

CO-PO-PSO Mapping

Course Details & Course Outcomes (COs)

Course Code: MAT-100

Course Title: Foundational Mathematics

Credits: 4 (3L + 1P)

As specified in the syllabus:

- **CO1:** Infer the truth of various sentences and its equivalents and outline various properties of sets.
- **CO2:** Examine and Identify the types of relations and functions.
- **CO3:** Make use of the strong and weak induction.
- **CO4:** Solve systems of linear equations.
- **CO5:** Discuss the properties of determinants.

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	3	3	2	2	3	2	0	1	3	1	2
CO2	2	3	1	2	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	0	1	3	1	3
CO4	3	2	1	2	2	2	1	2	3	3	3
CO5	2	2	1	2	2	2	1	2	3	2	2

- **PO1 (Complex Problem Solving):** Strong mapping (3) for CO1, CO3, and CO4 because mathematical logic, induction principles, and solving linear systems build foundational skills to solve multi-step mathematical problems.
- **PO2 (Critical Thinking):** High correlation (3) with CO1, CO2, and CO3 as logic proofs, relation/function classification, and induction require structured analytical thought and formal rigorous reasoning.
- **PO3 (Creativity):** Moderate mapping (2) with CO1 and CO3 as constructing mathematical proofs and selecting inductive strategies require logical ingenuity.
- **PO4 (Communication Skills):** Moderate mapping (2) across outcomes as mathematical logic and set theory train students to use precise technical language and symbols to convey clear reasoning.
- **PO5 (Analytical Reasoning/Thinking):** High mapping (3) with CO1, CO2, and CO3 since analyzing propositional logic, truth tables, equivalence classes, and mathematical proofs directly strengthens deductive reasoning.
- **PO9 (Learning How to Learn Skills):** Medium mapping (2) across all COs because foundational abstraction forms the basis for independent learning in advanced mathematics modules.

- **PO10 (Digital & Technological Skills):** Low mapping (1) for CO4 and CO5 as computational algorithms like Gaussian elimination and determinant operations provide the algorithmic groundwork for computational software.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) as problem-solving sets and practical manual tasks promote independent work habits.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs as foundational logic, set theory, functions, linear systems, and determinants are core topics in undergraduate mathematics.
- **PSO3 (Specialization Skills):** Medium to high mapping (2–3) for CO4 and CO5 due to practical problem-solving in matrix operations and row-echelon conversions.
- **PSO4 (Application & Translation):** High mapping (3) for CO3 and CO4 as induction and linear systems translate directly into applications across data science, computer science, and physical science problems.

Course Details & Course Outcomes (COs)**Course Code:** MAT-112**Course Title:** Elementary Statistics**Credits:** 4 (3L + 1T)**Effective from AY:** 2023-24

As specified in the syllabus:

- **CO1:** Interpret data and graphically represent it.
- **CO2:** Calculate measures of central tendencies and variations.
- **CO3:** Analyze correlation and regression.
- **CO4:** Solve problems in Probability theory.
- **CO5:** Understand different data sampling techniques.
- **CO6:** Apply statistical quality control.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix**Correlation Levels:**

- **3:** High Correlation
- **2:** Medium Correlation
- **1:** Low Correlation
- **0:** No Correlation
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Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	3	3	2	2	1	3	2	2
CO2	3	2	1	2	3	2	2	1	3	3	2
CO3	3	3	2	2	3	2	2	2	3	3	3
CO4	3	3	2	2	3	2	1	1	3	2	3
CO5	2	2	1	2	2	2	1	2	3	2	2
CO6	3	3	2	2	3	2	3	2	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) across CO2, CO3, CO4, and CO6 because statistical modelling, probability theorems (Bayes' theorem), bivariate regression, and statistical quality control require structured multi-step mathematical problem solving.
- **PO2 (Critical Thinking):** High correlation (3) with CO3, CO4, and CO6 as evaluating linear relationship strength, applying conditional probability logic, and monitoring process variability using control charts demand rigorous critical reasoning.
- **PO3 (Creativity):** Moderate mapping (2) with CO3, CO4, and CO6 as selecting appropriate statistical models, probability trees, and control chart layouts involves creative analytical structuring.

- **PO4 (Communication Skills):** High correlation (3) for CO1 because organizing raw data into class intervals, frequency tables, bar diagrams, histograms, and ogives translates complex raw data into clear visual communication.
- **PO5 (Analytical Reasoning/Thinking):** High mapping (3) across most outcomes (CO1–CO4, CO6) since calculating measures of central tendency, dispersion, correlation, and control chart statistics directly trains deductive and data-driven analytical thinking.
- **PO9 (Learning How to Learn Skills):** Consistent medium mapping (2) across all COs because mastering elementary descriptive statistics and probability establishes self-directed learning capabilities for higher-level data science and research modules.
- **PO10 (Digital & Technological Skills):** Moderate to high mapping (2–3), particularly for CO1, CO2, CO3, and CO6, as the practical/tutorial curriculum explicitly incorporates Excel tool usage for data entry, chart plotting, regression analysis, and quality control chart demonstrations.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) as students independently process data sets, maintain tutorial notebooks, and solve real-world case studies.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs, as data representation, descriptive statistics, correlation, probability, sampling, and quality control constitute fundamental core knowledge in applied mathematics and statistics.
- **PSO3 (Specialization Skills):** Strong mapping (3) for CO2, CO3, and CO6 due to practical computational proficiency in dispersion measures, rank/multiple correlation, regression lines, and control charts ($P, U, C, \bar{X}, R, S$ charts).
- **PSO4 (Application & Translation):** High mapping (3) for CO3, CO4, and CO6 as statistical estimation, probability models, and quality control translate directly into real-world industrial, business, and scientific applications.

Course Details & Course Outcomes (COs)

Course Code: MAT-141

Course Title: Numerical Analysis using Python/SageMath

Credits: 3 (1L + 2P)

As specified in the syllabus:

- **CO1:** Find the roots of algebraic and transcendental equations.
- **CO2:** Apply Interpolation to solve real life problems.
- **CO3:** Make use of the techniques of numerical differentiation and integration.
- **CO4:** Determine the best line/quadratic curve/exponential curve to fit the given data.
- **CO5:** Utilize Python/SageMath software to aid mathematical pursuits.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Correlation Levels:

- **3:** High Correlation
- **2:** Medium Correlation
- **1:** Low Correlation
- **0:** No Correlation

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	3	3	1	1	3	2	2	1	3	2	3
CO2	3	3	2	1	3	2	2	1	3	3	3
CO3	3	3	1	1	3	2	2	1	3	2	3
CO4	3	3	2	1	3	2	2	1	3	3	3
CO5	3	2	2	2	3	3	3	2	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) across all COs because iterative algorithms (Bisection, Newton-Raphson), finite differences, numerical integration, curve fitting, and computational scripting solve non-closed-form mathematical problems.
- **PO2 (Critical Thinking):** High mapping (3) for CO1–CO4 as selecting appropriate interpolation formulas, error analysis, and order of convergence require rigorous logical evaluation.
- **PO3 (Creativity):** Moderate mapping (2) for CO2, CO4, and CO5 as modeling observational data via curve fitting and writing custom computational algorithms require innovative problem structuring.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) as scripting code and outputting graphical visualizations communicate mathematical results algorithmically.
- **PO5 (Analytical Reasoning/Thinking):** High mapping (3) across all outcomes due to systematic evaluation of truncation errors, difference tables, and functional approximations.
- **PO9 (Learning How to Learn Skills):** Medium to high mapping (2–3) as acquiring computational tool skills (Python/SageMath) fosters self-directed technical learning.

- **PO10 (Digital & Technological Skills):** Maximum mapping (3) for CO5 and moderate (2) for CO1–CO4 due to direct hands-on implementation of numerical routines in Python/SageMath environments.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) driven by independent lab executions and computational assignments.
- **PSO1 (Disciplinary Knowledge):** High correlation (3) across all COs, as numerical methods and error analysis are essential core mathematical disciplines.
- **PSO3 (Specialization Skills):** High correlation (2–3) due to practical algorithm implementation in computational software.
- **PSO4 (Application & Translation):** Maximum correlation (3) across all COs as numerical methods directly bridge theoretical formulas to real-world computational applications.

Course Details & Course Outcomes (COs)**Course Code:** MAT-142**Course Title:** Statistical Methods Using R/SPSS/PSPP**Credits:** 3 (1L + 2P)

As specified in the syllabus:

- **CO1:** Calculate measures of central tendencies and variations.
- **CO2:** Interpret correlation and regression.
- **CO3:** Solve problems in Probability theory.
- **CO4:** Demonstrate and Infer based on various statistical tests using statistical software.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix**Correlation Levels:**

- **3:** High Correlation
- **2:** Medium Correlation
- **1:** Low Correlation
- **0:** No Correlation

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO10	PO13	PSO 1	PSO 3	PSO 4
CO1	2	2	1	2	3	2	2	1	3	2	2
CO2	3	3	2	2	3	2	3	2	3	3	3
CO3	3	3	2	1	3	2	1	1	3	2	3
CO4	3	3	2	3	3	3	3	2	3	3	3

- **PO1 (Complex Problem Solving):** Strong mapping (3) for CO2, CO3, and CO4 as analyzing correlation, solving probability distributions, and conducting parametric/non-parametric hypothesis tests require structured problem-solving skills.
- **PO2 (Critical Thinking):** High correlation (3) across CO2–CO4 as evaluating statistical significance, selecting appropriate test statistics (t-test, ANOVA, Chi-square, Mann-Whitney), and making data-driven inferences demand critical analytical thinking.
- **PO3 (Creativity):** Moderate mapping (2) for CO2, CO3, and CO4 as formulating statistical hypotheses and interpreting complex empirical data require creative analytical formulation.
- **PO4 (Communication Skills):** High correlation (3) for CO4 because presenting statistical inferences and test outputs effectively communicates quantitative research findings.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all outcomes due to systematic data summarization, distribution fitting, and hypothesis evaluation.
- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 and medium (2) for CO1–CO3 as mastering software tools like R/SPSS/PSPP enables continuous independent learning in research and data analytics.
- **PO10 (Digital & Technological Skills):** High correlation (3) for CO2 and CO4 as practicals directly involve executing computations, data importing, and hypothesis testing in R/SPSS/PSPP software environments.

- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) driven by independent execution of practical tasks, questionnaire data processing, and analysis reports.
- **PSO1 (Disciplinary Knowledge):** Maximum mapping (3) across all COs as descriptive statistics, probability theory, distribution theory, and hypothesis testing represent fundamental core concepts in applied statistics.
- **PSO3 (Specialization Skills):** High mapping (3) for CO2 and CO4 due to hands-on computational proficiency in software tools for ANOVA, regression, and non-parametric tests.
- **PSO4 (Application & Translation):** Strong mapping (3) for CO2, CO3, and CO4 as statistical modeling and hypothesis testing translate directly into practical research, business, and industrial decision-making.

Course Details & Course Outcomes (COs)

Course Code: MAT-131

Course Title: Mathematical Techniques in Competitive Exams

Credits: 3 (3L)

As specified in the syllabus:

- **CO1:** Apply mathematical techniques in solving problems.
- **CO2:** Identify tricks in solving problems quickly.
- **CO3:** Employ various strategies to solve problems arising in various competitive exams.
- **CO4:** Manage time in answering several questions appearing in the exam.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	3	3	1	1	3	2	0	1	3	2	3
CO2	3	3	2	1	3	2	0	2	2	2	3
CO3	3	3	2	1	3	3	0	2	2	2	3
CO4	2	3	2	1	3	3	0	3	2	2	3

- **PO1 (Complex Problem Solving):** High correlation (3) across CO1–CO3 as quantitative topics like work & time, speed-distance-time, and mixtures require rapid problem-solving frameworks.
- **PO2 (Critical Thinking):** Maximum mapping (3) across all COs because identifying shortcut tricks, logical strategies, and optimizing exam time depend on quick critical analysis.
- **PO3 (Creativity):** Moderate mapping (2) for CO2–CO4 as applying non-standard solution paths and alternative mathematical tricks requires flexible creative reasoning.
- **PO4 (Communication Skills):** Low correlation (1) as the focus is on competitive multiple-choice speed solving rather than formal mathematical communication.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to the systematic evaluation of numerical ratios, discount rates, proportions, and logical speed models.
- **PO9 (Learning How to Learn Skills):** High correlation (3) for CO3 and CO4 as developing competitive exam strategies fosters self-regulated, goal-driven lifelong learning.
- **PO10 (Digital & Technological Skills):** Zero mapping (0) since the syllabus relies purely on manual arithmetic techniques without digital tools.
- **PO13 (Autonomy, Responsibility, Accountability):** High mapping (3) for CO4 due to strict self-management and time-accountability required during competitive examinations.
- **PSO1 (Disciplinary Knowledge):** Strong mapping (2–3) as quantitative aptitude covers foundational arithmetic, algebraic ratio structures, and numerical reasoning.
- **PSO3 (Specialization Skills):** Moderate mapping (2) focusing on practical numerical techniques for competitive entrance tests.

- **PSO4 (Application & Translation):** Maximum correlation (3) across all COs as quantitative aptitude translates directly into real-world aptitude evaluation and employment screening exams.

Course Details & Course Outcomes (COs)**Course Code:** MAT-132**Course Title:** Descriptive Statistics**Credits:** 3 (3L)

As specified in the syllabus:

- **CO1:** Understand concepts of sample v/s population and Identify different types of scales.
- **CO2:** Distinguish between primary and secondary data and Organize the Statistical data.
- **CO3:** Calculate measures of central tendencies and variations.
- **CO4:** Interpret correlation and regression.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO10	PO13	PSO 1	PSO 3	PSO 4
CO1	2	2	1	2	3	2	1	1	3	2	2
CO2	2	2	1	3	3	2	1	1	3	2	2
CO3	3	2	1	2	3	2	1	1	3	3	2
CO4	3	3	2	2	3	2	1	2	3	3	3

- **PO1 (Complex Problem Solving):** Strong mapping (3) for CO3 and CO4 as computing measures of central tendency/dispersion and fitting regression models require structured problem-solving.
- **PO2 (Critical Thinking):** High mapping (3) for CO4 as evaluating bivariate correlation, rank correlation, and regression residual variance requires rigorous analytical interpretation.
- **PO3 (Creativity):** Moderate mapping (2) for CO4 as fitting polynomial/exponential curves to empirical data involves model selection creativity.
- **PO4 (Communication Skills):** High correlation (3) for CO2 as constructing frequency tables and graphical representations (histograms, ogives) communicates raw data clearly.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to systematic data classification, scale selection, skewness analysis, and regression modeling.
- **PO9 (Learning How to Learn Skills):** Consistent medium mapping (2) across all outcomes as acquiring descriptive statistical methods forms the foundation for higher-level empirical research.
- **PO10 (Digital & Technological Skills):** Low correlation (1) as this theory course focuses on concepts, tables, and hand calculations.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) driven by self-study and independent problem-solving tasks.

- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs as descriptive statistics and regression principles form core discipline knowledge in mathematics and statistics.
- **PSO3 (Specialization Skills):** Strong mapping (3) for CO3 and CO4 due to computational proficiency in dispersion, skewness, kurtosis, and least-squares curve fitting.
- **PSO4 (Application & Translation):** High mapping (3) for CO4 as regression and trend fitting translate directly into real-world data science and simple research applications.

Course Details & Course Outcomes (COs)**Course Code:** MAT-200**Course Title:** Calculus of One Variable**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Explain the algebra and properties of the set of real numbers.
- **CO2:** Analyze various real sequences, their properties, and examine their convergence.
- **CO3:** Prove and apply results in limits and continuity and disprove false statements.
- **CO4:** Prove and apply results in differentiability and disprove false statements.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	3	3	1	1	3	2	0	1	3	2	2
CO2	3	3	2	1	3	2	0	1	3	2	2
CO3	3	3	2	2	3	2	0	1	3	2	3
CO4	3	3	2	2	3	2	0	1	3	2	3

- **PO1 (Complex Problem Solving):** Maximum mapping (3) across all COs because proving limit theorems, analyzing sequence convergence, and evaluating indeterminate forms require fundamental mathematical problem-solving.
- **PO2 (Critical Thinking):** Maximum correlation (3) across all outcomes due to disproving false statements via counterexamples, verifying LUB properties, and epsilon-delta limit proofs.
- **PO3 (Creativity):** Moderate mapping (2) for CO2–CO4 as constructing counterexamples and applying Rolle's or Mean Value Theorems require creative analytical reasoning.
- **PO4 (Communication Skills):** Low to moderate correlation (1–2) as expressing formal mathematical proofs rigorizes logical communication.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to rigorous analysis of real number properties, uniform continuity, and higher-order derivatives.
- **PO9 (Learning How to Learn Skills):** Consistent medium mapping (2) as real analysis forms the theoretical bedrock for advanced independent study in mathematics.

- **PO10 (Digital & Technological Skills):** Zero correlation (0) as the course relies entirely on classical theoretical and analytical proofs.
- **PO13 (Autonomy, Responsibility, Accountability):** Low correlation (1) driven by individual tutorial problem solving and self-study.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs as real analysis is a primary core pillar of undergraduate mathematics.
- **PSO3 (Specialization Skills):** Medium mapping (2) for core theoretical specialization in analysis.
- **PSO4 (Application & Translation):** Moderate to high correlation (2–3) as differential calculus principles translate directly into modeling rate-of-change problems across scientific domains.

Course Details & Course Outcomes (COs)**Course Code:** MAT-201**Course Title:** Ordinary Differential Equations**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Identify the type of a given differential equation.
- **CO2:** Understand the concept and apply appropriate analytical techniques for finding the solution.
- **CO3:** Prove various results concerning the methods and existence and uniqueness of solutions of differential equations.
- **CO4:** Solve ordinary differential equations by using various numerical methods.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	0	1	3	2	2
CO2	3	3	2	1	3	2	0	1	3	3	3
CO3	3	3	2	2	3	2	0	1	3	2	2
CO4	3	3	2	1	3	2	2	1	3	3	3

- **PO1 (Complex Problem Solving):** High mapping (3) for CO2–CO4 as applying variation of parameters, D-operator techniques, and numerical methods solves multi-step differential equations.
- **PO2 (Critical Thinking):** High correlation (3) for CO2–CO4 as analyzing Picard's existence-uniqueness proofs and selecting appropriate analytical or numerical solvers require critical evaluation.
- **PO3 (Creativity):** Moderate mapping (2) as formulating mathematical models and choosing appropriate integrating factors or substitutions require creative insight.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) based on presenting structured analytical step-by-step solutions and mathematical proofs.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all outcomes due to systematic ODE classification, Wronskian analysis, and convergence of numerical schemes.

- **PO9 (Learning How to Learn Skills):** Medium mapping (2) as ODE methods build foundations for independent physical and engineering modeling.
- **PO10 (Digital & Technological Skills):** Moderate mapping (2) for CO4 due to standard numerical approximation algorithms (Euler, Runge-Kutta, Taylor series).
- **PO13 (Autonomy, Responsibility, Accountability):** Low correlation (1) through problem-solving assignments and tutorials.
- **PSO1 (Disciplinary Knowledge):** Maximum mapping (3) across all COs as ODEs represent a core domain in applied mathematics.
- **PSO3 (Specialization Skills):** High mapping (3) for CO2 and CO4 focusing on analytical and computational differential equation techniques.
- **PSO4 (Application & Translation):** Maximum correlation (3) for CO2 and CO4 as differential equations translate directly into real-world physical, biological, and engineering systems.

Course Details & Course Outcomes (COs)**Course Code:** MAT-211**Course Title:** Matrix Algebra**Credits:** 4 (3L + 1P)

As specified in the syllabus:

- **CO1:** Display familiarity and knowledge of System of Equations, Matrices and Matrix Operations.
- **CO2:** Demonstrate proofs of Matrix Algebra.
- **CO3:** Choose the appropriate procedures and modify them, if needed, to solve method-based problems on the concepts in the syllabus.
- **CO4:** Analyze and solve unseen problems in Matrix Algebra and invent mathematically precise arguments to justify their solutions.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	1	1	3	2	2
CO2	3	3	2	2	3	2	1	1	3	2	2
CO3	3	3	2	1	3	2	2	1	3	3	3
CO4	3	3	3	2	3	3	3	2	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2–CO4 as rank determinations, system reduction (Gauss-Jacobi, Gauss-Seidel), diagonalizations, and quadratic form reductions resolve complex linear systems.
- **PO2 (Critical Thinking):** High mapping (3) for CO2–CO4 as proving linear independence, verifying Cayley-Hamilton theorem, and devising original arguments for unseen problems require critical reasoning.
- **PO3 (Creativity):** Maximum mapping (3) for CO4 because inventing original arguments for unseen matrix problems demands creative mathematical formulation.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through structured logical proofs and practical report generation.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to rigorous vector space analysis, echelon reductions, eigenvalues, and quadratic forms.

- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 as solving unseen abstract problems fosters self-directed analytical learning.
- **PO10 (Digital & Technological Skills):** High correlation (3) for CO4 and moderate (2) for CO3 due to practical implementations using SageMath software (e.g., matrix operations, graph adjacency walks).
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) driven by independent lab executions and problem-solving assignments.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs as linear and matrix algebra form a fundamental pillar of university mathematics.
- **PSO3 (Specialization Skills):** High correlation (3) for CO3 and CO4 due to computational matrix algorithms and SageMath implementations.
- **PSO4 (Application & Translation):** Maximum mapping (3) for CO3 and CO4 as linear systems, graph adjacency matrices, and quadratic forms translate directly into data science, computer graphics, and engineering applications.

Course Details & Course Outcomes (COs)**Course Code:** MAT-231**Course Title:** Basic Financial Mathematics**Credits:** 3 (3L)

As specified in the syllabus:

- **CO1:** Introduction to the use of mathematical tools for financial calculations.
- **CO2:** Develop abilities to create, derive, and apply financial mathematical tools.
- **CO3:** Apply tax rules to file income tax returns.
- **CO4:** Use appropriate principles to plan in stock market investment.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	1	1	3	2	3
CO2	3	3	2	1	3	2	1	1	3	3	3
CO3	2	2	1	1	3	2	1	2	2	2	3
CO4	3	3	2	2	3	3	1	2	2	3	3

- **PO1 (Complex Problem Solving):** High mapping (3) for CO2 and CO4 as deriving present/future values, calculating duration/convexity, and modeling option strategies (bull/bear spreads, straddles) solve multi-variable financial problems.
- **PO2 (Critical Thinking):** High correlation (3) for CO2 and CO4 due to evaluating risk, yield rates, loan amortization schedules, and portfolio hedging strategies.
- **PO3 (Creativity):** Moderate mapping (2) for CO2 and CO4 as structuring custom option combinations and designing investment portfolios require strategic formulation.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through presenting investment analysis and financial report calculations.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to systematic evaluation of tax bands, annuity valuations, bond pricing, and term structures.
- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 as dynamic market environments require continuous self-learning in financial management.

- **PO10 (Digital & Technological Skills):** Low correlation (1) as the course relies on financial mathematics formulas, spreadsheets, and analytical calculations.
- **PO13 (Autonomy, Responsibility, Accountability):** Moderate mapping (2) for CO3 and CO4 due to regulatory compliance in tax filing and financial decision-making accountability.
- **PSO1 (Disciplinary Knowledge):** Strong mapping (2–3) as fundamental interest theories, annuities, and valuation models build financial mathematics expertise.
- **PSO3 (Specialization Skills):** High mapping (3) for CO2 and CO4 focusing on quantitative finance, derivatives, and investment management skills.
- **PSO4 (Application & Translation):** Maximum correlation (3) across all COs as financial concepts translate directly into corporate finance, taxation, and individual wealth management.

Course Details & Course Outcomes (COs)**Course Code:** MAT-241**Course Title:** Technical Typesetting Using LaTeX**Credits:** 3 (1L + 2P)

As specified in the syllabus:

- **CO1:** To Create and typeset a LaTeX document.
- **CO2:** To Build documents containing Mathematics.
- **CO3:** To experiment with pictures and graphics in LaTeX.
- **CO4:** To Prepare impressive Beamer presentations and typeset question papers using the exam class.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	1	1	2	3	2	2	3	1	2	2	2
CO2	2	2	2	3	3	2	3	1	3	3	3
CO3	2	2	3	3	2	2	3	1	2	3	3
CO4	2	2	3	3	2	3	3	2	2	3	3

- **PO1 (Complex Problem Solving):** Low to moderate mapping (1–2) as debugging syntax errors, constructing matrices/multiline equations, and configuring complex environments involve structured troubleshooting.
- **PO2 (Critical Thinking):** Low to moderate mapping (1–2) focused on structural document logic and package selection.
- **PO3 (Creativity):** High correlation (3) for CO3 and CO4 due to vector graphics design (PSTricks, GeoGebra embedding) and custom Beamer slide layout creation.
- **PO4 (Communication Skills):** Maximum correlation (3) across all COs as LaTeX is the global standard for professional, publication-grade technical and mathematical communication.
- **PO5 (Analytical Reasoning/Thinking):** Strong mapping (3) for CO2 due to precise syntax structuring for mathematical symbols, matrices, and multi-line equations.
- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 as mastering LaTeX enables lifelong independent technical authoring and academic publishing.

- **PO10 (Digital & Technological Skills):** Maximum mapping (3) across all outcomes due to direct, hands-on software markup compilation and bibliography database management (BibTeX).
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) through independent document compilation and assignment generation.
- **PSO1 (Disciplinary Knowledge):** Strong mapping (3) for CO2 as expressing complex mathematical notation is vital for discipline-specific work.
- **PSO3 (Specialization Skills):** High correlation (3) for CO2–CO4 focusing on specialized computational typesetting and presentation tools.
- **PSO4 (Application & Translation):** High correlation (3) for CO2–CO4 as document compilation directly translates into academic research publishing and professional documentation.

Course Details & Course Outcomes (COs)**Course Code:** MAT-202**Course Title:** Analysis**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Analyze various real sequences, their properties, and examine their convergence.
- **CO2:** Apply various convergence tests to identify convergent series.
- **CO3:** Decide on uniform and pointwise convergence of a sequence of functions.
- **CO4:** Judge the uniform and pointwise convergence of a series of functions.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	3	3	2	1	3	2	0	1	3	2	2
CO2	3	3	2	1	3	2	0	1	3	2	2
CO3	3	3	2	2	3	2	0	1	3	2	3
CO4	3	3	2	2	3	2	0	1	3	2	3

- **PO1 (Complex Problem Solving):** Maximum correlation (3) across all COs as evaluating Cauchy criteria, Weierstrass M-tests, power series, and term-by-term integration requires rigorous mathematical problem-solving.
- **PO2 (Critical Thinking):** Maximum mapping (3) across all outcomes due to proving convergence/divergence, analyzing non-uniformly convergent series, and testing pointwise vs. uniform limits.
- **PO3 (Creativity):** Moderate mapping (2) as constructing counterexamples and selecting suitable test criteria (Abel, Dirichlet, Cauchy root/ratio) demand analytical flexibility.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through writing rigorous epsilon-delta and bounding proofs.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to deep analytical evaluation of function spaces, continuity, and differentiability of limit functions.

- **PO9 (Learning How to Learn Skills):** Medium correlation (2) as real analysis forms the theoretical foundation for advanced independent study in pure and applied mathematics.
- **PO10 (Digital & Technological Skills):** Zero correlation (0) as the course is purely theoretical.
- **PO13 (Autonomy, Responsibility, Accountability):** Low correlation (1) driven by individual tutorial problem sets and theoretical assignments.
- **PSO1 (Disciplinary Knowledge):** Maximum mapping (3) across all outcomes as real analysis and function space convergence are core theoretical pillars of undergraduate mathematics.
- **PSO3 (Specialization Skills):** Medium mapping (2) for core theoretical specialization in analysis.
- **PSO4 (Application & Translation):** Moderate to high mapping (2–3) as power series and function approximation (Weierstrass Approximation Theorem, Taylor series) translate directly into numerical analysis and physical modeling.

Course Details & Course Outcomes (COs)**Course Code:** MAT-203**Course Title:** Linear Algebra**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Display familiarity and knowledge of the concepts in the syllabus.
- **CO2:** Demonstrate proofs to establish truths related to the concepts in the syllabus.
- **CO3:** Choose the appropriate procedures and modify them, if needed, to solve method-based problems on the concepts in the syllabus.
- **CO4:** Analyze and solve unseen problems in Linear Algebra and invent mathematically precise arguments to justify their solutions.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	0	1	3	2	2
CO2	3	3	2	2	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	1	1	3	3	3
CO4	3	3	3	2	3	3	1	2	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2–CO4 as determining basis/dimension, finding matrix representations of linear transformations, diagonalizing operators, and Gram-Schmidt orthogonalization require structured multi-step problem solving.
- **PO2 (Critical Thinking):** High mapping (3) for CO2–CO4 as verifying the Rank-Nullity Theorem, establishing inner product space properties, and inventing proofs for unseen abstract linear algebra problems demand rigorous critical evaluation.
- **PO3 (Creativity):** Maximum mapping (3) for CO4 because inventing original arguments for unseen problems requires creative mathematical reasoning.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through constructing precise mathematical proofs and structured solution paths.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all outcomes due to formal analytical evaluation of vector subspaces, quotients, linear dependence, and orthogonal complements.

- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 as proving abstract structural theorems fosters self-directed mathematical thinking.
- **PO10 (Digital & Technological Skills):** Low correlation (0–1) as this is a theoretical course centered on analytical derivations and proofs.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) driven by independent tutorial problem-solving and assignment tasks.
- **PSO1 (Disciplinary Knowledge):** Maximum mapping (3) across all COs as abstract vector spaces and linear transformations form a core foundational pillar of mathematics.
- **PSO3 (Specialization Skills):** High mapping (3) for CO3 and CO4 focusing on advanced algebraic operator techniques.
- **PSO4 (Application & Translation):** High mapping (3) for CO3 and CO4 as inner product spaces, orthogonal projections, and eigen-decompositions translate directly into physical science, machine learning, and engineering applications.

Course Details & Course Outcomes (COs)**Course Code:** MAT-204**Course Title:** Basic Number Theory**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Recollect the important definitions and theorems in the course.
- **CO2:** Explain the various proofs and concepts in the course.
- **CO3:** Solve various computational problems in the course.
- **CO4:** Solve problems using the concepts learnt in the course.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	0	1	3	2	2
CO2	3	3	2	2	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	1	1	3	3	3
CO4	3	3	3	2	3	3	1	2	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2–CO4 as solving linear Diophantine equations, systems of congruences via Chinese Remainder Theorem, and non-linear Diophantine equations requires systematic problem-solving methods.
- **PO2 (Critical Thinking):** High mapping (3) for CO2–CO4 due to proving foundational number-theoretic results (Fermat's, Wilson's, and Euler's theorems) and evaluating divisibility properties.
- **PO3 (Creativity):** High correlation (3) for CO4 as applying Mobius inversion and proving insolvability of non-linear Diophantine equations require creative mathematical insight.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through expressing formal proof steps and modular arithmetic derivations.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to rigorous analysis of arithmetic functions, prime distributions, and congruence relations.
- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 as classical number theory techniques build independent abstract mathematical reasoning.
- **PO10 (Digital & Technological Skills):** Low correlation (0–1) as the syllabus focuses primarily on theoretical and manual modular calculations.

- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) through individual problem sets and tutorial practice.
- **PSO1 (Disciplinary Knowledge):** Maximum mapping (3) across all COs as number theory is a primary core discipline in theoretical mathematics.
- **PSO3 (Specialization Skills):** High correlation (3) for CO3 and CO4 focusing on specialized arithmetic and algebraic techniques.
- **PSO4 (Application & Translation):** High mapping (3) for CO3 and CO4 as modular arithmetic, prime numbers, and Euler's phi function translate directly into modern cryptography and cybersecurity applications.

Course Details & Course Outcomes (COs)**Course Code:** MAT-205**Course Title:** Analytical 2D Geometry**Credits:** 2 (2L)

As specified in the syllabus:

- **CO1:** Define terms and explain concepts related to geometry.
- **CO2:** Understand metric properties in a plane, and the different forms of lines and circles in a plane.
- **CO3:** Classify various conics in a plane and establish results concerning them.
- **CO4:** Develop analytical skills in solving geometric problems.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	1	1	3	2	2
CO2	3	2	1	1	3	2	2	1	3	2	2
CO3	3	3	2	1	3	2	2	1	3	3	3
CO4	3	3	2	2	3	2	2	1	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2–CO4 as deriving locus equations, coordinate transformations (translation/rotation), and parametric conic equations requires structured algebraic problem-solving.
- **PO2 (Critical Thinking):** High mapping (3) for CO3 and CO4 due to metric classification of conics (parabola, ellipse, hyperbola), asymptotic analysis, and polar coordinate transformations.
- **PO3 (Creativity):** Moderate mapping (2) for CO3 and CO4 as geometric locus construction and polar curve visualization involve spatial visual reasoning.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through structured geometric proofs and Cartesian/polar representations.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to systematic evaluation of invariants, distance metrics, tangents, and normals.
- **PO9 (Learning How to Learn Skills):** Consistent medium mapping (2) as geometric visualization builds a foundation for advanced multivariable calculus and differential geometry.

- **PO10 (Digital & Technological Skills):** Moderate mapping (2) across CO2–CO4 due to explicit pedagogy integrating GeoGebra for visual dynamic manipulation of geometric figures.
- **PO13 (Autonomy, Responsibility, Accountability):** Low correlation (1) driven by individual problem-solving tasks.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs as classical coordinate geometry forms a fundamental branch of pure mathematics.
- **PSO3 (Specialization Skills):** High mapping (3) for CO3 and CO4 focusing on conic classification and parametric geometric representations.
- **PSO4 (Application & Translation):** High mapping (3) for CO3 and CO4 as conic sections and coordinate transformations translate directly into computer graphics, CAD modeling, and physical trajectory analysis.

Course Details & Course Outcomes (COs)

Course Code: MAT-223

Course Title: Graph Theory

Credits: 4 (3L + 1P)

As specified in the syllabus:

- **CO1:** Display familiarity and knowledge of the concepts in the syllabus.
- **CO2:** Demonstrate proofs to establish truths related to the concepts in the syllabus.
- **CO3:** Choose the appropriate procedures and modify them, if needed, to solve method-based problems on the concepts in the syllabus.
- **CO4:** Analyze and solve unseen problems in Graph Theory and invent mathematically precise arguments to justify their solutions.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	1	1	3	2	2
CO2	3	3	2	2	3	2	1	1	3	2	2
CO3	3	3	2	1	3	2	3	1	3	3	3
CO4	3	3	3	2	3	3	3	2	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2–CO4 as applying graph algorithms (Dijkstra's, Kruskal's/Prim's, Bellman-Ford/Floyd-Warshall, Fleury's, Welsh-Powell) solves complex optimization problems.
- **PO2 (Critical Thinking):** High mapping (3) for CO2–CO4 due to proving Euler's formula, Brooks' Theorem, verifying graph isomorphism, and testing degree sequences via Havel-Hakimi.
- **PO3 (Creativity):** Maximum mapping (3) for CO4 as inventing new graph-theoretic arguments and modeling real-world networks demand creative logical construction.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through structured algorithmic executions and formal mathematical proofs.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to rigorous analysis of adjacency matrices, vertex colorings, planarity, and tree properties.
- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 as studying network algorithms fosters self-directed algorithmic problem solving.

- **PO10 (Digital & Technological Skills):** High correlation (3) for CO3 and CO4 as the practical curriculum explicitly mandates executing 12 graph algorithms (e.g., shortest path, Huffman coding, bridge finding).
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) driven by individual practical lab assignments and algorithm implementations.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs as graph theory represents a major core domain of discrete mathematics.
- **PSO3 (Specialization Skills):** High mapping (3) for CO3 and CO4 focusing on discrete optimization and graph algorithmic proficiency.
- **PSO4 (Application & Translation):** Maximum mapping (3) for CO3 and CO4 as graph models translate directly into computer science, network routing, data compression (Huffman), and scheduling applications.

Course Details & Course Outcomes (COs)**Course Code:** MAT-300**Course Title:** Riemann Integration and Improper Integrals**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Apply the theory of Riemann integration in evaluating integrals.
- **CO2:** Prove various results in Riemann integration.
- **CO3:** Analyze and compare various number theoretic functions.
- **CO4:** Examine the convergence of improper integrals.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	3	3	2	1	3	2	0	1	3	2	2
CO2	3	3	2	2	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	0	1	3	2	3
CO4	3	3	2	2	3	2	0	1	3	2	3

- **PO1 (Complex Problem Solving):** High correlation (3) across all outcomes due to evaluating upper/lower Darboux sums, computing improper integrals (Type I, II, III), testing Beta and Gamma function convergence, and expressing infinite series sums as Riemann integrals.
- **PO2 (Critical Thinking):** Maximum mapping (3) as establishing Darboux integrability criteria, applying the First and Second Fundamental Theorems of Calculus, and determining convergence properties require rigorous analytical logic.
- **PO3 (Creativity):** Moderate mapping (2) as choosing key partition refinements, variable changes, and bounds for integral proofs requires logical flexibility.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through structured epsilon-partition proofs and rigorous convergence arguments.
- **PO5 (Analytical Reasoning/Thinking):** Maximum correlation (3) across all outcomes due to formal mathematical evaluation of function bounded pathways, integrability of step/monotonic functions, and improper integral bounds.

- **PO9 (Learning How to Learn Skills):** Consistent medium correlation (2) as integration theory builds foundational analytical tools necessary for advanced analysis.
- **PO10 (Digital & Technological Skills):** Zero correlation (0) as this module focuses purely on theoretical derivations and manual analytical integration.
- **PO13 (Autonomy, Responsibility, Accountability):** Low correlation (1) driven by individual tutorial problem sets and analytical homework tasks.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs as Riemann integration and improper integrals form a core foundation of classical real analysis.
- **PSO3 (Specialization Skills):** Medium mapping (2) providing fundamental advanced analytical techniques.
- **PSO4 (Application & Translation):** High mapping (3) for CO3 and CO4 as Beta, Gamma functions, and improper integral convergence apply directly to probability theory, statistical distributions, and physics.

Course Details & Course Outcomes (COs)**Course Code:** MAT-301**Course Title:** Group Theory I**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Recollect the basic definitions and theorems in Group Theory.
- **CO2:** Explain the various proofs and concepts in Group Theory.
- **CO3:** Solve the various computations problems in Group Theory.
- **CO4:** Solve problems using the concepts learnt in the course.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	0	1	3	2	2
CO2	3	3	2	2	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	1	1	3	3	3
CO4	3	3	3	2	3	3	1	2	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2–CO4 as analyzing coset decompositions, permutation groups, factor groups, plane isometries, and normal subgroups requires structured algebraic problem solving.
- **PO2 (Critical Thinking):** High mapping (3) for CO2–CO4 due to proving Lagrange's Theorem, the Fundamental Homomorphism Theorem, and evaluating kernel/image properties of group homomorphisms.
- **PO3 (Creativity):** High correlation (3) for CO4 as applying abstract algebraic structures (e.g., D_3, D_4, D_6) to unseen structural problems demands creative algebraic reasoning.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through presenting formal algebraic proofs and structural derivations.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all outcomes due to formal reasoning on binary operations, group isomorphisms, cyclic generators, and automorphisms.

- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 as abstract group theory develops structural and axiomatic thinking essential for advanced mathematics.
- **PO10 (Digital & Technological Skills):** Low correlation (0–1) as the course relies primarily on theoretical concepts and abstract algebraic structures.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) through self-directed problem sets and tutorial tasks.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs as group theory is a central pillar of pure abstract algebra.
- **PSO3 (Specialization Skills):** High correlation (3) for CO3 and CO4 focusing on core algebraic techniques.
- **PSO4 (Application & Translation):** High correlation (3) for CO3 and CO4 as group symmetries, plane isometries, and cyclic structures translate directly into quantum mechanics, crystallography, and coding/cryptography.

Course Details & Course Outcomes (COs)**Course Code:** MAT-302**Course Title:** Metric Spaces**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Display familiarity and knowledge of the concepts in the syllabus.
- **CO2:** Demonstrate proofs to establish truths related to the concepts in the syllabus.
- **CO3:** Choose the appropriate procedures and modify them, if needed, to solve method-based problems on the concepts in the syllabus.
- **CO4:** Analyze and solve unseen problems in Metric Spaces and invent mathematically precise arguments to justify their solutions.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	0	1	3	2	2
CO2	3	3	2	2	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	0	1	3	3	3
CO4	3	3	3	2	3	3	0	2	3	3	3

- **PO1 (Complex Problem Solving):** High mapping (3) for CO2–CO4 as applying Cantor's Intersection Theorem, verifying Cauchy completeness, proving connectedness, and working with contraction mappings require advanced structural problem solving.
- **PO2 (Critical Thinking):** High mapping (3) for CO2–CO4 due to proving topological properties (open/closed sets, closure, boundary, connectedness) and applying Banach's Fixed Point Theorem.
- **PO3 (Creativity):** Maximum correlation (3) for CO4 as constructing topological counterexamples and formulating original proofs for unseen metric space problems require high mathematical creativity.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through constructing formal topology proofs and continuous function characterizations.

- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to fundamental analysis of distance metrics, open balls, Hausdorff properties, and sequential continuity.
- **PO9 (Learning How to Learn Skills):** High correlation (3) for CO4 as abstract metric space theory prepares students for advanced graduate-level studies in topology and functional analysis.
- **PO10 (Digital & Technological Skills):** Zero correlation (0) as the curriculum is purely theoretical.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) driven by independent theoretical problem sets and tutorial tasks.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all outcomes as metric spaces form a primary foundation for modern mathematical analysis.
- **PSO3 (Specialization Skills):** High mapping (3) for CO3 and CO4 focusing on advanced topological and analytical techniques.
- **PSO4 (Application & Translation):** High mapping (3) for CO3 and CO4 as Banach's Fixed Point Theorem and metric convergence translate directly into differential equations, numerical analysis, and approximation algorithms.

Course Details & Course Outcomes (COs)**Course Code:** MAT-308**Course Title:** Analytical 3D Geometry**Credits:** 2 (2L)

As specified in the syllabus:

- **CO1:** Define terms and explain concepts related to 3D Geometry.
- **CO2:** Develop analytical skills in solving geometric problems.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	1	1	3	2	2
CO2	3	3	2	2	3	2	2	1	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2 as finding shortest distances between skew lines, calculating plane intersections, and formulating equations for spheres, cones, cylinders, and conicoids (ellipsoid, hyperboloids) require structured multi-step calculations.
- **PO2 (Critical Thinking):** High mapping (3) for CO2 due to transforming unsymmetrical line equations to symmetrical forms and evaluating general second-degree equations in 3D space.
- **PO3 (Creativity):** Moderate mapping (2) for CO2 as visual spatial manipulation of 3D geometric surfaces involves creative geometric spatial reasoning.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through concise algebraic representations of planes, lines, and quadric surfaces.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across both outcomes due to detailed vector/algebraic analysis of direction cosines, perpendicular projections, and surface equations.
- **PO9 (Learning How to Learn Skills):** Consistent medium correlation (2) as 3D coordinate geometry builds visual-spatial foundations for multivariable calculus and classical mechanics.
- **PO10 (Digital & Technological Skills):** Moderate mapping (2) for CO2 due to explicit pedagogical use of GeoGebra for visual dynamic manipulation of 3D geometric figures.
- **PO13 (Autonomy, Responsibility, Accountability):** Low correlation (1) driven by individual problem-solving tasks.

- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all outcomes as 3D coordinate geometry is a fundamental branch of core spatial mathematics.
- **PSO3 (Specialization Skills):** High mapping (3) for CO2 focusing on conicoid classification and spatial surface modeling.
- **PSO4 (Application & Translation):** High mapping (3) for CO2 as 3D coordinate transformations and quadric surface equations translate directly into 3D computer graphics, CAD engineering, robotics, and spatial physics modeling.

Course Details & Course Outcomes (COs)**Course Code:** MAT-327**Course Title:** Linear Programming Problems**Credits:** 4 (3L + 1P)

As specified in the syllabus:

- **CO1:** Formulate real world problems as mathematical problems.
- **CO2:** Solve the linear programming problems.
- **CO3:** Apply the concept of duality to solve LPPs.
- **CO4:** Formulate and solve transportation and assignment problems.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	3	3	3	2	3	2	2	2	3	3	3
CO2	3	3	2	1	3	2	3	1	3	3	3
CO3	3	3	2	1	3	2	3	1	3	3	3
CO4	3	3	2	2	3	2	3	2	3	3	3

- **PO1 (Complex Problem Solving):** Maximum correlation (3) across all outcomes as executing the Simplex algorithm, Two-Phase, Big-M, Dual Simplex, MODI, and Hungarian methods directly solves real-world optimization challenges.
- **PO2 (Critical Thinking):** Maximum mapping (3) across all outcomes due to identifying degeneracy, unboundedness, optimality conditions, and primal-dual relationships.
- **PO3 (Creativity):** High correlation (3) for CO1 as abstracting real-world industrial and managerial constraints into structured mathematical LPP models requires creative modeling skills.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through presenting tabular iterations and model formulations clearly.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all outcomes due to systematic linear algebra analysis of convex polyhedrons, extreme points, basis replacement, and net evaluation terms.

- **PO9 (Learning How to Learn Skills):** Medium mapping (2) establishing optimization techniques used in operations research and decision science.
- **PO10 (Digital & Technological Skills):** Very high correlation (3) for CO2–CO4 due to explicit practical pedagogy mandating software usage (TORA, Microsoft Excel Solver) for solving optimization problems.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) through maintaining individual practical journals and execution of lab exercises.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all outcomes as linear programming is a primary core domain of applied mathematics and operations research.
- **PSO3 (Specialization Skills):** Maximum correlation (3) across all COs focusing on practical optimization and computational algorithm mastery.
- **PSO4 (Application & Translation):** Maximum correlation (3) across all outcomes as LPPs translate directly into industrial logistics, resource allocation, supply chain management, and financial optimization.

Course Details & Course Outcomes (COs)**Course Code:** MAT-309**Course Title:** Ring Theory**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Recollect the basic definitions and theorems in Ring Theory.
- **CO2:** Explain the various proofs and concepts in the course.
- **CO3:** Solve the various computations problems in the course.
- **CO4:** Solve problems using the concepts learnt in the course.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	0	1	3	2	2
CO2	3	3	2	2	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	1	1	3	3	3
CO4	3	3	3	2	3	3	1	2	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2–CO4 as analyzing integral domains, ideal structure, polynomial factorization over fields, and unique factorization domains (UFDs, PIDs, EDs) requires structured algebraic analysis.
- **PO2 (Critical Thinking):** High mapping (3) for CO2–CO4 due to applying Eisenstein's Criterion, testing polynomial irreducibility, and proving prime/maximal ideal properties.
- **PO3 (Creativity):** High correlation (3) for CO4 as applying abstract ring-theoretic structures to unseen problems demands creative algebraic logic.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through presenting formal ring homomorphism proofs and structural derivations.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all outcomes due to rigorous analytical work with quotient rings, fields of fractions, and Euclidean division algorithms.

- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 as abstract ring theory forms a critical stepping stone toward advanced field extensions and Galois Theory.
- **PO10 (Digital & Technological Skills):** Low correlation (0–1) as the syllabus focuses primarily on theoretical concepts.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) driven by independent problem sets and self-study assignments.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all COs as ring theory is a core foundational pillar of modern pure mathematics.
- **PSO3 (Specialization Skills):** High correlation (3) for CO3 and CO4 focusing on advanced algebraic manipulation.
- **PSO4 (Application & Translation):** High correlation (3) for CO3 and CO4 as polynomial ring factorization and ideal theory translate directly into modern cryptography, coding theory, and algebraic geometry.

Course Details & Course Outcomes (COs)**Course Code:** MAT-305**Course Title:** Complex Analysis**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** Build the theory of limits, continuity, and differentiation to a function of a complex variable.
- **CO2:** Prove several results and assess suitable techniques of complex integration.
- **CO3:** Evaluate integrals of a complex valued function over contours.
- **CO4:** Apply the theory of residues, and theorems of Taylor and Laurent to solve complex integrals.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	3	3	2	1	3	2	0	1	3	2	2
CO2	3	3	2	2	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	0	1	3	3	3
CO4	3	3	3	2	3	2	0	2	3	3	3

- **PO1 (Complex Problem Solving):** Maximum correlation (3) across all outcomes due to computing contour integrals, Cauchy-Riemann equations, Taylor/Laurent series expansions, and residue evaluations at isolated singular points.
- **PO2 (Critical Thinking):** Maximum mapping (3) as applying Cauchy-Goursat theorem, Cauchy's Integral Formula, Liouville's theorem, Maximum Modulus Principle, and residue theory demands rigorous analytical evaluation.
- **PO3 (Creativity):** High correlation (3) for CO4 as selecting appropriate keyhole/semicircular contours and managing branch cuts require creative problem-solving techniques.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through presenting structured analytical proofs and contour evaluation steps.

- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all outcomes due to detailed analysis of harmonic functions, analyticity, differentiability, and series convergence.
- **PO9 (Learning How to Learn Skills):** Consistent medium correlation (2) as complex analysis provides powerful mathematical tools applicable across advanced pure and applied mathematics.
- **PO10 (Digital & Technological Skills):** Zero correlation (0) as the course relies on theoretical analytical methods.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) through problem-solving tutorial dedicated sessions and self-study.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all outcomes as complex analysis is a major foundational subject in mathematical analysis.
- **PSO3 (Specialization Skills):** High mapping (3) for CO3 and CO4 focusing on advanced contour integration and singular point classification.
- **PSO4 (Application & Translation):** High mapping (3) for CO3 and CO4 as residue integration and analytic functions directly translate into fluid dynamics, signal processing, electrostatics, and engineering analysis.

Course Details & Course Outcomes (COs)**Course Code:** MAT-310**Course Title:** Vector Calculus**Credits:** 4 (3L + 1T)

As specified in the syllabus:

- **CO1:** To build student's knowledge of multivariable calculus and introduce calculus on manifolds.
- **CO2:** To develop the ability to work with limits and continuity and differentiability of vector valued functions.
- **CO3:** To be able to calculate line, surface and volume integrals.
- **CO4:** To apply the concepts in calculus to solve some problems in physics, engineering etc.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	0	1	3	2	2
CO2	3	3	2	1	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	1	1	3	3	3
CO4	3	3	3	2	3	3	1	2	3	3	3

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2–CO4 as calculating double/triple integrals, directional derivatives, arc lengths, line/surface integrals, and applying integral theorems involves multi-step vector techniques.
- **PO2 (Critical Thinking):** High mapping (3) for CO2–CO4 due to verifying conservative fields, evaluating gradient fields, and testing conditions for Green's, Stokes's, and Gauss Divergence theorems.
- **PO3 (Creativity):** High correlation (3) for CO4 as applying vector calculus theorems to real-world physical boundaries and engineering problems requires spatial creativity.
- **PO4 (Communication Skills):** Low to moderate mapping (1–2) through structured geometric and vector derivations.

- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all COs due to rigorous analytical formulation of partial derivatives, Jacobian coordinate transformations, divergence, curl, and Laplacian operators.
- **PO9 (Learning How to Learn Skills):** High mapping (3) for CO4 as multivariable calculus serves as a key prerequisite for advanced differential geometry and field theories.
- **PO10 (Digital & Technological Skills):** Low correlation (0–1) as emphasis is placed on analytical mathematical computation.
- **PO13 (Autonomy, Responsibility, Accountability):** Low to moderate mapping (1–2) through individual problem sets and tutorial tasks.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all outcomes as multivariable and vector calculus form a fundamental core of pure and applied mathematics.
- **PSO3 (Specialization Skills):** High mapping (3) for CO3 and CO4 focusing on integral calculus over curves and surfaces.
- **PSO4 (Application & Translation):** High mapping (3) for CO3 and CO4 as line, surface, and volume integrals translate directly into physics, electromagnetism, fluid mechanics, and engineering mechanics.

Course Details & Course Outcomes (COs)**Course Code:** MAT-328**Course Title:** Operations Research**Credits:** 4 (3L + 1P)

As specified in the syllabus:

- **CO1:** Estimate the completion time of a project.
- **CO2:** Model and analyse conflicting situations using game theory.
- **CO3:** Understand the characteristics of a queueing system and acquire skills in analysing queueing models.
- **CO4:** Analyse the process of inventory management and techniques for businesses.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	3	3	2	2	3	2	3	2	3	3	3
CO2	3	3	2	1	3	2	3	1	3	3	3
CO3	3	3	2	2	3	2	3	2	3	3	3
CO4	3	3	2	2	3	2	3	2	3	3	3

- **PO1 (Complex Problem Solving):** Maximum correlation (3) across all outcomes as PERT/CPM critical path analysis, zero-sum game solutions, Poisson queueing models, and deterministic EOQ inventory control directly address real-world business optimization problems.
- **PO2 (Critical Thinking):** Maximum mapping (3) across all COs due to analyzing floats, saddle points, mixed strategies, steady states, and optimal inventory ordering strategies.
- **PO3 (Creativity):** Moderate mapping (2) as abstracting real-world project workflows, conflict scenarios, and supply chain constraints into quantitative models requires flexible problem-solving.
- **PO4 (Communication Skills):** Moderate mapping (1–2) through presenting project networks, payoff matrices, and inventory model formulations clearly.

- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all outcomes due to mathematical analysis of arrival/departure distributions, expected queue lengths, Little's formulae, and cost functions.
- **PO9 (Learning How to Learn Skills):** Medium mapping (2) building decision-science skill sets applied across management and quantitative analysis.
- **PO10 (Digital & Technological Skills):** Maximum mapping (3) across all outcomes due to explicit practical pedagogy mandating software tools like TORA to solve project, game theory, queueing, and inventory models.
- **PO13 (Autonomy, Responsibility, Accountability):** Moderate mapping (1–2) driven by maintaining certified practical journals and completing individual computer laboratory assignments.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all outcomes as operations research is a core applied discipline of mathematics.
- **PSO3 (Specialization Skills):** Maximum mapping (3) across all COs focusing on computational decision modeling and quantitative analysis.
- **PSO4 (Application & Translation):** Maximum correlation (3) across all outcomes as PERT/CPM, game theory, queueing systems, and EOQ models apply directly to project management, business strategy, service operations, and supply chain logistics.

Course Code: VAC-122

Course Title: Vedic Mathematics

Credits: 02 (T)

As specified in the syllabus:

- **CO1:** Understand fundamental Vedic sutras for arithmetic operations.
- **CO2:** Demonstrate Vedic multiplication and division techniques for efficient calculation.
- **CO3:** Apply Vedic sutras to accurately determine square, square roots, cube and cube roots.
- **CO4:** Develop skills in Vedic Mathematics for polynomial multiplication and quadratic equations.

Course Outcome – Programme Outcome (CO–PO–PSO) Mapping Matrix

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 9	PO1 0	PO1 3	PSO 1	PSO 3	PSO 4
CO1	2	2	1	1	3	2	0	1	3	2	2
CO2	3	3	2	1	3	2	0	1	3	2	2
CO3	3	3	2	1	3	2	0	1	3	2	2
CO4	3	3	2	1	3	2	0	1	3	2	2

- **PO1 (Complex Problem Solving):** High correlation (3) for CO2–CO4 due to executing multi-step mental arithmetic algorithms, Urdhva-Tiryagbhyam, Paravartya Yojyet division, and solving quadratic equations via Shunyam Sama Samuchchaya.
- **PO2 (Critical Thinking):** High mapping (3) for CO2–CO4 as selecting optimal sutras (e.g., Ekadhikena Purvena vs. Nikhilam vs. Antyayordashakepi) for specific numerical structures requires analytical decision-making.
- **PO3 (Creativity):** Moderate mapping (2) through non-conventional mental math techniques, digit-separator shortcuts, and alternative pattern recognition methods.
- **PO4 (Communication Skills):** Low correlation (1) through structured step-by-step arithmetic explanations.
- **PO5 (Analytical Reasoning/Thinking):** Maximum mapping (3) across all outcomes due to rapid computational analysis, mental digit manipulation, and algebraic expansion pattern identification.
- **PO9 (Learning How to Learn Skills):** Consistent medium correlation (2) as learning mental speed-math techniques builds self-directed learning and confidence in numerical fluency.
- **PO10 (Digital & Technological Skills):** Zero correlation (0) as Vedic Mathematics emphasizes manual and mental calculation without reliance on computational software tools.
- **PO13 (Autonomy, Responsibility, Accountability):** Low correlation (1) driven by individual problem-solving practice and self-study exercises.
- **PSO1 (Disciplinary Knowledge):** Maximum correlation (3) across all outcomes as arithmetic and algebraic sutras form a foundational branch of traditional computational mathematics.
- **PSO3 (Specialization Skills):** Medium mapping (2) focusing on specialized mental speed-calculation and polynomial expansion algorithms.
- **PSO4 (Application & Translation):** Medium mapping (2) as mental arithmetic speed directly aids competitive examination quantitative aptitude, computer algorithm design, and real-time mental estimation.