- Introduction: Definition, scope, and historical evolution of Geotechnical Engineering in mining operations. Distinction between soil mechanics and rock mechanics; the engineering distinction between intact rock material and a rock mass.
- Soil Characterization: Index properties of soil, phase relationships (void ratio, porosity, water content, saturation). Basic engineering classification of soils for mine site infrastructure.
- Rock Characterization: Geotechnical description of core samples. Core recovery and Rock Quality Designation (RQD) calculation.
- Discontinuities: Types of geological discontinuities (faults, joints, bedding planes, shears). Characterization of discontinuities: orientation (dip/strike), spacing, persistence, roughness, aperture, and infilling material. Impact of structural features on mining excavations.

**CO linkage: CO1** **Number of Hours (CI ): 8 hours**:

**Module-2**

**Engineering Properties of Soil and Rock:**

- Physical properties of soils and rocks: density, porosity, void ratio, moisture content and permeability.
- Mechanical properties of rocks. Swelling and slaking characteristics of rocks. Compressive, tensile and shear strength of rocks.
- Determination of engineering properties through laboratory and field tests.
- Hydraulic properties of rocks and rock masses. Groundwater flow through rock discontinuities and its engineering significance.

**CO linkage: CO2** **Number of Hours (CI ): 8 hours**:

**Module-3**

**Analysis of Stress and Strain:**

- Stress-Strain Relationships: Concept of stress and strain tensors. Equation of equilibrium, compatibility equation,
- Stress and strain analysis in two dimensions (2D). Principal stresses and invariant states of stress.
- Mohr's Circle: Construction of Mohr's Circle for 2D stress states. Applications of Mohr's Circle in determining normal and shear stresses on planes of weakness (joints/faults).

**CO linkage: CO3** **Number of Hours (CI ): 8 hours**:

**Module-4**

**Rock deformability, Rock Strength and Failure Theories:**

- Rock Deformability: Static and dynamic elastic constants (Young's Modulus E, Poisson's Ratio ν, Bulk Modulus K, Shear Modulus G). Methods for measuring rock deformability in the laboratory and in-situ (plate bearing test, borehole jack test).
- Rock Strength: Rock strength and factors affecting strength. Analysis and interpretation of stress–strain curves. Failure mechanisms in rocks under compression, tension and shear.
- Rock failure criteria: Mohr–Coulomb, Griffith and Hoek–Brown theories. Influence of anisotropy and discontinuities on rock strength.

**CO linkage: CO4** **Number of Hours (CI ): 8 hours**:

**Module-5**

**Rock Mass Classification Systems:**

- Engineering Classification of Rock Masses: Need for classification in engineering design. Objectives and limitations of empirical classification systems.
- Rock Quality Designation (RQD), Rock Mass Rating (RMR) system, Q-System of rock mass classification, Geological Strength Index (GSI), Estimation of rock mass properties from classification systems.
- Applications of rock mass classification in mining excavations, tunnels and slopes. Case studies illustrating the use of rock mass classification in engineering design and excavation assessment.

**CO linkage: CO5** **Number of Hours (CI ): 8 hours**:

**PRACTICAL COMPONENTS OF IPCC (LI=28 Hrs)**

1. Determine the natural water content (moisture content) of a given soil sample using the oven-drying method.
2. Determine the grain size distribution of a coarse-grained soil sample by mechanical sieve analysis
3. Determination of Porosity in rocks.
4. Determination of moisture content in rocks.
5. Determine the coefficient of permeability (k) of a soil sample using the Constant Head or Falling Head Permeameter method.
6. Determination of Rock Quality Designation (RQD) of Rock.
7. Determination Slake durability index of rocks.
8. Stereographic Hemispherical projections Problem – slope/bench failure.
9. Verification of 2D stress states using photoelastic bench or software simulation models.
10. RMR and Q-system rating calculation exercises for a given set of field mining data.

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

**Text books:**


1. *Goodman, Introduction to Rock mechanics, Easrtern Wiley*
2. *Deb, D. and Verma, A.K. – Fundamentals and Applications of Rock Mechanics, PHI Learning.*
3. Bhutada, S.M. – *Soil Mechanics and Rock Mechanics*, Kataria Publishers.


**Reference books / Manuals:**


4. Brady, B.H.G. and Brown, E.T. – *Rock Mechanics for Underground Mining*, Springer.
5. Gopal Ranjan & A.S.R. Rao – *Basic and Applied Soil Mechanics*, New Age International.
6. Ramamurthy, Introduction to Rock Engineering,, PHP


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

https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ce13
https://nptel.ac.in/courses/105105168
https://nptel.ac.in/courses/105105212
https://nptel.ac.in/courses/105103097

**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**.

**Continuous Internal Evaluation (CIE):**

i. **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.

ii. **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.

iii. 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.

**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).

**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 each from both Part A and Part B.

| **Table – ICs/IPCCs 1 Distribution of marks** | | |
|---|---|---|
| **Component** | **Description** | **Marks** |
| **Allotment of marks for regular class work** | | |

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

**Students' activities for TW/SL under NCrF:** As per National credit farmwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Selfe learning (TW/Sl-50 hours). Hence, students must complete minimum of two actives as part of NCrF. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below. The course coordinator can also design learning activities based on 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. | **Geotechnical Investigation and Rock Mass Characterization Project:** Collection and interpretation of borehole/core logging data, determination of RQD, identification and characterization of discontinuities using field photographs or mine/quarry case studies | 24 |
| 2. | **Stress Analysis and Rock Property Evaluation Assignment:** Numerical problems on stress-strain relationships, Mohr's circle, principal stresses, determination of elastic constants, and interpretation of laboratory test results on rock strength and deformability. | 24 |
| 3. | **Rock Mass Classification Case Study/Seminar:** Application of RMR, Q-System, and GSI to a mining or tunneling project. Preparation of a technical report and seminar presentation on the suitability of the rock mass for excavation. | 24 |

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

| Sl. No. | Self-Learning (SL) Activity | Number of Hours / Semester |
|---|---|---|
| 1 | **Online Learning Module:** Completion of MOOCs, NPTEL lectures, spoken tutorials, or online resources on Soil Mechanics, Rock Mechanics, Geotechnical Engineering, or Rock Mass Classification, followed by submission of a learning report. | 24 |
| 2 | **Literature Review and Technical Report:** Study of published case studies on mine excavations, tunnel failures, rock bursts, or geotechnical investigations, and preparation of a technical summary highlighting engineering lessons learned. | 24 |
| 3 | **Independent Study on Modern Geotechnical Practices:** Review of current technologies such as borehole imaging, geophysical investigations, numerical modeling, digital core logging, and AI applications in rock engineering, followed by a presentation/report. | 24 |

| Criteria | 4 – Excellent | 3 – Good | 2 – Fair | 1 – Needs Improvement | Criteria |
|---|---|---|---|---|---|
| PI-1: Technical Understanding and Application (CO1, CO2 / PO1, PO2) | Demonstrates comprehensive understanding of geotechnical investigation, rock mass characterization, stress analysis, and rock mass classification; applies concepts accurately to engineering problems. | Demonstrates good understanding with only minor conceptual errors. | Demonstrates satisfactory understanding with limited application of concepts. | Demonstrates limited understanding with several conceptual errors. | Unable to demonstrate basic understanding of the subject. |
| PI-2: Engineering Analysis and Interpretation (CO2, CO3 / PO2, PO4) | Accurately performs calculations (RQD, stresses, elastic constants, RMR/Q/GSI), interprets results critically, and provides technically justified conclusions. | Performs analysis with minor errors and provides reasonable interpretation. | Completes basic analysis with moderate accuracy and limited interpretation. | Frequent errors in calculations and interpretation. | Unable to perform engineering analysis or interpret results. |
| PI-3: Teamwork, Planning and Participation (CO3 / PO9) | Demonstrates excellent collaboration, equitable task distribution, leadership, and active participation throughout the project. | Works effectively within the team and completes assigned responsibilities. | Participates satisfactorily but contributes inconsistently. | Limited participation and coordination with team members. | Does not contribute effectively to team activities. |
| PI-4: Technical Report, Seminar Presentation and Communication (CO3 / PO10) | Produces a professional technical report with well-organized content, figures, tables, and references; delivers an excellent seminar with confident responses to questions. | Report and presentation are well organized with minor deficiencies. | Report and presentation are satisfactory but lack technical depth or clarity. | Report or presentation is incomplete, poorly organized, or contains significant errors. | Report not submitted or presentation ineffective. |

**Suggested rubrics for Practical continuous assessment:**

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

| SURFACE MINING TECHNOLOGY | | | |
|---|---|---|---|
| Course Code | **1BMN403** | Scheme | **2025** |
| Type of Course | Professional Core Course (PCC) | Semester | IV |
| Teaching Hours/Week (L:T:P) | 70 (3:2:0) | CIE Marks | 50 |
| Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL | 120(42:28:0:50) | SEE Marks | 50 |
| Credits | **4** | Total Marks | 100 |
| Examination type (SEE) | **Theory** | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

- CO1 (L3): Apply surface mining principles to select mining systems, design benches, plan box cuts, and estimate drilling requirements.
- CO2 (L3): Evaluate the applicability and productivity of cyclic excavation and transport equipment used in surface mines.
- CO3 (L3): Analyze continuous excavation and transportation systems and determine their suitability for different mining conditions.
- CO4 (L3): Select suitable semi-continuous mining systems and dimensional stone extraction methods for specific mining situations.
- CO5 (L4): Analyze mine slope stability problems and recommend appropriate slope protection, stabilization, and monitoring measures.

## Module-1

**Introduction**

Surface mining - Basic concepts, applicability, advantages and disadvantages; Role of surface mining in total mineral production; Deposits amenable to surface mining vis-à-vis excavation characteristics; Surface mining unit operations; Surface mining systems vis-à-vis equipment systems – classification, applicability, advantages and disadvantages. Bench parameters and the factors influencing the bench parameters. Problems.

**Opening up of deposits**

Box cut – objective, types, parameters, methods; Factors affecting selection of site for box; Production benches – formation, parameters and factors affecting their selection.

**Preparation for excavation**

Ripper: Types, classification, applicability and limitations; Method and cycle of operation; Estimation of output; Concept of rippability.

Estimation of number of drills required for a given mine production.

**Linked COs: CO1** **Number of Hours: 14**

## Module-2

**Discontinuous/cyclic methods of excavation and transport**

**Shovel-dumper operation:** Applicability and limitations of electric shovel, hydraulic excavators and dumpers; Cycle time and productivity calculation for shovel and dumper; Estimation for equipment (shovel, dumper and other heavy earth moving machines) required for a given mine production; Method of work for sub-surface bedded and massive deposits and for hilly massive deposits by shovel – dumper combination.

**Dragline operation:** Applicability and limitations, different modes of operation; Side cast diagram and calculation of reach; Cycle time and productivity calculation; Calculation of required bucket capacity for a given handling requirement; Maximum usefulness factor and its significance in selection of dragline for a given situation; Method of work by simple side casting.

**Front-end-loaders:** Applicability and limitations; Method and cycle of operation; Minimum tipping- load – concept, estimation and significance; Calculation of maximum working load and selection of bucket capacity of a front-end-loader for a given job condition.

**Scrapers:** Applicability and limitations, various types; Method and cycle of operation; Pusher dozer and pushpull operation.

**Dozers:** Applicability and limitations; Types and classification; Types of blade and corresponding merits and demerits; Method and cycle of operation.

**Linked COs: CO2** **Number of Hours:14**

## Module-3

**Continuous methods of excavation and transport**

**Bucket wheel excavators:** Applicability and limitations; Types and principle of operation; Operational methods – lateral block / half block method, full block methods and their corresponding merits and demerits; Calculation of productivity.

**Continuous surface miners:** Types, classification, applicability and limitations; Principles of operation; Operational methods – classification; Wide / full bench method, block mining method and stepped cut method; Empty travel back method, turn back method and continuous mining method; Conveyor / truck loading method, side casting method and windrowing method, Respective merits & demerits and applicability & limitations of these methods.

**Conveyors:** Mode of operation, applicability and limitations; Merits and demerits of conveyor as a system of transportation; Load Area Calculation for a troughed belt conveyor; Shiftable and high angle conveyors.

**Linked COs: CO3** **Number of Hours:14**

**Module-4**

**Semi-continuous methods of excavation and transport**

**Continuous excavation and partly/fully cyclic transport system:** Different methods and applicability & limitations. Cyclic excavation and partly/fully continuous transport system: Different in-pit crushing and conveying methods and their respective applicability &limitations.

**Dimensional stone Mining**

**Dimensional stones:** Types, occurrences and uses; Methods vis-à-vis equipment for extraction of primary blocks in granite and marble quarries.

**Linked COs:CO4** **Number of Hours:14**

**Module-5**

**Slopes in surface mines**

Types of mine slope – highwall and waste dumps; Common modes of slope failure; Factors influencing stability of slopes; Slope stability assessment techniques; Waste dumps - types and formation methods; Slope protection, stabilization and monitoring.

**Linked COs: CO5** **Number of Hours:14**

**Suggested Learning Resources**

**Text books:**

1. Surface Mining Technology S.K.Das, Lovely Prakashan, Dhanbad, 1994.
2. Surface Mining G.B.Mishra, Dhanbad Publishers, 1978.

**Reference books / Manuals:**

1. Opencast Mining R.T. Deshmukh M. Publications, Nagpur 1996
2. Rock Slope Engineering Hock and Bray, The Institution of Mining and Metallurgy, 1981.

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

4. https://onlinecourses.nptel.ac.in/noc21_mm40/preview

**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.

- Concept-driven lectures using visualisation of stress states, real civil-engineering examples (beams, columns, slabs) and frequent micro-questions.
- Regular tutorial/problem-solving sessions focusing on typical exam and design-style numericals.
- Short case snippets (e.g., beam cracking, column buckling) to connect theory with practice and safety.
- 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 farmwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-52 hour) and Teamwork/ Selfe learning (TW/Sl-64 hours). Hence, students must complete minimum of two actives as part of NCrF. These learning activitiesbThe 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 | Assignments on excavation methods, equipment selection, and productivity calculations (Modules 1–3) | 25 |
| 2 | Industrial Visit / Case study report on surface mining operations or slope stability analysis | 25 |

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

| Sl. No. | Self-Learning (SL) Activity | Number of Hours / Semester |
|---|---|---|
| 1. | NPTEL / MOOC course on Surface Mining / Mining Machinery (as given in syllabus link) | 25 |
| 2. | Study of reference books (S.K. Das, G.B. Mishra) and solving numerical problems | 25 |

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

| Criteria | 4 – Excellent | 3 – Good | 2 – Fair | 1 – Needs Improvement |
|---|---|---|---|---|
| PI-1: Understanding of excavation methods and equipment selection (CO1, PO1, PO2) | Demonstrates comprehensive understanding with accurate application to mining conditions. | Demonstrates good understanding with minor errors. | Shows satisfactory understanding but lacks depth. | Limited understanding with several conceptual errors. |
| PI-2: Productivity calculations and problem-solving (CO2, PO1, PO2) | Performs all calculations accurately with proper methodology and interpretation. | Minor calculation errors; methodology mostly correct. | Calculates correctly with guidance; interpretation limited. | Frequent errors in calculations and methodology. |
| PI-3: Industrial visit/case study analysis and technical report (CO3, PO3, PO4, PO10) | Excellent technical report with critical analysis, diagrams, and professional presentation. | Well-organized report with adequate analysis. | Satisfactory report with basic observations. | Incomplete report with limited analysis. |
| PI-4: Communication, teamwork and presentation (CO3, PO9, PO10) | Excellent teamwork, leadership, and confident technical presentation. | Good participation and communication skills. | Average participation with acceptable communication. | Minimal participation and weak communication. |

**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.
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.
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.
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:**

iv. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
v. 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.
vi. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).

| MINE SURVEYING AND GEOSPATIAL TECHNIQUE | | | |
|---|---|---|---|
| Course Code | **1BMN404** | Scheme | **2025** |
| Type of Course | **PCC** | Semester | IV |
| Teaching Hours/Week (L:T:P) | 42 (3:0:0 ) | CIE Marks | 50 |
| Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL | 90(42:0:0:48) | SEE Marks | 50 |
| Credits | **3** | Total Marks | 100 |
| Examination type (SEE) | **Theory** | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

- CO1 (L2): Explain the principles of surveying and perform linear measurements using chain surveying techniques.
- CO2 (L3): Determine bearings, measure angles using theodolites, and compute and adjust traverses.
- CO3 (L3): Carry out levelling operations and prepare profiles and cross-sections for engineering applications.
- CO4 (L3): Apply contouring and triangulation methods for topographic surveys and mapping.
- CO5 (L4): Utilize GIS and remote sensing techniques for mine planning and environmental monitoring.

**Module-1**

**Surveying:** Definition, objective, classification and principles of surveying.

**Linear Measurement:** Instruments for measuring distances; Ranging and taping survey lines; Chain surveying – principle, field work, off-sets, booking and plotting, obstacles in taping.

**Linked COs: CO1** **Number of Hours: 08**

**Module-2**

**Angular Measurement:** Bearing of lines; Rectangular coordinate system; Essentials of the micro-optic theodolite; Measurement of horizontal and vertical angles; Temporary and permanent adjustments; Theodolite traversing; Computation of co-ordinates; Adjustment of traverse.

**Linked COs: CO2** **Number of Hours:08**

**Module-3**

**Levelling:** Definition & terminology; Levelling instruments types - tilting, auto set and digital levels; Levelling staves; Different types of levelling - differential, profile, cross-sectional and reciprocal levelling; Booking and reduction methods; Underground levelling; Temporary and permanent adjustments of levels.

**Linked COs: CO3** **Number of Hours:09**

**Module-4**

**Contours:** Contour, contour interval and characteristics, uses of contours.

**Triangulation** – Principles, classification, steps in triangulation survey, base line measurements and corrections, base networks, Problems. Comparison with precise EDM traversing.

**Linked COs:CO4** **Number of Hours:08**

**Module-5**

**Geospatial Technologies in Mining:** Basics of Geographic Information Systems (GIS), Spatial data types: raster and vector, Remote sensing principles and platforms, Satellite imagery interpretation for mining, GIS applications in mine planning and environmental monitoring.

**Linked COs: CO5** **Number of Hours:09**

**Suggested Learning Resources**

**Text books:**

1. "Surveying Vol I & II" B.C.Punmia, Laxmi publications, 1999
2. "Surveying And Levelling", Rangwala, Charotar Publishing House Pvt. Ltd. Edition 7, Jan 2014.

**Reference books / Manuals:**

1 Surveying &Levelling By P.B.Shahani, Vol-I.

2 Surveying by S.K.Duggal, Vol-I

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

https://nptel.ac.in/courses/105107122

**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 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 farmwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-52 hour) and Teamwork/ Selfe learning (TW/Sl-64 hours). Hence, students must complete minimum of two actives as part of NCrF. These learning activities can be considered as CCA components of 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. | **Survey Field Assignment:** Conduct chain surveying, traversing, and levelling exercises for a selected area; prepare field books, calculations, and survey plans/maps. | 25 |
| 2. | **Seminar/Mini Project on Modern Surveying Technologies:** Study and present applications of GIS, Remote Sensing, GPS/GNSS, UAV-based surveying, or digital surveying techniques in mining. | 25 |

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

| Sl. No. | Self-Learning (SL) Activity | Number of Hours / Semester |
|---|---|---|
| 1 | **MOOC/Online Learning Activity:** Complete online modules, NPTEL courses, spoken tutorials, or technical videos related to surveying, GIS, remote sensing, and mine mapping; maintain a learning log/report. | 25 |
| 2 | **Case Study and Technical Report:** Review a mining project utilizing modern surveying and geospatial technologies and prepare a report highlighting surveying methods, data acquisition, and applications in mine planning and monitoring. | 25 |

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

| Criteria | 4 – Excellent | 3 – Good | 2 – Fair | 1 – Needs Improvement |
|---|---|---|---|---|
| PI-1: Survey Planning, Technical Knowledge and Field Execution (CO1, CO2 / PO1, PO2) | Demonstrates excellent understanding of surveying principles; performs field measurements accurately using appropriate techniques and instruments with negligible errors. | Demonstrates good understanding with minor errors in field procedures or measurements. | Demonstrates satisfactory understanding with acceptable accuracy and occasional guidance. | Demonstrates limited understanding with frequent procedural or measurement errors. |
| PI-2: Data Processing, Calculations and Map Preparation (CO2, CO3 / PO2, PO4, PO5) | Performs all calculations accurately; prepares well-presented survey plans/maps using appropriate software or manual methods with correct interpretation. | Performs calculations with minor errors and prepares clear survey plans/maps. | Completes calculations and maps with moderate accuracy and limited interpretation. | Frequent errors in calculations and map preparation; interpretation is inadequate. |
| PI-3: Teamwork, Planning and Task Management (CO3 / PO9) | Demonstrates excellent collaboration, leadership, equitable task distribution, and active participation throughout the activity. | Works effectively within the team and completes assigned responsibilities on time. | Participates satisfactorily but contributes inconsistently. | Limited participation and coordination with team members. |
| PI-4: Technical Report, Seminar Presentation and Communication (CO3 / PO10) | Produces a professional report with accurate field records, calculations, maps, references, and delivers an excellent seminar with confident responses to questions. | Report and presentation are well organized with minor deficiencies. | Report and presentation are satisfactory but lack technical depth or clarity. | Report or presentation is incomplete, poorly organized, or contains significant errors. |

| MINE SURVEYING AND GIS LAB | | | |
|---|---|---|---|
| Course Code | **1BMNL405** | Scheme | 2025 |
| Type of Course | PCCL | Semester | IV |
| Teaching Hours/Week (L:T:P) | 28 (0:0:2) | CIE Marks | 50 |
| Total Hours of Pedagogy L:T:P:SLTW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Examination type (SEE) | Practical | Exam Hours | 03 |

**Course outcome (Course Skill Set):**

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

1. CO1 – L3: Perform chain surveying and compass traversing to determine distances, bearings, and prepare survey plans.
2. CO2 – L3: Carry out levelling operations and compute reduced levels for surface and underground mine surveys.
3. CO3 – L3: Operate theodolites to measure angles and conduct traverse surveys for mine layout and control.
4. CO4 – L4: Analyze survey data to prepare traverse plots, contour maps, and mine gradients
5. CO5 – L5: Design and execute survey solutions for open-ended mining problems using surveying and GIS techniques.

**Note:**

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 6 - 8 conventional experiments, PART-B has 6 typical open-ended experiments. The maximum marks for the laboratory course are 100.
2. Both PART-A and PART-B are considered for CIE and SEE.
3. Students are required to answer 1(one) question from PART- A and 1(one) question from PART- B.
    a. The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for 70 marks out of the maximum 100 marks.
    b. The open-ended question set for SEE shall be any other open-ended question and not selected from the experiments under PART-A. It shall be evaluated for 30 marks out of the maximum 100 marks.

**PART – A**
**FIXED EXPERIMENTS**

1. To survey an area by chain survey across obstacles and to calculate the obstructed lengths by using different methods.
2. To conduct a compass traverse survey of a closed traverse and determine the included angles and plot the traverse.
3. To find the difference in elevation and calculate the reduced levels of various points by H.I method, and Rise & Fall method.
4. To determine the reduced levels (RLs) of underground points by levelling and transfer surface benchmark level to underground workings.
5. To determine horizontal and vertical angles using theodolite.
6. To conduct a theodolite traverse survey of a closed traverse and determine included angles, bearings, and plot the traverse.

**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.

1. Concept 1: Design a Survey for Area Mapping Using Chain Surveying.
2. Concept 2: Establish a Traverse for Mine Layout Using Theodolite

3. Concept 3: Determine Underground Mine Gradient Using Levelling
4. Concept 4: Generate Contour Map for a Proposed (Mine) Site
5. Concept 5: Compare Traverse Surveying and Triangulation for Mine Control
6. Concept 6: GIS-Based Mine Site Analysis Using Spatial Data

**Suggested Learning Resources: (Textbook/ Reference Book/ Manuals):**

**Text books:**

1. Punmia, B. C. (2005), Surveying Vol. 1 and II
2. "Surveying And Levelling", Rangwala, Charotar Publishing House Pvt. Ltd. Edition 7, Jan 2014.

**Reference books / Manuals:**

1. Surveying &Levelling By P.B.Shahani, Vol-I.
2. Surveying by S.K.Duggal, Vol-I

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

1. NPTEL: Introduction to Mining Engineering and Mine Planning.
2. NPTEL / IIT courses on CAD drafting and technical drawing.
3. Online resources on mine planning, ventilation, and safety drawings

**Assessment Structure:**

The assessment for each of the Laboratory courses 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).

- To pass the **CIE**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 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**.

The CIE marks awarded shall be based on continuous assessments for 30 marks through rubrics and lab tests for 20 marks.

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. The summation of all the experiments marks to be scaled down to 30 marks.

The laboratory test at the end of the last week of the semester / after completion of all the experiments (whichever is early) shall be conducted for 100 marks and scaled down to 20 marks. For laboratory test and SEE, the student is required to conduct one experiment each from both Part A and Part B. Part A is assessed with a weightage of 70%, while Part B carries a weightage of 30%.

**Rubrics suggested for Practical continuous assessment**

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

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

| BASIC PYTHON LABORATORY FOR MINING ENGINEERING | | | |
|---|---|---|---|
| Course Code | **1BMNL406A** | 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 L :T:P:SL:TW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Type of Examination | Practical | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

CO1 (L2): Develop Python programs using basic control structures, operators, and conditional statements to solve simple mining-related problems.

CO2 (L3): Implement Python programs employing lists, searching, and sorting techniques for processing and analyzing mining and geological data.

CO3 (L3): Develop Python programs for mining engineering calculations such as powder factor, stripping ratio, productivity, and blending ratio.

CO4 (L4): Analyze mining operational, exploration, and safety data to support engineering decision-making.

CO5 (L3): Create Python programs for processing textual and numerical mining records and equipment maintenance data.

**SET OF EXPERIMENTS (LI =28 hours)**

1. Develop a Python program to check whether a given blast hole number is odd or even to assign specific delay detonator series. (Odd/Even Check)
2. Develop a Python program to find the highest and lowest ore grade (%) from a list of assay values collected from a strike length, and identify if any value falls below the economic cut-off grade. (Min/Max in a List)
3. Develop a Python program to arrange a list of RQD (Rock Quality Designation) values or core sample lengths in both ascending and descending order to classify rock mass quality zones. (Sorting)
4. Develop a Python program using **Binary Search** to quickly locate a specific borehole depth or coal seam elevation from a sorted database of exploration drilling records.
5. Develop a Python program to accept gas concentration readings from three different shifts, calculate the average of the two highest readings, and generate a safety alert if the average exceeds permissible limits. (Best of Two Averages)
6. Develop a Python program to calculate the powder factor for a given mining condition.
7. Develop a Python program to calculate the stripping ratio for a given mining conditions and to select a suitable mining method.
8. Develop a Python program to calculate the productivity for the given mining conditions.
9. Develop a Python program to calculate the blending ratio for a given grade of deposits from different benches.
10. Write a Python program that accepts an equipment maintenance log entry (sentence) and counts the total number of words (for descriptions), digits (for equipment IDs), uppercase letters (for fault codes like "HEMM"), and lowercase letters. (String/Digit Counter)

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

**Text books:**

1. Core Python Programming, W.Chun, Pearson.
2. Introduction to Python, Kenneth A. Lambert, Cengage

**Reference books / Manuals:**

1. Learning Python, Mark Lutz, Orielly

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

- https://nptel.ac.in/courses/106106145

**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 (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) |

| AI APPLICATION LAB IN MINING ENGINEERING | | | |
|---|---|---|---|
| Course Code | 1BMNL406B | 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 L :T:P:SL:TW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Type of Examination | Practical | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

CO1 (L3): Apply machine learning algorithms such as k-NN, Decision Trees, Naïve Bayes, and Linear Regression to mining problems.

CO2 (L3): Develop AI-based classification and prediction models for mining and geological datasets.

CO3 (L4): Analyze mining operational and geoscientific data to support engineering decision-making.

CO4 (L3): Implement optimization and clustering techniques for mine planning and resource evaluation.

CO5 (L3): Utilize computer vision and intelligent monitoring methods for mine safety and operational applications.

**SET OF EXPERIMENTS (LI =28 hours)**

1. Rock Mass Classification using k-Nearest Neighbors (k-NN).
2. Drillability & Blastability Prediction using Decision Trees.
3. Ore vs. Waste Discrimination using Naive Bayes.
4. Optimizing Truck-Shovel Allocation using Genetic Algorithms (or Simple Heuristics).
5. Coal Seam Thickness Estimation using Linear Regression.
6. Mine Ventilation Gas Inflow Forecasting using Support Vector Regression (SVR).
7. Geochemical Anomaly Detection for Mineral Exploration.
8. Automated Ore-Body Domaining using k-Means Clustering.
9. Fragmentation Analysis using Image Thresholding (Basic Computer Vision).
10. HEMM Safety & Collision Warning System using Pre-trained Object Detection.

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

**Text books:**

1. Saptarsi Goswami, Amit Kumar Das and Amlan Chakrabarti, “AI for Everyone – A Beginner’s Handbook for Artificial Intelligence”, Pearson, 2024
2. Elaine Rich, Kevin Knight, and Shivashankar B. Nair, Artificial Intelligence, McGraw Hill Education.

**Reference books / Manuals:**

**2.** Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (4th Edition), Pearson Education, 2023.

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

1. Elements of AI – https://www.elementsofai.com
2. CS50’s Introduction to Artificial Intelligence with Python – Harvard https://cs50.harvard.edu/ai/
3. Google Machine Learning Crash Course – https://developers.google.com/machine-learning/crash-course
4. Learn Prompting (Open-Source Guide) – https://learnprompting.org
5. Google AI – Learn with Google AI https://ai.google/education/
6. Coursera – Machine Learning by Andrew Ng (Stanford University) https://www.coursera.org/learn/machine-learning
7. OpenAI Prompt Engineering Guide (for ChatGPT) https://platform.openai.com/docs/guides/gpt-best-practices
8. Prompt Engineering for Developers – DeepLearning.AI + OpenAI https://www.deeplearning.ai/short-courses/chatgpt-prompt-engineering-for-developers/
9. Ethics in AI – Google Responsible AI Practices https://ai.google/responsibilities/responsible-ai-practices/

**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 (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) |

| INTRODUCTION TO IOT & SENSORS LABORATORY | | | |
|---|---|---|---|
| Course Code | **1BMNL406C** | 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 L :T:P:SL:TW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Type of Examination | Practical | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

CO1 (L3): Develop IoT systems using Arduino/Raspberry Pi with appropriate sensors and actuators.

CO2 (L3): Design and implement IoT-based monitoring and control systems for real-time applications.

CO3 (L4): Analyze sensor data and system outputs for effective monitoring and automation.

CO4 (L3): Design smart IoT solutions for applications such as security, agriculture, parking management, and energy-efficient infrastructure.

CO5 (L3): Demonstrate advanced IoT applications integrating automation, cloud connectivity, voice assistants, and intelligent monitoring systems.

**SET OF EXPERIMENTS (LI =30Hrs)**

1. Design a smart bin using IoT with Arduino / Raspberry Pi.
2. Design water level monitoring system using IoT with Arduino / Raspberry Pi.
3. Design temperature monitoring system using IoT with Arduino / Raspberry Pi.
4. Design car parking management system using IoT with Arduino / Raspberry Pi.
5. Design smart street light monitoring system using IoT with Arduino / Raspberry Pi.
6. Design smart anti-theft system using IoT with Arduino / Raspberry Pi.
7. Design smart agriculture system using IoT with Arduino / Raspberry Pi.
8. Demonstration of face recognition bot using IoT.
9. Demonstration home automation system using IoT.
10. Demonstrate Alexa based smart home monitoring system using IoT

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

**Text books:**

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743).
2. Srinivasa K G, "Internet of Things", CENGAGE Leaning India, 2017.

**Reference books / Manuals:**

1 Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.(ISBN:978-8173719547)

2 Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

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

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs37

**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 (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) |

| DATA ANALYTICS WITH EXCEL LABORATORY | | | |
|---|---|---|---|
| Course Code | **1BMNL406D** | 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 L :T:P:SL:TW | 30 (0:0:28:2) | SEE Marks | 50 |
| Credits | 1 | Total Marks | 100 |
| Type of Examination | Practical | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

CO1 (L3): Operate spreadsheet software for creating, editing, formatting, and managing worksheets and workbooks.

CO2 (L3): Apply formulas, cell references, and built-in functions for data computation and analysis.

CO3 (L3): Import, clean, organize, and transform raw datasets for effective analysis.

CO4 (L4): Analyze datasets using sorting, filtering, lookup functions, conditional formatting, and Pivot Tables.

CO5 (L5): Develop complete spreadsheet-based analytical reports and dashboards from real-world datasets.

**SET OF EXPERIMENTS (LI =28 Hrs)**

1. Familiarize students with the Excel interface, workbook structure, and basic navigation properties.
2. Master entering, editing, moving, and rapidly populating data inside a worksheet.
3. Learn how to construct basic arithmetic formulas and understand how Excel handles dynamic cell locations.
4. Import raw data files into Excel and establish protocols for identifying structural data quality issues.
5. Resolve formatting inconsistencies and restructure text strings into normalized data columns.
6. Organize, isolate, and visually highlight key subsets of data based on specific analytical criteria.
7. Apply the most common mathematical and statistical functions used to summarize data distributions.
8. Learn how to merge and reference data across multiple tables or worksheets using lookup functions.
9. Build dynamic summary reports to analyze multi-dimensional data without writing complex formulas.
10. Independently apply the full spreadsheet data lifecycle to a raw, uncleaned industry dataset.

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

**Text books:**

1 **Walkenbach, J.**, *Excel 2019 Bible*, Wiley Publications.

2 **Winston, W.L.**, *Microsoft Excel Data Analysis and Business Modeling*, Microsoft Press.

3 **Alexander, M. and Kusleika, R.**, *Excel 2021 Power Programming with VBA*, Wiley Publications.

**Reference books / Manuals:**

1. **Frye, C.**, *Microsoft Excel Step by Step*, Microsoft Press.
2. **Marmel, E.**, *Teach Yourself Microsoft Excel*, Pearson Education.
3. **Powell, S.G. and Baker, K.R.**, *Management Science: The Art of Modeling with Spreadsheets*, Wiley Publications.
4. **Evans, J.R.**, *Business Analytics: Methods, Models and Decisions*, Pearson Education.
5. **Jelen, B.**, *Excel for Data Analysis: Your Visual Blueprint for Creating and Analyzing Data*, Wiley Publications.

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

https://www.coursera.org/learn/excel-basics-data-analysis-ibm

**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 (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) |

| BIOLOGY FOR MINING ENGINEERS | | | |
|---|---|---|---|
| Course Code | **1BMN407** | Scheme | **2025** |
| Type of Course | BSC | Semester | IV |
| Teaching Hours/Week (L:T:P) | 60(2:0:0) | CIE Marks | 50 |
| Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL | 60(28:0:0:32) | SEE Marks | 50 |
| Credits | **2** | Total Marks | 100 |
| Examination type (SEE) | **Theory** | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

CO1 (L2): Explain fundamental biological concepts and microbial activities relevant to mining environments.
CO2 (L2): Describe the role of microorganisms in mineral transformation and mining operations.
CO3 (L2): Explain the principles and applications of biomining and bioleaching for metal extraction.
CO4 (L2): Discuss biological methods for mine environmental management and remediation.
CO5 (L2): Illustrate sustainable mining practices and emerging biological technologies in the mining industry.

**Module-1**

**Introduction to Biology and Microorganisms:**

Basic concepts of biology and biotechnology; Cell structure and functions; Classification of microorganisms: bacteria, fungi, algae, and archaea; Microbial growth and environmental requirements; Interaction of microorganisms with minerals and rocks.

**Linked COs: CO1** **Number of Hours: 06**

**Module-2**

**Microbiology in Mining Operations:**

Introduction to mining microbiology; Iron- and sulfur-oxidizing microorganisms; Microbial weathering of rocks and minerals; Microbial activities in mine environments; Factors affecting microbial growth in mining systems.

**Linked COs: CO2** **Number of Hours: 06**

**Module-3**

**Biomining and Bioleaching:**

Principles of biomining, Bioleaching mechanisms, Recovery of metals using microorganisms, Applications in extraction of copper, gold, uranium, and zinc, Advantages and limitations of biomining.

**Linked COs: CO2, CO3** **Number of Hours:06**

**Module-4**

**Environmental Applications of Biology in Mining:**

Environmental impacts of mining, Acid Mine Drainage (AMD): causes and effects, Biological treatment of mine wastewater, Bioremediation of contaminated mine sites, Biosorption of heavy metals.

**Linked COs: CO5** **Number of Hours: 05**

**Module-5**

**Sustainable Mining and Future Biological Technologies:**

Concepts of sustainable and green mining, Biological methods for mine reclamation, Phytoremediation of degraded mine lands, Resource recovery from mine wastes, Emerging trends in biomining and environmental biotechnology.

**Linked COs: CO4, CO5, CO6** **Number of Hours: 05**

**Suggested Learning Resources:**

**Textbooks:**

1. Rawlings, D.E. and Johnson, D.B., *Biomining*, Springer.
2. Pepper, I.L., Gerba, C.P., and Gentry, T.J., *Environmental Microbiology*.
3. Ehrlich, H.L. and Newman, D.K., *Geomicrobiology*.

**Reference books / Manuals:**

1. Rittmann, B.E. and McCarty, P.L., *Environmental Biotechnology: Principles and Applications*.
2. Atlas, R.M. and Bartha, R., *Microbial Ecology: Fundamentals and Applications*.

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

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_bt17
2. https://nptel.ac.in/courses/127105593

**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. Use real samples, photographs, maps, and videos of mines, equipment, and mineral processing units.
2. ii. Encourage comparison of surface and underground mining methods through case-based discussions.
3. iii. Conduct field/site observations of mine layouts, drilling, blasting, ventilation, and safety systems.
4. iv. Use charts, models, and simple demonstrations to connect theory with mining 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 EE** is at least **40 out of 100 marks**.

**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).

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

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

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

As per National credit farmwork (NCrF) students must spend 90 hours of study for 3 credit courses, which include Course instructions (CI-42 hour) and Teamwork/ Selfe learning (TW/Sl-48 hours). Hence, students must complete minimum of two actives as part of NCrF. These learning activities can 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.

**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. | **Assignment and Case Study Analysis:** Study and report on applications of microorganisms in biomining, bioleaching, and environmental remediation in mining industries. | 16 |
| 2. | **Seminar/Mini Project:** Preparation and presentation on topics such as Acid Mine Drainage treatment, phytoremediation, sustainable mining practices, or emerging biological technologies in mining. | 16 |

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

| Sl. No. | Self-Learning (SL) Activity | Number of Hours / Semester |
|---|---|---|
| 1 | **Online Learning and Literature Survey:** Study MOOCs, NPTEL lectures, research articles, and technical reports related to biomining, mining microbiology, and environmental biotechnology. | 16 |
| 2 | **Technology Review and Report Writing:** Review recent developments in green mining, resource recovery from mine wastes, and biological reclamation techniques; prepare a summary report. | 16 |

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

| Criteria | 4 – Excellent | 3 – Good | 2 – Fair | 1 – Needs Improvement |
|---|---|---|---|---|
| **Problem Understanding** | 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. |
| **Construction/Design Details** | Sketches/details are accurate, neat, and professional. | Largely correct with minor layout errors. | Partially correct; several technical mistakes. | Incorrect or missing diagrams/details . |

| | | | | |
|---|---|---|---|---|
| **Safety & Sustainability** | 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. |
| **Presentation & Clarity** | Well-organized, easy to follow, and high-quality report. | Generally clear; some minor layout/format ti ng 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).

## ENVIRONMENTAL SCIENCE PROJECT

| | | | |
|---|---|---|---|
| Course Code | **1BEP408** | Scheme | **2025** |
| 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 | 1 | Total Marks | 100 |
| Examination type (SEE) | **Theory** | Exam Hours | 03 |

**Course Objectives:**

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

**Course outcome (Course Skill Set):**

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

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

**Restrictions and professional conduct:**

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

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

**Methods for project identification:**

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

**List of Project Topics and Engineering Outcomes:**

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

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

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

| | | | | |
|---|---|---|---|---|
| 16 | Smart irrigation system | Estimate crop water requirement, propose control logic, and quantify water savings compared with conventional irrigation. | PO1, PO2, PO3, PO4, PO5, PO10 | SDG 2, SDG 6, SDG 12 |
| 17 | Food security initiatives / cold storage system | Estimate storage need, design a simple cold-chain concept, and document reduction in spoilage or wastage. | PO1, PO2, PO3, PO4, PO5, PO10 | SDG 2, SDG 9, SDG 12 |

**Suggested Learning Resources**

| Particulars | Titles and Publishers |
|---|---|
| Textbooks | 1. Phadke, N. D., *Community Engagement and Social Innovation*, Oxford University Press, New Delhi.<br>2. Garg, N. R., *Project-Based Learning in Engineering Education*, Pearson India Education Services, Noida.<br>3. Gupta, A. and P. Singh, *Service Learning and Community Projects*, McGraw-Hill Education (India), New Delhi.<br>4. Wilson, G., *Practical Guide to Community Development Projects*, Routledge, London. |
| Reference books | 1. NPTEL courses on Project-Based Learning and Social Innovation.<br>2. SWAYAM courses on community engagement and sustainability.<br>3. UN Sustainable Development Goals portal.<br>4. MyGov India and local civic body portals for community initiatives.<br>5. YouTube resources on design thinking, social innovation, and community service learning.<br>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.<br>2. NPTEL courses on Soil Mechanics and Foundation Engineering.<br>3. Virtual Labs – Geotechnical Engineering Virtual Lab.<br>4. Geological Survey of India.<br>5. YouTube channels on civil engineering experiments.<br>6. American Society of Civil Engineers (ASCE) – Geotechnical resources and standards. |

**Teaching Learning Process:**

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

| **Week / Phase** | **Teaching–Learning Activity** | **Faculty Role** | **Student Activity** | **Output / Evidence** |
|---|---|---|---|---|
| 1 | Course introduction, objectives, ethics, conduct, and assessment briefing | Explain course scope, rules, rubrics, and expected deliverables | Understand course requirements and form teams | Team list, course plan |
| 2 | Community problem identification and topic selection | Guide topic framing and feasibility | Identify local issues through discussion and observation | Shortlisted project topic |
| 3 | Stakeholder interaction and preliminary survey | Demonstrate survey methods and stakeholder engagement | Collect initial data from community/users | Survey notes, interview record |
| 4 | Problem statement and objective formulation | Review and refine problem statement | Prepare problem statement, scope, and objectives | Approved problem statement |

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

**Assessment structure:**

**A. Continuous Internal Evaluation (CIE) – 50 marks**

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

**CIE pass requirement:**

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

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

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

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

the same department and one from a different department.

**SEE pass requirement and overall passing rule:**

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

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

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

**Notes for CIE rubric:**

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

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

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

**SEE pass rule:**

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

**Suggested implementation notes (for BoS / exam committees):**

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

| |
|---|
| • Awareness Campaign on Single-Use Plastic and E-Waste Management |
| **Suggested Learning Resources:**<br>**Text Books:**<br>1. Benny Joseph, *Environmental Studies*, Tata McGraw-Hill, 2nd Edition.<br>2. R. Rajagopalan, *Environmental Studies: From Crisis to Cure*, Oxford University Press, 2005.<br>3. Erach Bharucha, *Textbook of Environmental Studies*, University Press, latest edition as available in library.<br>4. M. P. Poonia and S. C. Sharma, *Environmental Studies*, Vikas Publishing House, latest edition as available<br>**Reference Books:**<br>1. R. Sivakumar, Principles of Environmental Science and Engineering, Cengage Learning, 2nd Edition.<br>2. G. Tyler Miller Jr., Environmental Science: Working with the Earth, Thomson Brooks/Cole, 11th Edition.<br>3. Pratibha Singh, Anoop Singh, and Piyush Malaviya, Text Book of Environmental and Ecology, Acme Learnin 1st Edition.<br>4. S. M. Prakash, Environmental Studies, Elite Publishing House, Mangalore, 3rd Edition, 2018. |
| **Web links and Video Lectures (e-Resources):**<br>1. VTU e-Learning Centre: http://elearning.vtu.ac.in<br>2. VTU e-Resources / e-Content: http://elearning.vtu.ac.in/e-Res.php<br>3. VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php<br>4. VTU Consortium Digital Resources: https://access.vtuconsortium.com/msec<br>5. VTU e-Learning Centre: http://elearning.vtu.ac.in<br>6. VTU e-Resources / e-Content: http://elearning.vtu.ac.in/e-Res.php<br>7. VTU e-Shikshana Lecture Videos: http://elearning.vtu.ac.in/esk3.php<br>8. VTU Consortium Digital Resources: https://access.vtuconsortium.com/msec |
| **Assessment Structure:**<br>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.<br>The weightage of marks for CIE and SEE is 50% each.<br>**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 | Analyzes most parameters correctly with minor | Some parameters analyzed, but interpretation is | Minimal or incorrect analysis. |

| Criterion | Weight (%) | 4 - Excellent | 3 - Good | 2 - Satisfactory | 1 - Needs improvement |
|---|---|---|---|---|---|
| | | parameters and interprets results. | interpretation gaps. | weak. | |
| 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. |

| MINE MECHANISATION – I | | | |
|---|---|---|---|
| Course Code | **1BMN409** | Scheme | **2025** |
| Type of Course | **PCC** | Semester | IV |
| Teaching Hours/Week (L:T:P) | 42 (3:0:0 ) | CIE Marks | 50 |
| Total Hours of Pedagogy per Semester CI (L /T): LI(P):TW&SL | 90(42:0:0:48) | SEE Marks | 50 |
| Credits | 3 | Total Marks | 100 |
| Examination type (SEE) | Theory | Exam Hours | 03 |

**Course outcome (Course Skill Set)**

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

CO1 (L2): Explain the construction, operation, maintenance, and calculations related to wire ropes and rope haulage systems used in mining applications.

CO2 (L2): Describe the working principles, applications, and performance calculations of locomotive haulage systems and underground ancillary equipment used in mines.

CO3 (L2): Describe the working principles, applications, and performance calculations of locomotive haulage systems and underground ancillary equipment used in mines.

CO4 (L2): Explain the construction, operation, and applications of rock drills, drilling accessories, and blast hole drilling equipment used in mining.

CO5 (L2): Understand the principles, components, safety devices, and calculations related to mine winding systems (drum and friction winding) used in underground mines.

**Module-1**

**Ropes:** Wire ropes of different types and their construction and selection, rope capping, recapping and rope splicing. estimation of size of rope and safety factor for ropes used in winding. Numerical problems.

**Rope haulages:** Classifications; Operation; Productivity calculation; Mine cars; Rope fittings; Scope and application.

**Linked COs: CO1** **Number of Hours: o8**

**Module-2**

**Locomotive haulages:** Electric, Battery, Diesel locomotives; Tractive effort; Drawbar pull; Ideal gradient; Optimum gradient; Neutral gradient; Super elevation; Track layouts & safety devices; Locomotive calculations; Scope & application.

**Ancillary Equipment:** Road header; LHD; Shuttle cars, LPDT, SDL. Man riding systems.

**Linked COs: CO2** **Number of Hours:09**

**Module-3**

**Ore Transporting Equipment in Surface Mines:** Dumpers: Classifications; System components and functions

**Belt conveyors:** System components and functions; Maintenance, Capacity & power calculations; Scope & application

**High Angle Conveyor:** Constructional features; Operation; Scope & application

**Cable belt conveyor:** Constructional features; Operation; Scope & application

**Pipe belt conveyor:** System components and functions; Scope & application

**Aerial ropeways:** Classifications; Operation; Angle stations; Loading & discharging stations; Buckets; Scope & application.

**Linked COs: CO3** **Number of Hours:09**

**Module-4**

**Rock Drills:** Types of rock drills, Constructional features and operation of electric and hydraulic coal drills; Jack hammers, Hydraulically operated drill machines, Electro hydraulic jumbo drills, Top hammer drills, DTH drills, Wagon drills, Blast hole drills, Drill bits, Drill rods, Flushing mechanisms.

**Linked COs:CO4** **Number of Hours:08**

**Module-5**

**Winding:** Drum and friction winding with their variations and limitations; duty cycle, torque time diagrams and computations; Multilevel and deep winding; Drives for winding; Safety devices on winders; emergency braking, over speed control, slow banking, depth indicators, automatic contrivances.

**Linked COs: CO5** **Number of Hours:08**:

**Suggested Learning Resources**

**Text books:**

1. **"**Elements of mining technology Vol III", ,D.J.Deshmukh, Vidyasewaprakashan, Nagpur, 7th Ed. 2000.
3. "Mine pumps haulage & winding", S. Ghatak, Coalfield Publishers, Asansol, 1st Ed. 1995.

**Reference books / Manuals:**

4. **"**Universal Mining School reports Vol I and Vol II", Cardif, Great , 1999.
5. "Mine Transport", Karerlin, Orient Longmans, 1967.
6. Mine Hoisting, M.A.Ramlu, Oxford & IBH, 1996.

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

- **https://onlinecourses.nptel.ac.in/noc21_mm17/preview**

**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 visualisation of stress states, real civil-engineering examples (beams, columns, slabs) and frequent micro-questions.
7. Regular tutorial/problem-solving sessions focusing on typical exam and design-style numericals.
8. Short case snippets (e.g., beam cracking, column buckling) to connect theory with practice and safety.
9. 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

**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 shall be awarded the grade 'F' (Fail).

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

As per National credit farmwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-52 hour) and Teamwork/ Selfe learning (TW/Sl-64 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. | Assignments on numerical problems related to wire ropes, haulage systems, conveyors, drilling and winding calculations | 8 |
| 2. | Seminar / Presentation on modern mine mechanization equipment (continuous miners, advanced drilling systems, automated haulage, etc.) | 8 |
| 3. | Mini project / Case study on selection and performance analysis of mine transportation or winding systems | 8 |
| | | |
| SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc. | | |
| Sl. No. | Self-Learning (SL) Activity | Number of Hours / Semester |
| 1 | Study through MOOCs / NPTEL / online resources on mine mechanization and mining equipment | 12 |
| 2 | Preparation of technical review/report on recent trends in mine mechanization and automation | 12 |

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

| Criteria | 4 – Excellent | 3 – Good | 2 – Fair | 1 – Needs Improvement |
|---|---|---|---|---|
| PI-1: Technical Knowledge and Application (CO1, CO2 / PO1, PO2) | Demonstrates comprehensive understanding of mine machinery, haulage, winding, drilling, and conveying systems; accurately applies engineering principles to solve problems. | Demonstrates good understanding with minor conceptual or application errors. | Demonstrates satisfactory understanding with moderate accuracy. | Demonstrates limited understanding with several conceptual errors. |
| PI-2: Engineering Analysis and Problem Solving (CO2, CO3 / PO2, PO4) | Performs numerical calculations accurately, selects suitable equipment/system, and provides well-justified engineering solutions based on technical analysis. | Performs calculations with minor errors and provides appropriate justification. | Solves basic engineering problems with acceptable accuracy but limited justification. | Frequent errors in calculations and engineering analysis. |
| PI-3: Teamwork, Planning and Project Execution (CO3 / PO9) | Demonstrates excellent collaboration, leadership, equitable task distribution, and timely completion of assigned work. | Actively participates and fulfills assigned responsibilities effectively. | Participates satisfactorily with occasional contribution. | Limited participation and coordination within the team. |
| PI-4: Technical Report, Seminar Presentation and Communication (CO3 / PO10) | Prepares a professional report with appropriate figures, calculations, and references; delivers an excellent presentation with confident responses to questions. | Report and presentation are well organized with minor deficiencies. | Report and presentation are satisfactory but lack technical depth or clarity. | Report or presentation is incomplete, poorly organized, or contains significant errors. |