Probability, Distributions and Statistics			
Course Code	**1BMATCS301**	Scheme	2025
Type of Course	Applied Science Course (ASC)	Semester	3
Teaching Hours/Week (L:T:P)	70 (3:2:0)	CIE Marks	50
Total Hours of Pedagogy per semester L :T:P:SL&TW:TH	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. **Apply** the concepts of modular arithmetic, congruences, linear Diophantine equations, Euler's theorem, Fermat's theorem, Wilson's theorem, and the RSA cryptographic algorithm to solve engineering and computational problems.
2. **Apply** least squares curve fitting, correlation, regression analysis, and rank correlation techniques to analyse engineering data and establish relationships between variables.
3. **Solve** engineering problems involving discrete and continuous random variables using probability distributions, mathematical expectation, variance, and standard probability models such as Binomial, Poisson, and Normal distributions.
4. **Analyse** joint probability distributions and Markov chains by determining expectations, covariance, correlation, transition probabilities, stationary distributions, and absorbing states for stochastic systems.
5. **Apply** statistical inference techniques including hypothesis testing, confidence intervals, large and small sample tests, Student's *t*-test, Chi-square test, and the Central Limit Theorem to draw valid conclusions from engineering data.

Module-1: Modular Arithmetic

Introduction of modular arithmetic and its applications in Computer Science and Engineering. Introduction to Congruences, Linear Congruences, The Remainder theorem, Solving Polynomials,
Linear Diophantine Equation, System of Linear Congruences, Euler's Theorem, Wilson Theorem and Fermat's little theorem. Applications of Congruences-RSA algorithm.

[Textbook-3: Chapters 4, 5, 6, 7 and 9]

Number of Hours: (8 Theory + 3 Tutorials)

Module-2: Statistics

Principles of least squares, Curve fitting by the method of least squares in the form: $y = a + bx$, $y = a + bx + cx^2$, and $y = ax^b$. Correlation, Coefficient of correlation, Lines of regression, Angle between regression lines, rank correlation.

[Textbook-1: Chapters 11 and 12]

[Textbook-2: Chapters 13 and 14]

Number of Hours: (8 Theory + 3 Tutorials)

Module-3: Probability Distributions

Review of basic probability theory. Random variables (discrete and continuous), probability mass and density functions. Mathematical expectation: mean and variance. Binomial, Poisson and normal distributions-problems (derivations for mean and standard deviation for Binomial and Poisson distributions only).

[Textbook-1: Chapter -3, 4, 5, 6]

[Textbook-2: Chapters 6 and 7]

Number of Hours: (9 Theory + 3 Tutorials)

Module-4: Joint probability distribution

Joint Probability distribution for two discrete random variables, expectation, covariance and correlation.

Markov Chain: Introduction to Stochastic Process, Probability Vectors, Stochastic matrices, Regular stochastic matrices, Markov chains, Higher transition probabilities, Stationary distribution of Regular Markov chains.

[Textbook-1: Chapter -3, 4, 5, 6]

[Textbook-4: Chapter-8] Number of Hours: (8 Theory + 3 Tutorials)

Module-5: Statistical Inference

Sampling distribution, standard error. Levels of significance. Testing of hypothesis. Test of significances. Confidence limits, simple sampling of attributes. Sampling variables, central limit theorem and confidences limit for unknown mean.

Test of significance for large samples (mean, proportion). Comparison of large samples (mean, proportion).

Test of Significance for means of two small samples, students-'t' distribution, and Chi-square distribution as a test of goodness of fit.

[Textbook-1: Chapter 8 and 10]
[Textbook-2: Chapters-8, 9, 10 and 12]

Number of Hours: (9 Theory + 5 Tutorials)

TUTORIAL COMPONENT OF PCC

Tutorial Topic/Problem solving/Case ... etc. (for 2 hours each)**:** Number of Hours: 28

1. Practise Problems on linear congruences
2. Practise Problems on Linear Diophantine Equation, System of Linear Congruences
3. Practise Problems on Euler's Theorem, Wilson Theorem and Fermat's little theorem.
4. Practise Problems on fitting linear form and quadratic form
5. Practise Problems on $y = ax^b$ and correlation
6. Practise Problems on lines of regression and rank correlation
7. Practise Problems on mathematical expectations
8. Practise Problems on Binomial and Poisson distributions
9. Practise Problems on Normal distributions
10. Practise Problem on covariance, correlation of two discrete random variables
11. Practise Problem on Markov chain, stochastic matrices, probability vectors
12. Practise Problem on higher transition probabilities and stationary distributions
13. Practise Problem on test of significance for large samples
14. Practise Problem on test of significance for small samples

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

Textbooks:

1. Ronald E. Walpole, Raymond H Myers, Sharon L Myers & Keying Ye "Probability and Statistics for Engineers and Scientists", Pearson Education, Ninth edition, 2012.
2. Murray R. Spiegel, Larry J. Stephens, Statistics, Schaum's outline series, Third edition,
3. Koshy, Thomas. *Elementary number theory with applications*. Academic press, 2nd Edition, 2009.
4. Seymour Lipschutz and Marc Lars Lipson, Probability, Schaum's Outline Series, Second edition, 2011.

Reference books / Manuals:

5. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 9 th Edition, 2006.
6. B. S. Grewal "Higher Engineering Mathematics", Khanna publishers, 44 th Ed., 2021.
7. Irwin Miller & Marylees Miller, John E. Freund's "Mathematical Statistics with Applications" Pearson. Dorling Kindersley Pvt. Ltd. India, 8th edition, 2014.
8. S C Gupta and V K Kapoor, "Fundamentals of Mathematical Statistics", S Chand and Company, Latest edition.
9. P. G. Hoel, S. C. Port and C. J. Stone, "Introduction to Probability Theory", Universal Book Stall, (Reprint), 2003.
10. S. Ross, "A First Course in Probability", Pearson Education India, 6 th Ed., 2002.
11. David M Burton: "Elementary Number Theory" Mc Graw Hill, 7th Ed.,2017

Web links and e-Resources:

1. Probability and statistics: https://nptel.ac.in/courses/111105090
2. Introduction to Probability and Statistics for Machine Learning: https://www.classcentral.com/course/codesignal-introduction-to-probability-and-statistics-for-machine-learning-358081
3. Probability and Statistics: https://www.classcentral.com/course/probability-statistics-11755 Introduction to probability, statistics, and random processes: https://probabilitycourse.com/
4. Introduction to Probability and Statistics: https://ocw.mit.edu/courses/18-05-introduction-to-probability-and-statistics-spring-2022/
5. VTU e-Shikshana Program
6. VTU EDUSAT Program

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 EvaluationCIE [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 Teamwork (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 assignments, seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours/ Semester
1	Seminar on RSA algorithms, Probability, Statistics and Sampling Distribution concepts	5
2	MATLAB/Python computations for the problems related to RSA algorithms, Probability, Statistics and Sampling Distribution concepts.	5
3	Course Project on sampling distribution for testing of hypothesis.	5
4	Case Study on testing hypothesis for large and small samples	5
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1	Application of RSA algorithms, Probability, Statistics and Sampling Distribution concepts.	6
2	Explore the real-life problems related to RSA algorithms, Probability, Statistics and Sampling Distribution concepts	6
3	Solve a set of problems on RSA algorithms, Probability, Statistics and Sampling Distribution concepts.	6
4	Develop and solve two real-world sampling distribution problems	6
5	Study industrial applications of statistics, probability, sampling distributions and congruences.	6

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).