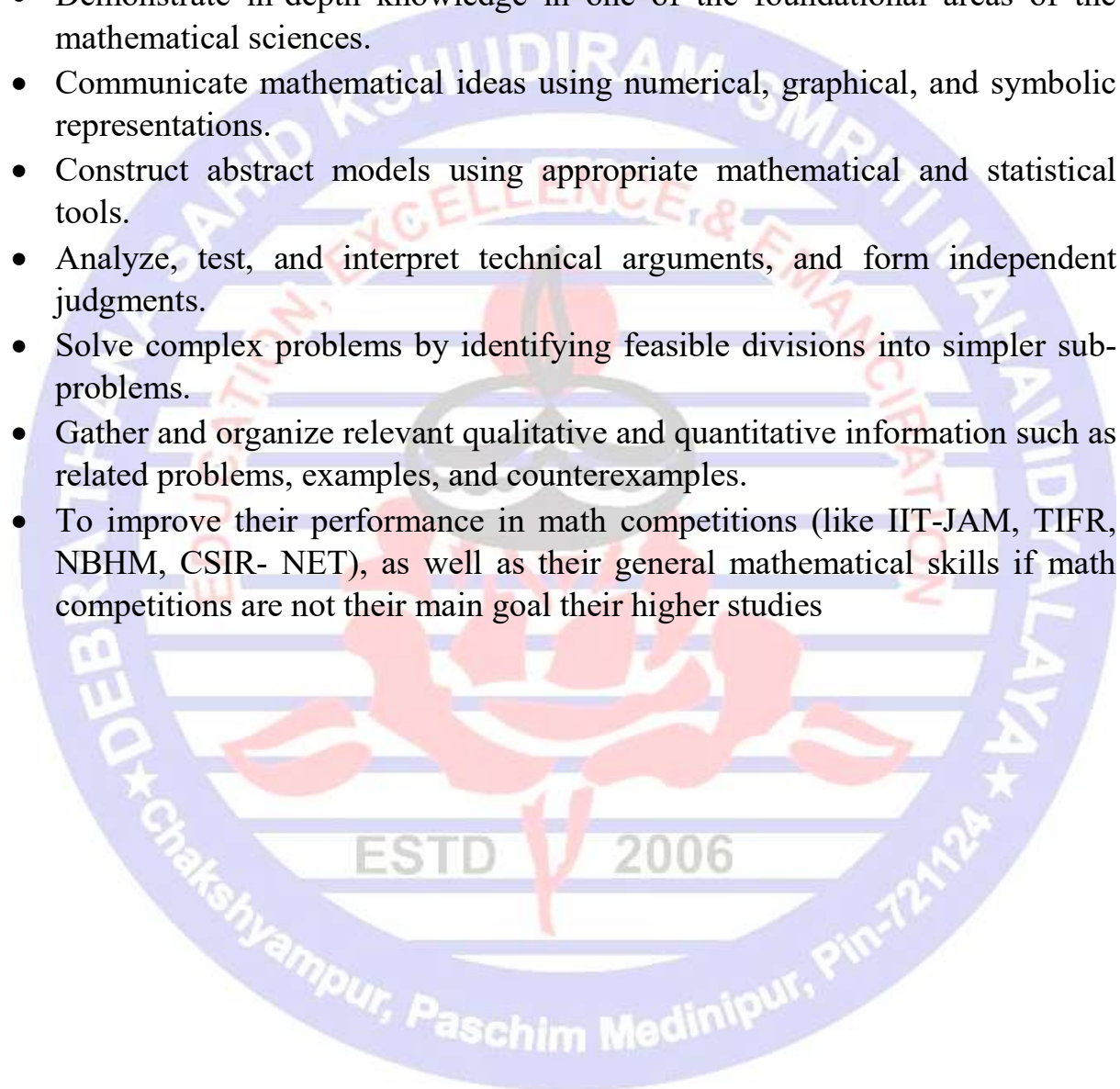


## B. Sc. Honours in Mathematics

### Programme Specific Outcome (PSO)

By the end of the program UG in Mathematics, the student will be able to:

- Demonstrate in-depth knowledge in one of the foundational areas of the mathematical sciences.
- Communicate mathematical ideas using numerical, graphical, and symbolic representations.
- Construct abstract models using appropriate mathematical and statistical tools.
- Analyze, test, and interpret technical arguments, and form independent judgments.
- Solve complex problems by identifying feasible divisions into simpler sub-problems.
- Gather and organize relevant qualitative and quantitative information such as related problems, examples, and counterexamples.
- To improve their performance in math competitions (like IIT-JAM, TIFR, NBHM, CSIR- NET), as well as their general mathematical skills if math competitions are not their main goal their higher studies



## Course Outcome (CO)

### MTMHCC01: Calculus, Geometry & Differential Equation

#### Outcomes:

##### Calculus:

- Students will be able to differentiate a function successively.
- Students will be able to integrate functions like  $\sin^n x$ ,  $\cos^n x$ ,... by applying the reduction formula.
- Students will learn about the hyperbolic function, concavity, and inflection points.
- Students will be able to find envelopes and asymptotes of a curve.
- Students will know and indeterminate form and be able to solve this type of problem.
- Students will be able to sketch graphs of various curves.
- Students will be able to obtain the surface of the revolution of curves.

##### Geometry:

- Students will be able to classify the conics with the help of a determinant and find their canonical forms.
- Students will have clear concepts about the polar coordinate section.
- Students will know about conicoid in three dimensions and be able to solve various problems regarding conicoids.

##### Differential equation:

- Students will be able to formulate differential equations from various practical problems and solve them.
- Students will be able to solve various types of differential equations of 1<sup>st</sup> order.
- Students will be able to sketch ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using cartesian coordinates.

### MTMHCC02: Algebra

#### Outcomes:

- Students will be able to know about the polar form of a complex number and be experts in solving problems of complex numbers in polar form.
- Students will be experts in solving an algebraic equation up to degree 4 and able to solve various inequality problems
- Students will know about equivalence relations and their properties.
- Students will know about functions, the composition of functions, Invertible functions, one-to-one correspondence, and the cardinality of a set.
- Students will know about the fundamental theorem of arithmetic.
- Students will be able to solve a system of linear equations.
- Students will know the fundament definition and ideas of linear transformations.

### **MTMHCC03: Real Analysis**

#### **Outcomes:**

- Students will know the fundamental topological concepts and many properties of real number systems.
- Students will know about sequence and infinite series of real numbers and be able to solve problems regarding sequence and series.

### **MTMHCC04: Differential Equations & Vector Calculus**

#### **Outcomes:**

- Students will be able to solve differential equations 2<sup>nd</sup> order and know about the power series solution of a differential equation.
- Students will obtain the basic concepts of vector differentiation and integration.

### **MTMHCC05: Theory of Real Functions & Introduction to Metric Space**

#### **Outcomes:**

- Students will know the concept and various theorems on limit, continuity, and differentiation of a real function and can solve various problems regarding this.
- Students will obtain the basic concepts of metric space and its properties.

### **MTMHCC06: Group Theory 1**

#### **Outcomes:**

- Students will know the concept, definitions, and various theorems on Group, subgroup, centralizer, normalizer, center of the group, cyclic group, permutations, normal subgroups, factor group, and external and internal direct product of groups.
- Students will also be able to solve various problems on the aforesaid topics.
- Students will know the definitions, properties, and various problems on homomorphism, isomorphism, and automorphism.
- Students will learn First, Second, and Third isomorphism theorems with their proof.

### **MTMHCC07: Numerical Methods**

#### **Outcomes:**

- Students will know about rounding off a number and possible errors regarding round-off.
- Students will be able to solve various types of equations, differentiate and integrate various functions and solve various differential equations by numerical methods.
- Students will be able to solve the above problems by C++ programming in the departmental lab.



### **MTMHCC08: Riemann Integration and Series of Functions**

#### **Outcomes:**

- Students will know the concept, definitions, and various theorems on Riemann and Improper integral and can integrate various functions by those methods.
- Students will know about the sequence of functions, series of functions, power series, and Fourier series and can solve various problems.

### **MTMHCC09: Multivariate Calculus**

#### **Outcomes:**

- Students will know about the difference between derivation and differentiation.
- Students will be experts in calculating double and triple integrals by the calculus method and vector method.
- Students will be experts in calculating area, surface, and volume by integration method.
- Students will know the relation between single, double, and triple integral.

### **MTMHCC10: Ring Theory and Linear Algebra I**

#### **Outcomes:**

- Students will know definitions, examples, and properties of the ring, integral domain, field, subring, ideals, and factor ring.
- Students will know the basic concept of vector space.
- Students will be able to know the isomorphism in linear transformation.

### **MTMHCC11: Partial Differential Equations & Applications**

#### **Outcomes:**

- Students will know the basic concept of vector space.
- Students will know the basic concept of the partial differential equation.
- Students will be able to solve various types of 1<sup>st</sup> order partial differential equations and some special types of 2<sup>nd</sup> order partial differential equations like Wave equation, Heat equation, Cauchy problem, Semi-infinite string problem, etc.
- Students will know the basic concept of a central force, constrained motion, tangential and normal components of accelerations and velocity, planetary motion, and Kepler's law.

### **MTMHCC12: Group Theory II**

#### **Outcomes:**

- Students will know details about the automorphism group and properties of external and internal direct products.
- Students will learn about group action, p-group, Sylow theorem, and Cauchy theorem.

### **MTMHCC13: Metric Spaces and Complex Analysis**

#### **Outcomes:**

- Students will know details about convergence in metric space, limit, and continuity in metric space.
- Students will learn about the analytic function and its properties.
- Students will learn about various types of infinite series of a complex number and can solve problems from these chapters.

### **MTMHCC14: Ring Theory and Linear Algebra II**

#### **Outcomes:**

- Students will know about polynomial rings and their properties.
- Students will know about dual space and inner product space in vector space.

### **MTMHSE01: Logic & Sets**

#### **Outcomes:**

- Students will know about truth table, negation, conjunction, disjunction, implications, biconditional propositions, converse, contrapositive, and inverse propositions, and precedence of logical operators.
- Student will learn about Propositional equivalence and Predicates and quantifiers.
- Students will be able to know the definitions and properties of sets, subsets, finite sets, empty sets, classes of sets, and the power set of a set.
- Students can solve various problems on difference and symmetric difference of two sets, union, and intersections of sets, and relations.

### **MTMHSE02: Graph Theory**

#### **Outcomes:**

- Students know about definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bipartite graphs isomorphism of graphs.
- Student will learn about Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles, theorems Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph,

- Student will learn about Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm.

### **MTMHDS01: Theory of Equations**

#### **Outcomes:**

- Student will learn about general properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descartes' rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.
- Students can solve problems on Symmetric functions, Transformation of equations, Reciprocal and binomial equations, Cubic and biquadratic
- Student will learn about symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.
- Student can separation of the roots of equations by Strums theorem.

### **MTMHDS02: Probability & Statistics**

#### **Outcomes:**

- Student will learn about Sample space, Probability axioms, Real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.
- Students can solve problems on Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, the expectation of a function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function and calculation of covariance, linear regression for two variables.
- Students will learn about Chebyshev's inequality, (weak) law of large numbers and strong law of large numbers, the Central limit theorem for independent and identically distributed random variables with finite variance, Markov chains, Chapman-Kolmogorov equations, and classification of states.
- Students can solve problems on Random Samples, Sampling Distributions, Estimation of parameters, and Testing of hypotheses.

### **MTMHDS03: Number Theory**

#### **Outcomes:**

- Student will know about Linear diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences,



complete set of residues. Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

- Students will learn about Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.
- Student will improve their concepts on order of an integer modulo  $n$ , primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the  $x^2 + y^2 = z^2$ , Fermat's Last theorem.

#### **MTMHDS04: Mathematical Modelling**

##### **Outcomes:**

- Students will learn about the solution methodology of Bessel's equation and Legendre's equation by Power Series Method, Laplace transform and inverse transform, application to initial value problem up to second order.
- Student will briefly know about Monte Carlo simulation modelling, queuing models, Optimization model, Linear programming model.

#### **MTMHGE01: Calculus, Geometry & Differential Equation**

##### **Outcomes:**

##### **Calculus:**

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#### **Outcomes:**

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#### **Outcomes:**

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