



DEPARTMENT OF MATHEMATICS
INDAS MAHAVIDYALAYA

HONOURS COURSE
PROGRAMME OUTCOMES

PO1. Student will be able to understand and analyze the concepts of mathematical problems with their application to Industries, Engineering Science, Biology and Environmental Science.

PO2. Student will be able to develop the skill to analyze the real and abstract concepts on mathematics.

PO3. Student will be able to formulate the mathematical arguments in logical manner.

PO4. Student will be able to develop the problems solving skills in different branches of mathematics like as calculus, differential equation, dynamics and linear programming problems etc.

PO5. Student will be able to develop the think critically on complex variable.

PO6. Student will be able to making a decision for high quality research project in the appropriate disciplinary or multidisciplinary context.

PO7. Student will be able to develop the computer C programming skill for solving numerical and various physical problem.

COURSE OUTCOMES

Semester 1

Course Code: SH/MTH/101/C-1

Course Title: Calculus, Geometry & Differential Equation

CO1. Student will be able to analyze the concepts of Higher Order Derivative and understand the Leibnitz rule and its applications. Student will be able to understand clear concepts of Concavity and Inflection points, envelope, asymptote, Curve Tracing in Cartesian and Polar coordinates. Student will be able to understand the L'Hospital rule and its application.

CO2. Student will be able to apply the definite integral to evaluate arc length, area, volume.

CO3. Student will be able to Learn the classification of conics using discriminant and understand different type of conics and polar equation of conics.

CO4. Student will be able to understand and remembering the properties of spheres, cylindrical surface, central conicoids, paraboloids, plane sections of conicoids and generating line with view of geometry aspect.

CO5. Student will be able to understand the linear and non-linear differential equations and remembering the method of solution of variety of first order differential equations with an emphasis on linear equations.

CO6. Student will be able to Derive and apply the mathematical model in different real life problems.

Semester 1

Course Code: SH/MTH/102/C-2

Course Title: Algebra

CO1. Student will be able to understand the fundamental concepts of complex numbers including its representation and able to apply the De Moivre's theorem.

CO2.. Student will be able to calculate Know the relations between the roots and coefficients of an equation. Student will be understand the solution process of a cubic and bi-quadratic equation.

CO3. Student will be able to analyze and interpret the fundamental concepts of relations, functions and cardinality of a set.

CO4. Student will be able to analyze and understand the concepts of division algorithm, divisibility and Euclidean algorithm. Student will be able to remember the fundamental concepts of congruence, greatest common divisor, prime and prime-factorization.

CO5. Student will be able to understand and remember the clear concepts on Matrices, operation on matrix, echelon form and row reduced form, inverse of a matrix, rank of a matrix.

CO6. Student will be able to understand the idea of eigen values and eigen functions and able to apply the Cayley-Hamilton theorem to find the inverse of matrix.

Semester 2

Course Code: SH/MTH/201/C-3

Course Title: Real Analysis

CO1. Student will be able to analyze the familiar concept of the ordering, countability, Archimedian, completeness properties of \mathbb{R} .

CO2.. Student will be able to understand the clear concepts of open set, closed set, limit point, isolated point, compact set.

CO3. Student will be able to understand the full concepts of convergent, divergent and oscillating sequences.

CO4. Student will be able to apply the limit supremum, limit infimum of sequences.

CO5. Student will be able to test the convergence of sequence and series.

CO6. Student will be able to determine the limit of the sequence and series.

Semester 2

Course Code: SH/MTH/202/C-4

Course Title: Differential Equations and Vector Calculus

CO1. Student will be able to understand the general solution of homogeneous equation of second order linear differential equations, the linear homogeneous and non-homogeneous equations of higher order with constant coefficients.

CO2. Student will be able to apply the Euler's Equation, the method of undetermined coefficients and method of variation of parameter to solve a ODE.

CO3. Student will be able to understand the real life situation by constructing ordinary differential equations.

CO4. Student will be able to understand and assimilate the concepts of equilibrium points, Interpretation of the phase plane.

CO5. Student will be able to remember the vector triple product and operations with vector valued function.

CO6. Student will be able to understand and remember the concepts of divergence, curl and integration of vector point functions.

Semester 3

Course Code: SH/MTH/301/C-5

Course Title: Theory of Real Function & Introduction to Metric Space

CO1. Student will be able to understand the approach of ϵ - δ definition of limit, continuity and differentiability with pure analytical point of view.

CO2. Student will be able to analyze and remember the characteristic of continuous functions i.e. boundedness property, intermediate-value property, location of roots theorem, interval preservation property etc.

CO4. Student will be able to understand the fundamental concept of Rolle's theorem, Mean value theorem and Darboux's theorem and will be able to apply these theorems to evaluate the derivatives of a function at a point.

CO5. Student will be able to understand the proper definition and examples of metric space, sub-space.

CO6. Student will be able to understand the concepts of open balls, closed balls, open Sets, limit point of a set, closed sets and diameter of a set in a metric space along with geometry structure.

Semester 3

Course Code: SH/MTH/302/C-6

Course Title: Group Theory-I

CO1. Student will be able to analyze and justify whether a given mathematical structure forms a group or not and also realize the general properties of group and its applications.

CO2. Student will be able to understand and realize the properties of different groups including Dihedral group, Quaternion group and permutation group.

CO3. Student will be able to understand the concepts of subgroups, cyclic subgroups, normal subgroups, quotient group and its examples and also able to understand the coset, Lagrange's theorem and its application.

CO4. Students will be able to understand the idea of external direct product of finite number of groups. Student will be able to analyze Cauchy's theorem for finite abelian group and its consequences.

CO5. Student will be able to remember the group homomorphism and their properties and will be able to understand the Cayley's theorem.

CO6. Student will be able to analyze and understand the concepts about first, second, third isomorphism theorem.

Semester 3

Course Code: SH/MTH/303/C-7

Course Title: Numerical Methods

CO1. Student will be able to remember the concepts about error i.e. relative, absolute, round off, truncation error in numerical calculation and also able to understand the difference operators, interpolation with equi-spaced & unequi-spaced.

CO2. Student will be able to solve the algebraic and transcendental equations for finding roots along with geometry point of view using various methods and also analyze the rate of convergence and error estimation.

CO3. Student will be able to remember the various methods of solving technique of simultaneous linear algebraic equations and also able to analyze their convergences.

CO4. Student will be able to understand the various method of evaluating a definite integral numerically.

CO5. Student will be able to understand the solution process on higher order differential equations using Euler's, Runge-Kutta methods.

CO6. Student will be able to understand and write C programming language to evaluate any particular numerical problem like solution of an equation, evaluation of integrations, etc.

Semester 3

Course Code: SH/MTH/305/SEC-I

Course Title: Programming using C

- CO1.** Student will be able to understand C character set, keywords, constants and variables.
- CO2.** Student will be able to understand Basic Data types, Variable Operators and Expression in C, Assignment statement and I/O Statement.
- CO3.** Student will be able to understand the decision making statements and looping structures in C
- CO4.** Student will be able to understand the concept of arrays in a C program.
- CO5.** Student will be able to understand the concept of sub-program and its purpose, definition of function and function prototype,
- CO6.** Student will be able to recall writing skill to solve various program in C.

Semester 4

Course Code: SH/MTH/401/C-8

Course Title: Riemann Integration and Series of Functions

- CO1.** Student will be able to understand and apply the concept of Darboux integrability, Riemann integrability Fundamental theorems of calculus.
- CO2.** Student will be able to understand and remember the knowledge of Riemann integrability of monotone function, continuous function and the properties of the Riemann Integrals .
- CO3.** Student will be able to analyze the convergence of improper integrals and its different properties and able to explain the difference between Riemann Integrals and Improper Integral.
- CO4.** Student will be able to understand the point-wise and uniform convergence of a sequence and series of real valued functions.
- CO5.** Student will be able to understand and remember the Fourier series, Riemann Lebesgue Lemma, Bessel's inequality, Parseval identity, Dirichlet's conditions for Fourier expansion of a real valued function.
- CO6.** Student will be able to Understand and analyze the Power series and its radius of convergence. Student will be able to understand concept of Cauchy-Hadamard theorem.

Semester 4

Course Code: SH/MTH/402/C-9

Course Title: Multivariate Calculus

- CO1.** Student will be able to understand the fundamental concepts of functions with several variables & the notions of limit, continuity and derivability for a function of double variable.
- CO2.** Student will be able to understand and remember the sufficient condition of differentiability, chain rule and directional derivative.
- CO3.** Student will be able to determine the extreme value of a function in two variables in both constrained and unconstrained cases.

CO4. Student will be able to evaluate the double integrals over rectangle and non-rectangle region and also able to understand the change of variables in double and triple integrals.

CO5. Student will be able to understand the problems related to ordinary integrals of vectors, line integrals, line integrals, surface integrals and volume integrals.

CO6. Student will be able to understand and remember the knowledge on the concept of divergence, curl and integration of vector point functions.

Semester 4

Course Code: SH/MTH/403/C-10

Course Title: Ring Theory and Linear Algebra-I

CO1. Student will be able to understand the basic concepts of ring and the various properties of several examples of rings.

CO2. Student will be able to Identify the properties which make a ring an integral domain or a field and also able to understand the idea of a factor ring.

CO3. Student will be able to calculate a basis of a vector space by extension, deletion and replacement theorem.

CO4. Student will be able to understand and visualize the concepts of ring homomorphism and isomorphism.

CO5. Student will be able to understand the basic concepts of vector space and subspaces, linear dependence, linear independence, dimension of a subspace.

CO6. Student will be able to determine the rank and nullity of the space and matrix of linear transformation.

Semester 4

Course Code: SH/MTH/405/SEC-2

Course Title: Graph Theory

CO1. Student will be able to understand graph theory in technically accurate manner.

CO2. Student will be able to express adjacency matrix and incidence matrix of a graph.

CO3. Student will be able to understand the concepts of connectedness in graph.

CO4. Student will be able to understand the concept about Eulerian and Hamiltonian graph.

CO5. Student will be able to understand and remember the knowledge about Tree, Minimal Spanning Tree.

CO6. Student will be able to understand the Dijkstra's algorithm and Warshall algorithm to find the shortest path between any two vertices in a graph.

Semester 5

Course Code: SH/MTH/501/C-11

Course Title: Partial Differential Equations and Applications

CO1. Student will be able to understand basic definition of PDEs and classification of various first order PDEs and understand how construct it and its geometrical interpretation.

CO2. Student will be able to understand the method of characteristics for obtaining general solution of Quasi Linear Equations and various methods of solving first order PDEs.

CO3. Student will be able to understand and remember derivation of the Heat equation, Wave equation and Laplace equation and its geometrical interpretation.

CO4. Student will be able to understand and remember the classification of second order linear PDEs like hyperbolic, parabolic or elliptic and also able to understand the reduction it to its canonical forms.

CO5. Student will be able to understand Cauchy problem and apply problem solving using concepts and techniques from PDEs in different cases.

CO6. Student will be able to understand and remember central force, Constrained motion, varying mass, tangent and normal component of acceleration and understand modelling of ballistics and planetary motion, kepler's second law and also analyze the practical problems.

Semester 5

Course Code: SH/MTH/502/C-12

Course Title: Group Theory-II

CO1. Student will be able to understand the knowledge about automorphism, inner automorphism and automorphism group and also able to understand characteristic subgroup and commutator subgroup and its properties.

CO2. Student will be able to understand the properties of external direct product and internal direct product .

CO3. Student will be able to understand and remember the fundamental theorem for finite abelian groups. Student will be able to determine the number non-isomorphic abelian groups of a given order.

CO4. Student will be able to understand the definition of Group actions, stabilizers and kernels and also Gain knowledge about the permutation representation associated with a given group action. Student will be able to understand the application of Group action.

CO5. Student will be able to understand Generalized Cayley's theorem, Index theorem and Gain Knowledge how can apply these theorem to Group theory. Student will be able to understand and remember the class equation of a group and its consequences.

CO6. Student will be able to understand and remember the Syllow's theorem and consequences. Student will be able to understand Cauchy theorem and learn apply these theorem to test whether a given group is simple or not.

Semester 5

Course Code: SH/MTH/503/DSE-1

Course Title: Linear Programming

CO1. Student will be able to formulate L.P.P. Student will be able to solve L.P.P. by Simplex method, Big M method and Two Phase simplex methods.

CO2. Student will be able to formulate the Dual problem and find the solution of a LPP by solving its dual.

CO3. Student will be able to understand Transportation problem and its mathematical formulation. Student will be able to solve transportation problem by different method like VAM Method, North-West corner method etc and its optimality condition.

CO4. Student will be able to understand Assignment problem and its mathematical formulation. Student will be able to solve an Assignment problem by Hungarian method.

CO5. Student will be able to develop concept on Games & Strategies and formulation of two person zero sum games.

CO6. Student will be able to solve the game problems by different methods.

Semester 5

Course Code: SH/MTH/504/DSE-2

Course Title: Probability and Statistics

CO1. Student will be able to understand the clear concepts of sample space, probability axioms, conditional probability and independent events and related Baye's theorem.

CO2. Student will be able to understand the definition of real random variables in case of discrete and continuous and also able to understand Cumulative distribution and probability mass/density function and different types of distribution functions.

CO3. Student will be able to understand the joint probability density functions and also marginal, conditional distribution. Student will be able to calculate the mathematical expectation, moment generating function, characteristic functions and covariance

CO4. Student will be able to understand and apply Chebyshev's inequality, Central Limit theorem and Markov Chain.

CO5. Student will be able to random sample and sample distribution.

CO6. Student will be able to test the hypothesis for small samples by the idea of student's t-distribution and f-distribution.

Semester 6

Course Code: Metric Spaces and Complex Analysis

Course Title: SH/MTH/601/C-13

CO1. Student will be able to understand the concepts of metric spaces and continuous function and also able to analyze the properties of continuous functions on various metric spaces.

CO2. Student will be able to understand the concepts of connectedness and completeness in a metric space.

CO3. Student will be able to understand and acquire the knowledge about compactness and uniform continuity.

CO4. Student will be able to analyse the fundamental concepts of Cauchy – Riemann equations and also able to decide the analyticity of complex function.

CO5. Student will be able to understand contour integration and also able to present the emphasis of Cauchy – Goursat theorem in simply and multiply connected domains.

CO6. Student will be able to determine a contour integral by applying Cauchy's Integral formula and be accomplished in implementing the Liouville's theorem and the maximum modulus principle.

Semester 6

Course Code: SH/MTH/602/C-14

Course Title: Ring Theory and Linear Algebra II

CO1. Student will be able to understand and remember the properties of polynomial rings.

CO2. Student will be able to understand the concepts of divisibility, irreducibility of integers in a rings and also able to understand the knowledge of ED, PID, UFD.

CO3. Student will be able to understand the definition of dual spaces, double dual spaces, and able to realize the identification of transformations in double dual space with the vectors.

CO4. Student will be able to determine the Jordan form and other canonical forms of a linear transformation.

CO5. Student will be able to acquire knowledge about the concepts of inner product spaces and also able to construct an orthonormal basis of a vector space by Gram- Schmidt process.

CO6. Student will be able to visualize Orthogonal projections and analyze a linear transformation by Spectral Theory.

Semester 6

Course Code: SH/MTH/603/DSE-3

Course Title: Number Theory

CO1. Student will be able to understand the different types results involving divisibility, greatest common divisors and solve the systems of linear congruence.

CO2. Student will be able to understand and apply the concepts of the linear Diophantine equation $ax+by=c$

CO3. Student will be able to apply Euler-Fermats theorem to prove relations involving prime numbers.

CO4. Student will be able to understand the different types of number theoretic functions.

CO5. Student will be able to understand the concept of Fermat's theorem, generalisation of Fermat's Wilson's theorem and Lagrange's theorem and solve the problems related to them.

CO6. Student will be able to apply the law of quadratic reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues.

Semester 6

Course Code: SH/MTH/604/DSE-4

Course Title: Project Work

CO1. Student will be able to Demonstrate a sound technical knowledge of their selected project topic.

CO2. Student will be able to take up any physical problem, model it mathematically and search for its possible solution.

CO3. Student will be able to develop themselves as future researchers in the field of Mathematics or any inter-disciplinary subject.

CO4. Student will be able to Communicate with the mathematicians and the community at large in written and oral forms.

CO5. Student will be able to explain and develop their presentation skills.

PROGRAM COURSE

PROGRAMME OUTCOMES

PO1. Student will be able to understand and analyze the concepts of mathematical problems with their application to Industries, Engineering Science, Biology and Environmental Science.

PO2. Student will be able to develop the skill to analyze the real and abstract concepts on mathematics.

PO3. Student will be able to formulate the mathematical arguments in logical manner.

PO4. Student will be able to develop the problems solving skills in different branches of mathematics like as calculus, differential equation, dynamics and linear programming problems etc.

PO5. Student will be able to develop the think critically on complex variable.

PO6. Student will be able to making a decision for high quality research project in the appropriate disciplinary or multidisciplinary context.

PO7. Student will be able to develop the computer C programming skill for solving numerical and various physical problem.

Course Outcomes

Semester 1

Course Code: SP/MTH/101/C-1A

Course Title: Calculus, Geometry & Differential Equation

CO1. Student will be able to analyze the concepts of Higher Order Derivative and understand the Leibnitz rule and its applications. Student will be able to understand clear concepts of Concavity and Inflection points, envelope, asymptote, Curve Tracing in Cartesian and Polar coordinates. Student will be able to understand the L'Hospital rule and its application.

CO2. Student will be able to apply the definite integral to evaluate arc length, area, volume.

CO3. Student will be able to Learn the classification of conics using discriminant and understand different type of conics and polar equation of conics.

CO4. Student will be able to understand and remembering the properties of spheres, cylindrical surface, central conicoids, paraboloids, plane sections of conicoids and generating line with view of geometry aspect.

CO5. Student will be able to understand the linear and non-linear differential equations and remembering the method of solution of variety of first order differential equations with an emphasis on linear equations.

CO6. Student will be able to Derive and apply the mathematical model in different real life problems.

Semester 2

Course Code: SP/MTH/201/C-1B

Course Title: Real Analysis

CO1. Student will be able to analyze the familiar concept of the ordering, countability, Archimedian, completeness properties of \mathbb{R} .

CO2. Student will be able to understand the clear concepts of open set, closed set, limit point, isolated point, compact set.

CO3. Student will be able to understand the full concepts of convergent, divergent and oscillating sequences.

CO4. Student will be able to apply the limit supremum, limit infimum of sequences.

CO5. Student will be able to test the convergence of sequence and series.

CO6. Student will be able to determine the limit of the sequence and series.

Semester 3

Course Code: SP/MTH/301/C-1C

Course Title: Algebra

CO1. Student will be able to understand the fundamental concepts of complex numbers including its representation and able to apply the De Moivre's theorem.

CO2. Student will be able to calculate Know the relations between the roots and coefficients of an equation. Student will be understand the solution process of a cubic and bi-quadratic equation.

CO3. Student will be able to analyze and interpret the fundamental concepts of relations, functions and cardinality of a set.

CO4. Student will be able to analyze and understand the concepts of division algorithm, divisibility and Euclidean algorithm. Student will be able to remember the fundamental concepts of congruence, greatest common divisor, prime and prime-factorization.

CO5. Student will be able to understand and remember the clear concepts on Matrices, operation on matrix, echelon form and row reduced form, inverse of a matrix, rank of a matrix.

CO6. Student will be able to understand the idea of eigen values and eigen functions and able to apply the Cayley-Hamilton theorem to find the inverse of matrix.

Semester 3

Course Code: SP/MTH/304/SEC-1

Course Title: Logic and Sets

CO1. Understand the law of logic of natural language . understand the proposition, truth table, negation, conjunction, disjunction, implications, biconditional propositions.

CO2. Determine the truth value of unquantified sentence using logical rules. Determine the converse, inverse and contrapositive of a given implication and explain their relation

CO3. Determine if a quantified statement involving either one or two quantifiers is true or false.

CO4. Understand the basic principles of sets and operation on sets.

CO5. Construct proofs of basic set theoretic identities involving unions, intersections and Cartesian products.

CO6. Demonstrate an understanding of relations and functions and be able to determine the properties.

Semester 4

Course Code: SP/MTH/401/C-1D

Course Title: Differential Equations and Vector Calculus

CO1. Student will be able to understand the general solution of homogeneous equation of second order linear differential equations . the linear homogeneous and non-homogeneous equations of higher order with constant coefficients.

CO2. Student will be able to apply the Euler's Equation, the method of undetermined coefficients and method of variation of parameter to solve a ODE.

CO3. Student will be able to understand the real life situation by constructing ordinary differential equations.

CO4. Student will be able to understand and assimilate the concepts of equilibrium points, Interpretation of the phase plane.

CO5. Student will be able to remember the vector triple product and operations with vector valued function.

CO6. Student will be able to understand and remember the concepts of divergence, curl and integration of vector point functions.

Semester 4

Course Code: SP/MTH/404/SEC-2

Course Title: Graph Theory

- CO1.** Student will be able to understand graph theory in technically accurate manner.
- CO2.** Student will be able to express adjacency matrix and incidence matrix of a graph.
- CO3.** Student will be able to understand the concepts of connectedness in graph.
- CO4.** Student will be able to understand the concept about Eulerian and Hamiltonian graph.
- CO5.** Student will be able to understand and remember the knowledge about Trees, Minimal Spanning Tress.
- CO6.** Student will be able to understand the Dijkstra's algorithm and Warshall algorithm to find the shortest path between any two vertices in a graph.

Semester 5

Course Code: SP/MTH/501/DSE-1A

Course Title: Linear Programming

- CO1.** Student will be able to formulate L.P.P. Student will be able to solve L.P.P. by Simplex method, Big M method and Two Phase simplex methods.
- CO2.** Student will be able to formulate the Dual problem and find the solution of a LPP by solving its dual.
- CO3.** Student will be able to understand Transportation problem and its mathematical formulation. Student will be able to solve transportation problem by different method like VAM Method, North-West corner method etc and its optimality condition.
- CO4.** Student will be able to understand Assignment problem and its mathematical formulation. Student will be able to solve an Assignment problem by Hungarian method.
- CO5.** Student will be able to develop concept on Games & Strategies and formulation of two person zero sum games.
- CO6.** Student will be able to solve the game problems by different methods.

Semester 5

Course Code: SP/MTH/504/SEC-3

Course Title: Programming using C

- CO1.** Student will be able to understand C character set, keywords, constants and variables.
- CO2.** Student will be able to understand Basic Data types, Variable Operators and Expression in C, Assignment statement and I/O Statement.

CO3. Student will be able to understand the decision making statements and looping structures in C

CO4. Student will be able to understand the concept of arrays in a C program.

CO5. Student will be able to understand the concept of sub-program and its purpose, definition of function and function prototype,

CO6. Student will be able to recall writing skill to solve various program in C.

Semester 6

Course Code: SP/MTH/601/DSE-1B

Course Title: Probability and Statistics

CO1. Student will be able to understand the clear concepts of Sample space, probability axioms, conditional probability and independent events and related Baye's theorem

CO2. Student will be able to understand the definition of real random variables in case of discrete and continuous and also able to understand Cumulative distribution and probability mass/density function and different types of distribution functions.

CO3. Student will be able to understand the joint probability density functions and also marginal, conditional distribution. Student will be able to calculate the mathematical expectation, moment generating function, characteristic functions and covariance

CO4. Student will be able to understand and apply Chebyshev's inequality, Central Limit theorem and Markov Chain.

CO5. Student will be able to random sample and sample distribution.

CO6. Student will be able to test the hypothesis for small samples by the idea of student's t-distribution and f-distribution.

Semester 6

Course Code: SP/MTH/604/SEC-4

Course Title: Numerical Analysis with Practical

CO1. Student will be able understand the solution of algebraic and transcendental equations by applying various methods.

CO2. Student will be able understand the knowledge about difference operators and interpolations.

CO3. Students will be able to understand and identify the different methods for solving simultaneous linear algebraic equations.

CO4. Students will be able to understand the Rule of evaluating a definite integral numerically like as Trapezoidal Rule, Simpson's $1/3^{\text{rd}}$ Rule ,etc.

CO5. Student will be able to understand the methods for solution of higher order differential equations like Advanced Euler'S method, Runge-Kutta methods

CO6. Student will be able to apply the programming language C to evaluate any particular numerical problem like solution of an equation, evaluation of an integrations, etc.