PROBABILITY AND STATISTICS			
Course Code	1BMATIF301	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)

Linked COs:CO1, CO3 **Number of Hours: 14 Hours**

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)

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

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 Hours**

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)

Linked COs:CO3, CO4 **Number of Hours: 14 Hours**

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)

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

Suggested Learning Resources Textbooks:

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

Reference Books:

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

Web links and e-Resources:
NPTEL (National Programme on Technology Enhanced Learning) - Probability and Statistics courses for Engineers: https://nptel.ac.in/..
SWAYAM learning modules on statistics and data analysis.

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

Teaching-Learning Process (Innovative Delivery Methods):
The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students to learn groups to improve their creative and analytical skills.
6. Show short-related video lectures in the following ways:

- As an introduction to new topics (pre-lecture activity).
- As a revision of topics (post-lecture activity).
- As additional examples (post-lecture activity).
- As an additional material of challenging topics (pre-and post-lecture activity).
- As a model solution of some exercises (post-lecture activity).

Assessment Structure:
The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.
The CIE Theory component consists of average of TWO IA tests for 25 marks and Continuous Comprehensive Assessments (CCA) for 25 marks.
To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA):

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

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

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

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

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

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

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

As per National credit formwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Self learning (TW/Sl-50 hours). Hence, students must complete minimum of two activities as part of NCrF. These learning activities shall be considered as CCA components of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The following sample activities are listed below. The course coordinator can also give their own TW/SL activities as per the course outcomes.

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

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

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	**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-programming/Python/MATLAB implementing core course computations: descriptive stats, distribution fitting, regression, confidence intervals and simple reliability metrics.	25

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):
1. Sample Rubrics - Mini-Project

Criterion	Exemplary (3)	Proficient (2)	Basic (1)	Weight
Problem definition & data	Clear, relevant civil-engineering questions; data source and limitations documented.	Mostly clear; minor gaps in context or data description.	Vague questions or poorly documented data.	10%
Data processing & descriptive statistics	Correct cleaning, visualization, and computation of key measures; patterns clearly highlighted.	Mostly correct; minor computational errors.	Significant errors, missing key measures or plots.	25%
Probabilistic modeling (distributions, inference)	Appropriate distributions and tests used; assumptions stated; results interpreted in context.	Reasonable choice of models; some assumptions implicit; interpretation mostly sound.	Inappropriate or poorly justified models; limited interpretation.	30%
Civil engineering insight / risk framing	Clear link to design/assessment decisions, safety and	Some discussion of implications; limited treatment of	Minimal civil engineering interpretation on	20%

	uncertainty; limitations discussed.	limitations.	beyond numbers.	
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):

(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).