

| PROBABILITY AND STATISTICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                              |             |                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-------------|----------------------------|
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1BMATCV301                   | Scheme      | 2025                       |
| Type of Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Applied Science Course (ASC) | Semester    | III                        |
| Teaching Hours/Week (L: T: P)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 70 (3:2:0)                   | CIE Marks   | 50                         |
| Total Hours of Pedagogy per semester<br>CI (L /T):LI(P):SL&TW:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 120 (42:28:0:50)             | SEE Marks   | 50                         |
| Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 4                            | Total Marks | 100                        |
| Examination type (SEE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Theory                       | Exam Hours  | 03                         |
| CO1: Apply probability rules, random variables, and common probability distributions to engineering problems.<br>CO2: Use sampling distributions, estimation, and hypothesis testing to draw statistical inferences.<br>CO3: Interpret statistical results, discuss assumptions and limitations, and relate them to engineering practice.<br>CO4: Analyze relationships between variables using correlation and regression models.                                                                                                                                    |                              |             |                            |
| Module-1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |             |                            |
| <b>DESCRIPTIVE STATISTICS:</b> Role of statistics in engineering; types of data, scales of measurement, collection and presentation of data. Frequency distribution, histograms, bar diagrams, pie charts, and box plots. Measures of central tendency: mean, median, and mode for grouped and ungrouped data. Measures of dispersion: range, variance, standard deviation, and coefficient of variation. Concept of skewness and kurtosis.<br><b>(RBT Levels: LI, L2 and L3)</b>                                                                                     |                              |             |                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                              |             | <b>Number of Hours: 8</b>  |
| Module-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |             |                            |
| <b>PROBABILITY AND RANDOM VARIABLES</b><br><b>Review</b> on sample space, events, axioms of probability, conditional probability, independence of events, total probability theorem, and Bayes theorem.<br>Random variables, discrete and continuous types, probability mass function, probability density function, cumulative distribution function. Expectation and variance. Joint distributions for two discrete variables.<br><b>(RBT Levels: LI, L2 and L3)</b>                                                                                                |                              |             |                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                              |             | <b>Number of Hours: 8</b>  |
| Module-3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |             |                            |
| <b>PROBABILITY DISTRIBUTIONS</b><br>Discrete distributions: Binomial, Geometric, and Poisson - definitions, mean, and variance.<br>Continuous distributions: Uniform, exponential, and normal - definitions, mean, and variance and related problems.<br><b>(RBT Levels: LI, L2 and L3)</b><br><b>Linked COs: CO2, CO3, CO5</b>                                                                                                                                                                                                                                       |                              |             |                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                              |             | <b>Number of Hours: 10</b> |
| Module-4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |             |                            |
| <b>SAMPLING AND ESTIMATION</b><br>Sampling concepts: population, sample, parameter, statistic, random sampling, bias, and standard error. Sampling distributions and central limit theorem. Point estimation and interval estimation. Confidence intervals for mean and proportion.<br>Hypothesis testing: null and alternative hypotheses, type I and type II errors, one-tailed and two-tailed tests.<br>Basic tests for mean and proportion for large sample; student's t-distribution, chi-square test for goodness of fit.<br><b>(RBT Levels: LI, L2 and L3)</b> |                              |             |                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                              |             | <b>Number of Hours: 8</b>  |
| 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.<br><b>(RBT Levels: LI, L2 and L3)</b>                                                                                                                                                                                                     |                              |             |                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                              |             | <b>Number of Hours: 8</b>  |
| Suggested Learning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                              |             |                            |
| <b>Resources Textbooks:</b> <ol style="list-style-type: none"> <li>1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Publishing.</li> <li>2. V.K. Rohatgi and A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, Wiley.</li> <li>3. S. Ross, A First Course in Probability, Pearson India.</li> <li>4. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House.</li> </ol>                                                                                                         |                              |             |                            |

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.

- **Flipped Classroom Approach**
  - Students review video lectures and reading materials before class.
  - Classroom sessions focus on problem-solving, discussions, and applications of transform techniques and optimization models.
- **Problem-Based Learning (PBL)**
  - Real-world engineering problems involving Fourier Transforms, Z-Transforms, and Linear Programming are assigned for collaborative solution development.
- **ICT-Enabled Teaching** (may be conducted in Tutorial hours)
  - Use of MATLAB, Python, and online simulation tools to visualize transforms, optimization problems, and signal-processing applications.
- **Collaborative Learning** (may be conducted in Tutorial hours)
- Group assignments and mini-projects on optimization models and transform applications.

**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:

| Sl. No. | Name of the Learning activity                                         | Maximum Marks |
|---------|-----------------------------------------------------------------------|---------------|
| 1.      | Assignment at RBL3 and RBL4 levels based on Team Work(TW) activities. | 10            |
| 2.      | GATE-based Aptitude Test.                                             | 15            |

**Rubrics for Learning Activity-1: Assignment (10 Marks)**

| Performance Indicator       | Superior (10)                                             | Good (8)                             | Fair (6)                      | Needs Improvement (5)                |
|-----------------------------|-----------------------------------------------------------|--------------------------------------|-------------------------------|--------------------------------------|
| Understanding of Concepts   | Demonstrates excellent conceptual clarity and application | Good understanding with minor errors | Basic understanding           | Poor understanding                   |
| Problem Solving Ability     | Solves all problems correctly with proper methodology     | Solves most problems correctly       | Partial solutions with errors | Unable to solve problems effectively |
| Mathematical Accuracy       | Calculations and derivations are error-free               | Minor computational errors           | Several errors                | Significant errors                   |
| Presentation & Organization | Well-structured, neat, and professionally presented       | Organized with minor deficiencies    | Average presentation          | Poor presentation                    |

**Rubrics for Learning Activity-2: GATE-Based Aptitude Test (15 Marks)**

| Performance Indicator | Superior (15)                                  | Good (12)                | Fair (10)                | Needs Improvement (8) |
|-----------------------|------------------------------------------------|--------------------------|--------------------------|-----------------------|
| Quantitative Aptitude | ≥90% correct responses                         | 75–89% correct           | 60–74% correct           | <60% correct          |
| Analytical Thinking   | Excellent logical reasoning and interpretation | Good reasoning ability   | Moderate reasoning       | Weak reasoning        |
| Time Management       | Completes all questions within allotted time   | Completes most questions | Requires additional time | Unable to complete    |
| Accuracy & Precision  | Very high accuracy                             | Good accuracy            | Moderate accuracy        | Low accuracy          |

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

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

| Sl. No. | Term Work (TW) Activity                                                                                                                                                                                                                                   | Number of Hours / Semester |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| 1.      | <b>Analysis of engineering data using descriptive statistics.:</b> Collect or obtain a dataset of specific programme and perform descriptive statistics, fit distributions, and pose at least one reliability-style question with a short report.         | 5                          |
| 2.      | <b>Mini Project:</b> Prepare concise case studies on extreme events or demand patterns (e.g., flood peaks, daily traffic), using probability plots, return-period calculations and risk statements with a short seminar.                                  | 5                          |
| 3.      | <b>Programming &amp; Tools Workbook:</b> Develop a digital workbook in Excel/R-programming/Python/MATLAB implementing core course computations: descriptive stats, distribution fitting, regression, confidence intervals and simple reliability metrics. | 5                          |

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

| Sl. No. | Self-Learning (SL) Activity                                         | Number of Hours / Semester |
|---------|---------------------------------------------------------------------|----------------------------|
| 1       | Applications of probability, statistics and sampling distributions. | 6                          |

|                                                                                                                                                                |                                                                                                        |                                                                                      |                                                                   |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------|---------------|
| 2                                                                                                                                                              | Explore applications of probability, statistics and sampling distributions.                            | 6                                                                                    |                                                                   |               |
| 3                                                                                                                                                              | Solving problems related to probability, statistics and sampling distributions                         | 6                                                                                    |                                                                   |               |
| 4                                                                                                                                                              | Develop and solve two real-world statistics problems                                                   | 6                                                                                    |                                                                   |               |
| 5                                                                                                                                                              | Study industrial applications of sampling distribution problems                                        | 6                                                                                    |                                                                   |               |
| <b>Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):</b><br><b>Sample Rubrics-Course Project</b> |                                                                                                        |                                                                                      |                                                                   |               |
| <b>Criterion</b>                                                                                                                                               | <b>Exemplary (3)</b>                                                                                   | <b>Proficient (2)</b>                                                                | <b>Basic (1)</b>                                                  | <b>Weight</b> |
| Problem definition & data                                                                                                                                      | Clear, relevant civil-engineering questions; data source and limitations documented.                   | Mostly clear; minor gaps in context or data description.                             | Vague questions or poorly documented data.                        | 10%           |
| Data processing & descriptive statistics                                                                                                                       | Correct cleaning, visualization, and computation of key measures; patterns clearly highlighted.        | Mostly correct; minor computational errors.                                          | Significant errors, missing key measures or plots.                | 25%           |
| Probabilistic modeling (distributions, inference)                                                                                                              | Appropriate distributions and tests used; assumptions stated; results interpreted in context.          | Reasonable choice of models; some assumptions implicit; interpretation mostly sound. | Inappropriate or poorly justified models; limited interpretation. | 30%           |
| Civil engineering insight / risk framing                                                                                                                       | Clear link to design/assessment decisions, safety and uncertainty; limitations discussed.              | Some discussion of implications; limited treatment of limitations.                   | Minimal civil engineering interpretation on beyond numbers.       | 20%           |
| Report & communication                                                                                                                                         | Well-structured report, clear figures/tables, reproducible calculations; effective brief presentation. | Acceptable structure; some clarity issues; presentation adequate.                    | Disorganized or incomplete report; weak presentation.             | 15%           |

### 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).