FOUR -YEAR (EIGHT-SEMESTER)

HONOURS AND

HONOURS WITH RESEARCH

COURSE WITH

MATHEMATICS MAJOR

UNDER

CURRICULUM AND

CREDIT

FRAMEWORK

(CCF)

CO Statements and Mapping with PO

Graduate Attributes in Mathematics

The aspiring mathematician embarks on a journey woven from logic, proof, and the boundless beauty of numbers. As they progress, they cultivate a unique set of attributes, becoming not just masters of calculation, but architects of knowledge and contributors to the advancement of science and society.

1. **Disciplinary Expertise:** A deep understanding of the fundamental concepts, theories, and techniques across various subfields of mathematics forms the bedrock of their intellectual prowess. From abstract number theory to real-world applications in optimization and modeling, their knowledge empowers them to tackle diverse challenges with clarity and rigor.
2. **Algorithmic Architects:** They wield algorithms as tools, constructing computational solutions to complex problems. Be it optimizing financial models, forecasting weather patterns, or deciphering the inner workings of physical systems, their fluency in the language of algorithms equips them to bridge the gap between theory and practice.
3. **Crystal Clear Communicator:** The arcane language of mathematics becomes transparent in their articulation. They translate complex concepts into clear and concise explanations, fostering collaboration and nurturing the next generation of mathematical talent.
4. **Critical Problem Solver:** Faced with an enigmatic mathematical puzzle, their mind delves into a tapestry of logical deduction. They dissect assumptions, forge elegant solutions, and navigate intricate complexities with unwavering persistence.
5. **Inquiry Weaver:** A burning curiosity propels them forward. They craft insightful questions that challenge established paradigms and pave the way for groundbreaking discoveries. They meticulously conduct proofs, present their findings with conviction, and contribute to the ever-evolving dialogue of mathematical inquiry.
6. **Collaborative Virtuoso:** The spirit of teamwork flourishes in diverse mathematical ensembles. They seamlessly integrate their expertise, learn from fellow explorers, and cultivate a synergistic environment where knowledge thrives.
7. **Project Maestro:** Orchestrating research projects becomes an art form. They identify crucial resources, map strategic pathways, and navigate challenges with meticulous planning and unwavering ethical conduct.

8. **Digital Wizardry:** The computer becomes their laboratory, where algorithms paint vibrant landscapes of data. They wield advanced computational tools with mastery, transforming raw numbers into profound insights and unraveling the hidden patterns

within.

9. **Ethical Architect:** Integrity becomes the cornerstone of their work. They identify and navigate ethical dilemmas with transparency and fairness, upholding the highest standards of academic conduct and intellectual property.
10. **Global Citizen:** Their perspective transcends borders, embracing a deep understanding of the international landscape of mathematics. They see their contributions as threads woven into the global tapestry of scientific progress, driving advancements for the betterment of humanity.
11. **Lifelong Learner:** The quest for knowledge knows no bounds. They remain self-directed learners, constantly seeking new avenues to refine their skills, update their knowledge, and reshape their expertise. The journey through the boundless world of mathematics is a lifelong pursuit, fueled by unwavering dedication and a boundless passion for exploration.

These attributes paint a portrait of a graduate mathematician poised to make a significant impact on the world. They are not just skilled technicians, but architects of knowledge, collaborators, and leaders in the pursuit of understanding the very fabric of reality through the lens of mathematics.

Program Learning Outcomes (POs) in a B.Sc. (Major) Mathematics

Program Learning Outcomes (POs) in a Bachelor of Science (Major) Mathematics program outline the specific knowledge, skills, and abilities that students are expected to acquire by the end of their studies. These outcomes reflect the overall goals of the program and serve as a guide for curriculum development and assessment. Here are some key Program Learning Outcomes for a B.Sc (Major) Mathematics program:

1. **Mathematical Knowledge and Understanding:** Graduates should demonstrate a comprehensive understanding of foundational mathematical concepts, theories, and principles across various branches of mathematics, including but not limited to algebra, calculus, analysis, geometry, and discrete mathematics.
2. **Problem-Solving Proficiency:** Graduates should be proficient in applying mathematical techniques to solve complex problems. This involves the ability to analyze problems, formulate mathematical models, and apply appropriate methods for solution.
3. **Mathematical Reasoning and Proof:** Graduates should possess strong mathematical reasoning skills and be able to construct rigorous mathematical proofs. This includes understanding the logical structure of mathematical arguments and the ability to communicate proofs effectively.
4. **Advanced Calculus and Analysis:** Graduates should have a deep understanding of advanced calculus and mathematical analysis, including the convergence of sequences and series, limits, continuity, and the fundamental theorems of calculus.
5. **Algebraic Structures:** Graduates should be familiar with algebraic structures such as groups, rings, and fields, and be able to apply abstract algebraic concepts to various mathematical problems.
6. **Geometry and Topology:** Graduates should have a solid understanding of geometry and topology, including concepts such as symmetry, transformations, and the properties of geometric shapes.
7. **Applied Mathematics:** Graduates should be able to apply mathematical techniques to real-world problems in various scientific and engineering domains. This includes proficiency in mathematical modeling, data analysis, and numerical methods.
8. **Mathematical Software and Technology:** Graduates should be proficient in using mathematical software and technology to aid in problem-solving, visualization, and data analysis.

9. **Effective Communication:** Graduates should be able to communicate mathematical ideas clearly and effectively, both in written and oral forms, to diverse audiences, including peers and non-specialists.
10. **Independent Research Skills:** Graduates should demonstrate the ability to conduct independent research in mathematics. This includes formulating research questions, conducting literature reviews, and applying appropriate research methodologies.
11. **Ethical and Professional Conduct:** Graduates should adhere to ethical standards in mathematical research and practice, including proper citation of sources, integrity in data analysis, and responsible use of mathematical knowledge.
12. **Lifelong Learning:** Graduates should recognize the importance of lifelong learning in mathematics, staying abreast of new developments in the field, and continuously enhancing their mathematical skills and knowledge.

These Program Learning Outcomes collectively ensure that graduates of the B.Sc (Major) Mathematics program are well-prepared for a variety of career paths, including further study at the graduate level or employment in fields requiring strong analytical and mathematical skills.

DSCC/MAJOR Papers for 4-year B.Sc Mathematics (Hons.)

S. No.	POs	CC- 1	CC-2	CC-3	CC-4	CC-5	CC-6	CC-7	CC-8	CC-9	CC-10	CC-11	CC-12
1	Fundamental understanding of the field	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2	Application of basic Mathematics concepts	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
3	Linkages with related disciplines	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
4	Procedural knowledge for professional subjects	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
5	Skills in related field of specialization	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
6	Ability to use in Mathematics problem	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
7	Skills in Mathematical modeling	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔
8	Skills in performing analysis and interpretation of data	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
9	Develop investigative Skills	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔
10	Skills in problem solving in Mathematics and related discipline	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
11	Develop Technical Communication skills	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔
12	Developing analytical skills and popular communication	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔
13	Developing ICT skills	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔
14	Demonstrate professional behaviour with respect to attribute like objectivity, ethical values, self reading, etc	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Minor Papers for 4-year B.Sc Mathematics (Hons.)

S. No.	POs	MC- 1	MC- 2	MC- 3	MC- 4
1	Fundamental understanding of the field	✔	✔	✔	✔
2	Application of basic Mathematics concepts	✔	✔	✔	✔
3	Linkages with related disciplines	✔	✔	✔	✔
4	Procedural knowledge for professional subjects	✔	✔	✔	✔
5	Skills in related field of specialization	✔	✔	✔	✔
6	Ability to use in Mathematics problem	✔	✔	✔	✔
7	Skills in Mathematical modeling	✔	✔	✔	✔
8	Skills in performing analysis and interpretation of data	✔	✔	✔	✔
9	Develop investigative Skills	✔	✔	✔	✔
10	Skills in problem solving in Mathematics and related discipline	✔	✔	✔	✔
11	Develop Technical Communication skills	✔	✔	✔	✔
12	Developing analytical skills and popular communication	✔	✔	✔	✔
13	Developing ICT skills	✔	✔	✔	✔
14	Demonstrate professional behaviour with respect to attribute like objectivity, ethical values, self reading, etc	✔	✔	✔	✔

Skill Enhancement Course (SEC) for B.Sc. Mathematics (Hons.)

Sl. No	POs	SEC 1	SEC 2.2	SEC 3
1	Fundamental understanding of the field	✔	✔	✔
2	Application of basic Mathematical concepts	✔	✔	✔
3	Linkages with related disciplines	✔	✔	✔
4	Procedural knowledge for professional subjects	✔	✔	✔
5	Skills in related field of specialization	✔	✔	✔
6	Ability to use in Mathematics problem	-	✔	✔
7	Skills in Mathematical modeling	-	✔	✔
8	Skills in performing analysis and interpretation of data	-	✔	✔
9	Develop investigative Skills	-	✔	✔
10	Skills in problem solving in Mathematics and related discipline	✔	✔	✔
11	Develop Technical Communication skills	✔	✔	✔
12	Developing analytical skills and popular communication	✔	✔	✔
13	Developing ICT skills	✔	✔	✔
14	Demonstrate Professional behaviour with respect to attribute like objectivity, ethical values, self-reading, etc	✔	✔	✔

Interdisciplinary Course (IDC) for B.Sc. Mathematics (Hons.)

Sl. No	POs	IDC
1	Fundamental understanding of the field	✔
2	Application of basic Mathematical concepts	✔
3	Linkages with related disciplines	✔
4	Procedural knowledge for professional subjects	✔
5	Skills in related field of specialization	✔
6	Ability to use in Mathematics problem	✔
7	Skills in Mathematical modeling	-
8	Skills in performing analysis and interpretation of data	✔
9	Develop investigative Skills	-
10	Skills in problem solving in Mathematics and related discipline	✔
11	Develop Technical Communication skills	-
12	Developing analytical skills and popular communication	✔
13	Developing ICT skills	✔
14	Demonstrate Professional behaviour with respect to attribute like objectivity, ethical values, self-reading, etc	✔

Course Learning Outcomes (CLO)

DSCC/ MAJOR PAPERS

MATH-H-CC1-1-Th

(same for MATH-H-MC 1-1-Th & MATH-H-MC 1-3-Th)

Calculus, Geometry & Vector Analysis

Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Calculus

CO1: Define and apply the concept of differentiability for functions at a point and in an interval.

CO2: Interpret the meaning of the sign of a derivative and its relationship to increasing/decreasing behavior.

CO3: Differentiate hyperbolic functions, higher order derivatives, and functions involving exponential and logarithmic terms.

CO4: Utilize Leibnitz's rule for differentiation and apply it to specific types of functions.

CO5: Identify and handle indeterminate forms using L'Hopital's rule.

CO6: Derive and apply reduction formulae to integrate trigonometric functions, logarithmic functions, and product of trigonometric functions.

CO7: Find the arc length of curves, including parametric curves, and calculate the area under a curve and the volume of a surface of revolution.

Group B: Geometry

CO8: Analyze and categorize second-degree equations using rotation of axes and the discriminant.

CO9: Represent conics (ellipses, parabolas, hyperbolas) in both rectangular and polar forms, and find tangents and normals for these curves.

CO10: Define and identify various types of three-dimensional surfaces, including spheres, cylinders, and conicoids.

CO11: Analyze plane sections of conicoids and identify surfaces such as cones, cylinders, ellipsoids, hyperboloids.

CO12: Classify quadric surfaces based on their geometric properties.

Group C: Vector Analysis

CO13: Perform the triple product and apply vector equations to solve problems in geometry and mechanics.

CO14: Analyze and solve problems involving concurrent forces in a plane, theory of couples, and systems of parallel forces.

CO15: Define and analyze vector-valued functions, including limits, continuity, differentiation, and integration.

CO16: Utilize derivatives and integrals of vector functions to solve problems in various contexts.

Additional Outcomes:

CO17: Students will develop strong problem-solving skills and critical thinking abilities within the realm of calculus, geometry, and vector analysis.

CO18: They will enhance their communication skills by effectively demonstrating mathematical concepts verbally and through written representation.

CO19: Students will gain a deeper appreciation for the interconnectedness of different areas of mathematics and their relevance to various fields of study.

MATH-H-CC1-1-Th

(same for MATH-H-MC 1-1-Th & MATH-H-MC 1-3-Th)

Calculus, Geometry & Vector Analysis

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	CO 13	CO 14	CO 15	CO 16	CO 17	CO 18	CO 19
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔	_	✔	✔	✔	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔	-	✔	✔	✔	✔	✔	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC2-2-TH
(same for MATH-H-MC 2-2-Th & MATH-H-MC 2-4-Th)
Basic Algebra
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Complex Numbers and Equations

- **Complex Numbers:**

  CO1: Represent complex numbers in polar forms and find n-th roots of unity.

  CO2: Apply De Moivre's theorem to solve problems involving rotations and powers of complex numbers.

  CO3: Analyze and differentiate functions of a complex variable (exponential, logarithmic, trigonometric, and hyperbolic).

- **Theory of Equations:**

  CO4: Understand the relationship between roots and coefficients of polynomial equations.

  CO5: Apply techniques like Descartes' rule of signs and Sturm's theorem to analyze the nature of roots.

  CO6: Solve cubic and biquadratic equations using methods like Cardano's and Ferrari's formulas.

- **Inequalities:**

  CO7: Utilize key inequalities like AM-GM and Cauchy-Schwartz to solve inequality problems.

Group B: Relations, Mappings, and Number Theory

- **Relations:**

  CO8: Distinguish and analyze different types of relations (equivalence, partial order, linear order).

  CO9: Understand equivalence classes and partitions associated with equivalence relations.

- **Mappings:**

  CO10: Compose mappings and analyze their relationship with set operations.

  CO11: Interpret and apply the concept of a preimage for a mapping and

subset.

- **Number Theory:**

  CO12: Apply the well-ordering property of integers and principles of mathematical induction to prove theorems.

  CO13: Utilize the division algorithm and Euclidean algorithm to analyze divisibility and find greatest common divisors.

  CO14: Understand and apply properties of prime numbers, including Euclid's theorem and the Fundamental Theorem of Arithmetic.

  CO15: Solve systems of congruences using the Chinese remainder theorem.

  CO16: Explore and utilize specific arithmetic functions like phi, tau, and sigma.

Group C: Linear Systems and Vector Spaces

- **Linear Systems:**

  CO17: Solve systems of linear equations (homogeneous and non-homogeneous) and determine their existence and uniqueness.

  C018: Utilize the matrix equation Ax = b and row reduction techniques to find solutions and analyze echelon forms.

  CO19: Understand the concepts of rank, invertible matrices, and pivot positions.

  CO20: Represent solutions parametrically and interpret them geometrically.

- **Vectors and Vector Spaces:**

  CO21: Perform operations on vectors in R^n and understand their algebraic and geometric properties.

  CO22: Represent linear systems with vectors and analyze their solutions based on linear combinations.

  CO23: Visualize the geometry of linear combinations and spanned subsets.

  CO24: Understand the concepts of linear independence and its algebraic and geometric characterizations.

Additional Outcomes:

CO25: Develop computational skills for solving various algebraic problems efficiently.

CO26: Enhance proficiency in using mathematical software and technology for representing and analyzing mathematical concepts.

CO27: Appreciate the historical development of certain mathematical ideas and their connections to scientific and engineering applications.

MATH-H-CC2-2-TH

(same for MATH-H-MC 2-2-Th & MATH-H-MC 2-4-Th)

Basic Algebra

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	CO 13	CO 14	CO 15	CO 16	CO 17	CO 18	CO 19	CO 20	CO 21	CO 22	CO 23	CO 24	CO 25	CO 26	CO 27	CO 28
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔	-	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 3-3-TH
Real Analysis
Full Marks: 100 (Theory: 75 and Tutorial:25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

CO1: Understand the fundamental properties of real numbers: This includes closure, commutativity, associativity, identity, inverse, and distributive properties, as well as the concepts of order and completeness.

CO2: Distinguish between countable and uncountable sets: Students will be able to determine whether a given set is countable or uncountable.

CO3: Comprehend the concepts of boundedness, supremum, and infimum: Students will be able to identify bounded sets and determine their supremum and infimum.

CO4: Understand the structure of the real line: This includes concepts like intervals, neighborhoods, open and closed sets, limit points, and the relationship between open and closed sets.

CO5: Analyze the behavior of sequences of real numbers: Students will be able to determine convergence or divergence of sequences, find limits, and understand the concepts of boundedness, monotonicity, and subsequential limits.

CO6: Apply convergence tests to infinite series: Students will be able to determine the convergence or divergence of different types of infinite series using various tests.

CO7: Distinguish between absolute and conditional convergence: Students will be able to understand the difference between absolute and conditional convergence and their implications.

CO8: Prove mathematical statements using the epsilon-delta definition of limits: Students will be able to rigorously prove results related to limits of sequences and functions.

CO9: Construct proofs using mathematical induction: Students will be able to apply the principle of mathematical induction to prove various mathematical statements.

CO10: Apply the concepts of real analysis to solve problems in other areas of mathematics and related fields: Students will be able to connect the concepts learned in this course to other mathematical topics and real-world applications.

MATH-H-CC 3-3-TH

Real Analysis

Full Marks: 100 (Theory: 75 and Tutorial:25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 4-3-TH
(Same for MATH-H-MC 3-5-Th)
Ordinary Differential Equations – I
and Group Theory - I
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Ordinary Differential Equations – I

CO1: Understand the formation, order, and degree of differential equations and solve first-order and first-degree differential equations, including homogeneous and exact types.

CO2: Apply conditions for exactness and determine integrating factors for solving first-order differential equations, including linear and Bernoulli equations.

CO3: Solve first-order higher-degree differential equations in forms solvable for xx, yy, and pp, including Clairaut's form, and find singular solutions.

CO4: Analyze and determine the equations of tac-locus, nodal locus, and cuspidal locus for higher-order differential equations.

CO5: Apply the concept of the Wronskian and its properties to solve higher-order linear and nonlinear differential equations, and find complementary functions and particular integrals.

CO6: Solve linear homogeneous and non-homogeneous differential equations with constant coefficients using the method of undetermined coefficients and variation of parameters.

CO7: Solve simultaneous linear differential equations and apply methods for higher-order linear equations with variable coefficients, including Euler's equation.

CO8: Determine conditions for the exactness of higher-order linear differential equations and apply integrating factors for solving such equations.

CO9: Solve differential equations of the form dnydtn=f(y)dtndny=f(y) for n≥2n≥2 and apply

methods for finding solutions.

Group B: Group Theory – I

CO10: Define a group and identify examples, including permutation groups, dihedral groups, and quaternion groups, and understand elementary properties of these groups.

CO11: Determine and analyze subgroups, including conditions for a subset to be a subgroup, and identify normalizer, centralizer, and center of a group.

CO12: Explore the order of elements and groups, classify cyclic groups, and apply properties of cyclic groups to solve related problems. Analyze permutation groups using cycle notation, and understand properties of permutations, including even and odd permutations and alternating groups.

MATH-H-CC 4-3-TH

(Same for MATH-H-MC 3-5-Th)

Ordinary Differential Equations – I

and Group Theory - I

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 5-4-TH
Theory of Real Functions
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Limit and Continuity of Functions

CO1: Apply the ϵ−δ\epsilon-\deltaϵ−δ definition to determine the limit of functions and use the sequential criterion for limits.

CO2: Understand and apply Cauchy's criterion for the existence of limits and use limit theorems to solve problems involving limits, including one-sided limits.

CO3: Analyze the continuity of functions at a point and on an interval using sequential criteria, and understand the concept of oscillation and its relationship to continuity.

CO4: Apply the algebra of continuous functions and understand the continuity of composite functions, including cases where continuity at a point does not imply continuity in a neighborhood.

CO5: Determine the boundedness of continuous functions, apply the Bolzano's theorem and Intermediate Value Theorem, and analyze neighbourhood properties related to boundedness and sign maintenance.

CO6: Classify types of discontinuities, including step functions and piecewise continuity, and understand properties of monotone functions with respect to discontinuities.

CO7: Define and apply uniform continuity, including conditions for uniform continuity on closed and bounded intervals and sufficient conditions for uniform continuity on bounded and unbounded open intervals.

CO8: Understand and apply the Lipschitz condition to analyze uniform continuity of functions.

Group B: Differentiability of Functions

CO9: Apply the concept of local extrema and use sufficient conditions to determine the existence of local maxima and minima of functions at given points.

CO10: Utilize the principle of maximum/minimum in geometrical problems to solve practical optimization problems, applying theorems and conditions related to differentiability and extrema.

CO11: Apply Darboux's theorem, Rolle's theorem, and the Mean Value Theorems (Lagrange and

Cauchy) to analyze and solve problems involving differentiability and function behavior.

CO12: Use Taylor's theorem, including Lagrange's and Cauchy's forms of the remainder, to expand functions such as e^x, $log(1 + x), (1 + x)^m, \sin x \; and \; \cos x$, and apply Taylor's theorem to solve inequalities and find local extrema (maximum and minimum) of functions.

MATH-H-CC 5-4-TH

Theory of Real Functions

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 6-4-TH
(Same for MATH-H-MC 4-6-Th)
Mechanics-I
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Statics-I

CO1: Understand and apply the principles of physical independence of forces, transmissibility of forces, action and reaction, and the parallelogram law of forces.

CO2: Analyze and solve problems involving the composition and resolution of forces, including concurrent forces in a plane.

C**O3:** Apply the principles of equilibrium to three forces acting at a point, using Lami's theorem, and determine the moment of a force about a point and an axis.

CO4: Utilize Varignon's theorem to find resultant forces and resultant couples in systems of coplanar forces, and solve problems related to the reduction of forces and conditions for equilibrium.

Particle Dynamics-I

CO5: Apply the law of gravitation and Newton's laws of motion to describe and analyze rectilinear motion in various force fields, including uniform gravity and resisting media.

CO6: Understand and analyze simple harmonic motion, damped oscillations, forced oscillations, and resonance, and apply these concepts to the motion of elastic strings.

CO7: Solve problems involving work, power, energy, and conservative forces, including the existence and properties of potential energy functions and the principle of conservation of energy.

CO8: Analyze impulse and impulsive forces, and apply the principle of conservation of linear momentum to collisions, including elastic bodies, coefficient of restitution, and impacts involving smooth spheres.

CO9: Determine and interpret the components of velocity and acceleration in two-dimensional Cartesian coordinates, and analyze projectile motion in a resisting medium under gravity.

CO10: Understand and apply concepts related to motion in polar coordinates, including central forces and central orbits, Kepler's laws of planetary motion, and the motion of artificial satellites.

CO11: Analyze constrained motion of a particle on a smooth curve and apply relevant principles to solve problems involving tangential and normal components of velocity and acceleration.

MATH-H-CC 6-4-TH

(Same for MATH-H-MC 4-6-Th)

Mechanics-I

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 7-4-TH
Multivariate Calculus – I and Partial Differential Equations – I
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Multivariate Calculus – I

CO1: Understand and describe the concepts of neighborhood, interior points, limit points, open sets, and closed sets in $\mathbb{R}^n$ $(for\ n > 1)$.

CO2: Analyze the limit and continuity of functions from $\mathbb{R}^n$ to $\mathbb{R}$, including partial derivatives, mean value theorem for functions of multiple variables, and sufficient conditions for continuity.

CO3: Compute and interpret directional derivatives, gradients, and their properties, including the maximal and normal properties of the gradient and tangent planes.

CO4: Apply concepts of partial derivatives of higher order, including conditions for the equality of mixed-order partial derivatives (Schwarz's and Young's theorems), and work with differentials and total differential for functions of functions.

CO5: Use Euler's theorem for homogeneous functions of two and three variables, and solve problems involving change of variables and Taylor's theorem for two variables.

CO6: Understand and apply the concept of implicit functions, including the statement of the existence theorem, and solve problems involving derivatives of implicit functions and Jacobians.

CO7: Analyze extrema of functions of two variables, solve constrained optimization problems, and apply the method of Lagrangian multipliers for optimization with two variables.

CO8: Work with multiple integrals by understanding upper sums, lower sums, and double integrals, and apply the existence theorem for continuous functions.

CO9: Use iterated integrals and apply Fubini's theorem to change the order of integration, and compute areas of plane regions.

CO10: Compute triple integrals and use cylindrical and spherical coordinates for solving related problems.

CO11: Apply the change of variables in double and triple integrals and solve problems involving transformations of double and triple integrals.

CO12: Determine volume and surface area using multiple integrals, and apply differentiation under the integral sign using Leibniz's rule to solve problems.

Group B: Partial Differential Equations - I

CO13: Define, classify, and derive partial differential equations (PDEs) and understand their order and degree, including examples like the heat equation, wave equation, Laplace equation, and KdV equation.

CO14: Solve first-order PDEs using various methods, including quasilinear equations, Lagrange's method, and the method of characteristics, and understand the Cauchy problem for quasilinear PDEs. Apply Charpit's general method to nonlinear first-order PDEs.

MATH-H-CC 7-4-TH

Multivariate Calculus – I and Partial Differential Equations – I

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	CO 13	CO 14
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔	✔	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 8-4-TH
Group Theory – II and Ring Theory – I
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Group Theory – II

CO1: Understand and apply the concept of normal subgroups and their properties, including quotient groups, and use group homomorphisms and their properties in problem-solving.

CO2: Apply the correspondence theorem to establish a one-to-one correspondence between normal subgroups and congruences on a group, and understand and utilize Cayley's theorem and properties of isomorphisms.

CO3: Analyze and work with automorphisms, including inner automorphisms, and automorphism groups, and explore applications of factor groups to automorphism groups.

CO4: Understand and apply the concepts of external and internal direct products, including their properties, and apply these concepts to the group of units modulo nnn.

CO5: Use the converse of Lagrange's theorem for finite abelian groups and apply Cauchy's theorem to finite abelian groups to solve related problems.

Group B: Ring Theory – I

CO6: Define and analyze rings, including properties, subrings, integral domains, and fields, and determine conditions for a subset to be a subring or subfield.

CO7: Understand and work with ideals, including generating ideals, factor rings, operations on ideals, and properties of prime and maximal ideals.

CO8: Apply ring homomorphisms, including their properties, and use the first, second, and third isomorphism theorems to solve problems involving rings.

CO9: Apply the correspondence theorem to understand the one-to-one correspondence between ideals and congruences on a ring, and analyze congruences on rings.

MATH-H-CC 8-4-TH

Group Theory – II and Ring Theory – I

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 9-5-TH
Probability and Statistics
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Probability

CO1: Understand and apply fundamental concepts of probability, including random experiments, sample space, events, σ-field, and the axioms of probability.

CO2: Calculate and use conditional probability, apply the multiplication rule, and use the law of total probability and Bayes' theorem to solve problems involving conditional events and trials.

CO3: Analyze joint probability, Bernoulli trials, and the binomial law, and apply the Poisson approximation to the binomial law for various probability models.

CO4: Work with real random variables, including discrete and continuous types, and understand their distribution functions, probability mass/density functions, and their properties.

CO5: Utilize discrete probability distributions (Binomial, Poisson) and continuous distributions (Uniform, Normal, Exponential), and understand the transformation of random variables.

CO6: Compute and interpret mathematical expectation, mean, variance, moments, quantiles, skewness, kurtosis, median, and mode of random variables.

CO7: Apply moment generating functions and characteristic functions to solve problems involving random variables and their distributions.

CO8: Analyze multivariate random variables, including joint distributions, marginal and conditional distributions, independence, covariance, correlation coefficient, and linear regression for two variables.

CO9: Work with the bivariate normal distribution and analyze the distribution of sums and products of independent discrete/continuous random variables.

CO10: Understand and apply Chebyshev's inequality, convergence in probability, and the weak and strong laws of large numbers. Apply the Central Limit Theorem and De Moivre-Laplace limit theorem for normal approximation of the binomial distribution.

CO11: Use the Uniqueness Theorem of Characteristic Functions to solve problems involving random variables and their distributions.

Group B: Statistics

CO12: Understand and apply concepts of populations and samples, random sampling, sampling distributions, and characteristics of sample statistics, including sample moments and sample variance.

CO13: Estimate parameters using point and interval estimation methods, and evaluate properties of good estimators, such as unbiasedness, consistency, and sufficiency, including the Minimum-Variance Unbiased Estimator (MVUE).

CO14: Apply the method of Maximum Likelihood to estimate parameters, including the likelihood function, log-likelihood function, and properties of maximum likelihood estimators for both discrete and continuous models.

CO15: Analyze bivariate frequency distributions, including correlation, covariance, and linear regression, and use the principle of least squares for fitting polynomials and exponential curves.

CO16: Compute and interpret confidence intervals for the mean and variance of a normal population, considering both known and unknown variances.

CO17: Understand and apply statistical hypothesis testing, including simple and composite hypotheses, null and alternative hypotheses, critical regions, type I and type II errors, level of significance, power functions, and likelihood-ratio tests.

CO18: Perform hypothesis tests for the mean of a normal distribution (variance known and unknown), test population proportions, and apply the Chi-square test for goodness of fit.

MATH-H-CC 9-5-TH

Probability and Statistics

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	CO 13	CO 14	CO 15	CO 16	CO 17	CO 18
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	_	_	✔	_	_	✔	_
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	_	✔	✔	_	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	-	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	-	✔	-	_	✔	-	_
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	_	✔	✔	_	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 10-5-TH

Ring Theory - II and Linear Algebra - I
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Ring Theory - II

CO1: Understand and apply the concepts of principal ideal domains (PID), principal ideal rings, prime and irreducible elements, and the greatest common divisor (gcd) and least common multiple (lcm) in ring theory.

CO2: Compute and express gcd in various rings and analyze examples where gcd does not exist, including understanding the relationship between Euclidean domains and principal ideal domains.

CO3: Analyze polynomial rings, including the division algorithm, and understand concepts of factorization domains, unique factorization domains, and the relationship between principal ideal domains and unique factorization domains.

CO4: Apply the Eisenstein criterion to establish unique factorization in polynomial rings, particularly in $\mathbb{Z}[x]$, and understand the concept of unique factorization in polynomial rings over unique factorization domains.

CO5: Explore ring embeddings and quotient fields, including the properties of regular rings and examples of regular rings, and analyze ideals within regular rings.

Group B: Linear Algebra - I

CO6: Define and work with vector spaces, subspaces, algebra of subspaces, quotient spaces, and concepts such as linear combinations, linear span, linear independence, basis, and dimension of vector spaces.

CO7: Analyze the dimension of subspaces of $\mathbb{R}^n$, including geometric significance up to $\mathbb{R}^3$,, and understand the four fundamental subspaces associated with a matrix, as well as rank and dimension of solution spaces.

CO8: Apply full rank factorization, rank inequalities, and Sylvester's inequality to solve problems related to the rank of matrices and dimensions of solution spaces.

CO9: Understand and compute linear transformations, including null space, range, rank, nullity, and matrix representation of linear transformations, and apply change of coordinate matrices.

CO10: Explore the algebra of linear transformations, including isomorphisms, isomorphism theorems, invertibility, and the relationship between linear transformations and their matrix representations.

CO11: Compute eigenvalues, eigenvectors, and the characteristic equation of a matrix (over $\mathbb{C}$), and apply the Cayley-Hamilton theorem to find the inverse of a matrix.

MATH-H-CC 10-5-TH

Ring Theory - II and Linear Algebra - I

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 11-5-TH
Riemann Integration and Series of Functions
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Riemann Integration

CO1: Understand and apply the concepts of partition of a closed and bounded interval, refinement of partitions, and the computation of upper and lower Darboux sums, as well as their implications for Riemann integrability.

CO2: Analyze the equivalence of Darboux's and Riemann's definitions of integrability and apply Darboux's theorem to determine Riemann integrability, including understanding the necessary and sufficient conditions for a function to be Riemann integrable.

CO3: Define and identify negligible sets (zero sets) and understand their properties, including how a bounded function on a closed and bounded interval is Riemann integrable if the set of points of discontinuity is negligible.

CO4: Compute and analyze the integrability of operations involving Riemann integrable functions, including sums, scalar multiples, products, quotients, and moduli, and apply these properties to practical problems.

CO5: Understand the concept of antiderivatives (primitives or indefinite integrals) and their properties, and apply the fundamental theorem of integral calculus to solve problems involving definite integrals.

CO6: Apply the first and second Mean Value theorems of integral calculus, including Weierstrass's and Bonnet's forms of the second Mean Value theorem, to analyze and solve integration problems.

CO7: Understand and apply the concept of improper integrals, including necessary and sufficient conditions for convergence and Cauchy's principal value, and utilize tests for convergence such as comparison and μ-test.

CO8: Analyze and compute integrals using the Beta and Gamma functions, including understanding their interrelations and applying these functions to solve integration problems where they exist.

Group B: Series of Functions

CO9: Define and distinguish between pointwise and uniform convergence of sequences of functions, and apply the Cauchy criterion of uniform convergence and Weierstrass's M-test to analyze convergence properties.

CO10: Apply the concepts of pointwise and uniform convergence to series of functions, including the passage to the limit term by term, and understand the implications for boundedness, continuity, integrability, and differentiability of the limit function.

CO11: Understand and apply the fundamental theorem of power series, including the Cauchy-Hadamard theorem for determining the radius of convergence, and analyze uniform and absolute convergence of power series.

CO12: Explore the properties of power series, including differentiation and integration of power series, Abel's limit theorems, and the uniqueness of power series having a given sum function.

CO13: Understand and apply the concept of Fourier series, including the conditions for a trigonometric series to be a Fourier series, the computation of Fourier coefficients for periodic functions, and the convergence of Fourier series as stated by Dirichlet's condition and Fourier's theorem.

MATH-H-CC 11-5-TH

Riemann Integration and Series of Functions

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	CO 13
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	_	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-CC 12-5-TH
Mechanics-II
Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Group A: Statics-II

CO1: Analyze the laws of static friction, including limiting friction, angle of friction, and cone of friction. Evaluate equilibrium positions of particles on rough planes and surfaces.

CO2: Apply the principle of virtual work to determine equilibrium conditions for systems with coplanar forces. Use concepts of degrees of freedom, constraints, and virtual displacement.

CO3: Assess stability in equilibrium situations, including the energy test of stability for systems with one degree of freedom. Determine conditions for stability involving gravity and bodies resting on one another.

CO4: Resolve and reduce arbitrary force systems in three dimensions. Utilize Poinsot's central axis for analyzing wrench intensity and deriving equations of equilibrium.

Group B: Dynamics of a Particle-II and Dynamics of Rigid Bodies

CO5: Evaluate the stability of nearly circular orbits and motion on rough curves. Analyze the dynamics of particles with varying mass, including problems related to mass addition and reduction.

CO6: Apply principles related to the mass, center of mass, linear momentum, and angular momentum of a system of particles. Understand energy conservation in mechanical systems.

CO7: Study moments and products of inertia for rigid bodies. Apply theorems related to the parallel and perpendicular axes and determine the principal axes.

CO8: Derive and use equations of motion for rigid bodies. Analyze motion about fixed axes, including concepts such as compound pendulums and the interchangeability of the point of suspension and center of oscillation.

CO9: Formulate and solve equations of motion for rigid bodies in two dimensions. Assess conditions for pure rolling and sliding and analyze kinetic energy and angular momentum about the origin.

CO10: Determine the effects of impulsive forces on motion. Apply conservation principles for linear and angular momentum in systems subjected to impulsive forces.

MATH-H-CC 12-5-TH

Mechanics-II

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-SEC 1-1-Th

C Language with Mathematical Applications

Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Programming Fundamentals:

CO1: Explain the fundamental concepts of computer architecture and programming languages, including machine code, assembly language, high-level languages, and object-oriented languages.

CO2: Demonstrate a strong understanding of constants, variables, data types, operators, and expressions in C programming.

CO3: Apply decision-making constructs (if, if-else, switch) and control flow statements (while, do-while, for) to create structured programs.

CO4: Effectively utilize arrays (one-dimensional, two-dimensional, and multi-dimensional) to organize and manipulate data.

Function Design and Implementation:

C05: Define and implement user-defined functions in C, understanding scope, return values, parameter passing, and recursion.

CO6: Apply library functions from standard C libraries (stdio.h, math.h, string.h, stdlib.h, time.h) to perform common tasks.

Problem-Solving and Programming Skills:

C07: Analyze programming problems and design algorithms using appropriate C constructs and techniques.

CO8: Write well-structured, readable, and efficient C programs to solve a variety of computational problems, including:

- Numerical calculations (arithmetic, series summation, approximations)
- Data processing (array manipulation, sorting, searching)
- Mathematical problems (quadratic equations, linear systems, geometric calculations)
- Text processing (strings, anagrams)
- Decision-making and branching based on user input or data conditions
- File I/O operations (reading and writing data files)

Practical Application and Communication:

CO9: Develop practical C programming skills through hands-on exercises and assignments, including the creation of a practical notebook.

CO10: Demonstrate clarity and precision in writing C code and explaining programming concepts.

CO11: Apply C programming skills to solve real-world problems in various domains, such as finance (compound interest), geometry, and problem-solving challenges.

MATH-H-SEC 1-1-Th

C Language with Mathematical Applications

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-SEC 2.2-2-Th

Artificial Intelligence

Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Unit 1: Introduction to Artificial Intelligence

CO1: Define AI and its scope within the broader context of computer science.

CO2: Trace the historical development of AI and identify key milestones and influential figures.

CO3: Distinguish between artificial and human intelligence, outlining their distinctive characteristics and limitations.

Unit 2: AI Subfields and Technologies

CO4: Explain the core principles of various machine learning approaches, including supervised, unsupervised, and reinforcement learning.

CO5: Analyze the structure and function of deep learning neural networks, recognizing their strengths and challenges.

CO6: Identify and describe applications of natural language processing (NLP) and computer vision in AI systems.

Unit 3: Applications of AI

CO7: Discuss the utilization of AI in healthcare diagnostics, treatment planning, and medical image analysis.

CO8: Evaluate the use of AI in financial applications like fraud detection, algorithmic trading, and risk assessment.

CO9: Analyze the potential and challenges of autonomous vehicles and AI-powered traffic optimization in transportation systems.

CO10: Critically examine the role of AI in customer service chatbots and its impact on user experience.

CO11: Explore the development of personalized learning platforms and intelligent tutoring systems in the field of education.

Unit 4: Ethical and Social Implications of AI

CO12: Identify and analyze potential biases and fairness concerns associated with AI algorithms and data.

CO13: Discuss privacy and data protection issues arising from the development and deployment of AI systems.

CO14: Evaluate the potential impact of AI on employment and job displacement, proposing mitigation strategies.

CO15: Analyze the relationship between AI and social inequality, identifying potential risks and promoting responsible development.

Unit 5: Other Important Issues

CO16: Critically assess existing ethical guidelines and best practices for responsible AI development and implementation.

CO17: Discuss the role of AI in driving innovation and transformation across various sectors.

CO18: Identify and analyze emerging trends and future directions in the field of AI.

CO19: Explore the intersection of AI and creativity, including generative models and their potential artistic applications.

Additional Outcomes:

CO20: Develop critical thinking and analytical skills through evaluating real-world AI applications and their implications.

CO21: Enhance communication skills by effectively presenting arguments, insights, and concerns related to AI technology.

CO22: Cultivate an informed and responsible perspective on the development and deployment of AI in society.

MATH-MD-SEC 2.2-2-Th

Artificial Intelligence

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	CO 13	CO 14	CO 15	CO 16	CO 17	CO 18	CO 19	CO 20	CO 21	CO 22
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔	-	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-SEC 3-3-Th

Linear Programming and Rectangular Games

Full Marks: 100 (Theory: 75 and Tutorial: 25)

Course learning outcome (COs):

Upon successful completion of this course, students will be able to:

Unit 1: Introduction to Linear Programming

CO1: Define linear programming problems and formulate them from real-life examples involving inequalities.

CO2: Graphically solve simple linear programming problems and identify basic feasible solutions.

CO3: Understand the concepts of matrix formulation, degeneracy, and non-degeneracy in B.F.S.

Unit 2: Convexity and Extreme Points

CO4: Explain the concepts of hyperplanes, convex sets, cones, extreme points, convex hulls, and convex polyhedra.

CO5: Analyze the relationship between feasible solutions of an L.P.P. and its convex set, extreme points, and optimal values.

CO6: Differentiate between bounded and unbounded feasible regions and their implications for optimality.

Unit 3: The Simplex Method and Duality

CO7: Implement the simplex method and two-phase method to solve linear programming problems.

CO8: Understand the theoretical basis of feasibility and optimality conditions in the simplex method.

CO9: Identify and resolve degeneracy issues in linear programming problems.

CO10: Apply duality theory to understand the relationship between primal and dual problems and their optimal values.

Unit 4: Post-Optimal Analysis and Applications

CO11: Analyze the impact of changes in cost and requirement vectors, coefficient matrix, and addition of variables/constraints on optimal solutions.

CO12: Solve transportation and assignment problems using mathematical justifications and Hungarian method.

CO13: Understand the Traveling Salesman problem and its complexity.

Unit 5: Rectangular Games and Interrelations

CO14: Explain the concept of game problems and rectangular games with pure and mixed strategies.

CO15: Identify and analyze saddle points and their existence in rectangular games.

CO16: Determine optimal strategies and values of the game, applying necessary and sufficient conditions.

CO17: Utilize dominance concepts and the fundamental theorem of rectangular games to solve problems.

CO18: Compare and contrast the relationships between game theory and linear programming.

Additional Outcomes:

CO19: Proficiently utilize software packages to formulate and solve linear programming problems.

CO20: Develop a practical notebook documenting internal assignments and solutions for partial course fulfillment.

CO21: Effectively communicate mathematical concepts and problem-solving techniques in both written and spoken forms.

CO22: Apply critical thinking skills to analyze complex optimization scenarios and develop creative solutions.

MATH-H-SEC 3-3-Th

Linear Programming and Rectangular Games

Full Marks: 100 (Theory: 75 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	CO 13	CO 14	CO 15	CO 16	CO 17	CO 18	CO 19	CO 20	CO 21	CO 22
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔	-	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

MATH-H-IDC-1-Th
(same for MATH-H-IDC-2-Th and MATH-H-IDC-3-Th)
Mathematics in Daily Life
Full Marks: 75 (Theory: 50 and Tutorial: 25)

Course learning outcome (COs):

Overall:

Upon successful completion of "Mathematics in Daily Life," students will be able to:

CO1: Recognize and apply foundational mathematical concepts to solve practical problems and make informed decisions in various everyday scenarios.

CO2: Develop critical thinking and problem-solving skills by analyzing real-world data and situations through a mathematical lens.

CO3: Effectively communicate and explain mathematical reasoning and solutions in a clear and understandable way.

CO4: Appreciate the relevance and power of mathematics in diverse aspects of daily life, from personal finance and budgeting to understanding news and making responsible choices.

Specific Group-Level Outcomes:

Group A: Basics of Set Theory

CO5: Organize and categorize information based on set operations like union, intersection, and complement, applicable to sorting items, managing schedules, or planning events.

CO6: Visualize relationships between sets using Venn diagrams to understand connections and overlap in diverse contexts, like comparing dietary options or analyzing social groups.

CO7: Utilize the formula for number of elements to estimate quantities or make informed decisions in daily situations.

Group B: Understanding Integers

CO8: Apply divisibility rules to quickly assess quantities in shopping, cooking, or other activities involving calculations.

CO9: Solve linear Diophantine equations to optimize resource allocation or find optimal combinations in scenarios like recipe balancing or budget planning.

CO10: Utilize congruence of integers to create scheduling arrangements, game plans, or even solve puzzles, demonstrating its practical applications beyond abstract

mathematics.

Group C: Mathematical Logic

CO11: Analyze information and arguments critically using logical connectives like OR, AND, and NOT, improving decision-making in daily life scenarios like evaluating news claims or weighing options.

CO12: Identify tautologies and contradictions in everyday arguments to enhance critical thinking and logical reasoning skills.

Group D: Basics of Operations Research

CO13: Formulate simple real-world problems as linear programs, such as optimizing travel routes, planning schedules, or allocating resources, and visualize solutions using the graphical method.

CO14: Understand the concept of game theory and apply it to analyze competitive situations in daily life, like negotiations, resource sharing, or even game strategies.

Group E: Financial Mathematics

CO15: Calculate and compare different interest rates for loans, investments, or savings, making informed financial decisions based on mathematical calculations.

CO16: Apply annuity concepts to understand loan repayments, pension plans, or investment schemes, planning for their financial future.

CO17: Navigate tax calculations and optimize financial decisions using basic mathematical principles.

Additional Outcomes:

CO18: Develop confidence and comfort applying mathematical knowledge to real-world challenges.

CO19: Foster a sense of curiosity and exploration, actively seeking and appreciating the presence of mathematics in everyday life.

CO20: Communicate the value and relevance of mathematics beyond academic settings, showcasing its practical applications and empowering students to make informed decisions.

MATH-H-IDC-1-Th

(same for MATH-H-IDC-2-Th and MATH-H-IDC-3-Th)

Mathematics in Daily Life

Full Marks: 75 (Theory: 50 and Tutorial: 25)

	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	CO 13	CO 14	CO 15	CO 16	CO 17	CO 18	CO 19	CO 20
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	_	_	✔	_	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO10	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO11	✔	✔	✔	✔	-	-	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO12	✔	✔	✔	✔	-	-	✔	-	_	_	✔	✔	-	✔	✔	✔	✔	✔	✔	✔
PO13	✔	✔	✔	✔	✔	✔	_	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO14	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔