

MATHEMATICS HONOURS SYLLABUS

Semester	Paper Code No	Papers	Credits	Marks
I	MAT-UG-E101	Differential and Integral Calculus	4	100
II	MAT-UG-E201	Analytical Geometry and Vector Calculus	4	100
III	MAT-UG-E301	Algebra	4	100
IV	MAT-UG-C401	Abstract Algebra	4	100
	MAT-UG-C402	Differential Equation and Mechanics	4	100
V	MAT-UG-C501	Real and Complex Analysis	4	100
	MAT-UG-C502	Operations Research	4	100
VI	MAT-UG-C601	Mathematical Modelling and Graph theory	4	100
	MAT-UG-C602	Computer Oriented Numerical Analysis using C	4	100

MAT-UG-E101: DIFFERENTIAL AND INTEGRAL CALCULUS

Unit I: Differential Calculus I

Limit, Continuity, Differentiability, Successive differentiation, nth derivative, Leibnitz theorem and its application, partial differentiation, first and higher order derivatives, differentiation of homogeneous functions, Euler's theorem, total derivative and differential, differentiation of implicit functions and composite functions, Rolle's theorem, Mean value theorem, Taylor's theorem, Maclaurin's theorem for one variable, indeterminate form, L Hospital's theorem, continuity and differentiability of functions of variables, Taylor's theorem (statement only), expansions.

Unit II: Differential Calculus II

Polar coordinates, angle between the radius vector and the tangent, angle of intersection of curves (polar form), polar subtangent and polar subnormal, pedal equations, derivative of an arc in Cartesian, parametric and polar form, convexity, concavity and curvature of plane curves, formula for radius of curvature in Cartesian, parametric and polar forms, center of curvature, evolutes and involutes, envelopes, asymptotes, singular points, cusp, node and conjugate points, tracing of standard Cartesian and polar curves.

Unit III: Integral Calculus

Length of arcs, surface areas and volumes of solids of revolutions for standard curves in Cartesian and polar coordinates, Improper integrals, beta and gamma functions, properties, relation between beta and gamma functions.

Unit IV: Differential Equations

Solution of ordinary differential equations of first order and first degree, variable separable and reducible to variable separable forms, homogeneous and reducible to homogeneous forms, linear equations and Bernoulli equations, exact equations, equations reducible to exact form with standard integrating factors, equations reducible to exact form with standard integrating factors, equations of first order and higher degree, Clairut's equation, singular solution for Clairut's equation, orthogonal trajectories in Cartesian and polar forms.

Text Books:

1. Ghosh and Maity: Differential and Integral Calculus, New Central Book Agency.
2. Rajkumar Roychoudhuri: Basic College Calculus, (Vol-I, II), B.M. Publication, Kolkata.

Reference Books:

1. H.S. Dhama: Differential Calculus, New Age International.
2. Das, Mukherjee: Differential and Integral Calculus, Central book agency, Kolkata.

MAT-UG-E201: ANALYTICAL GEOMETRY AND VECTOR CALCULUS

Unit I: Analytical Geometry I

Plane: General form, intercept and normal form, equation of a plane passing through the intersection of two planes, angle between two intersecting planes, bisectors of angles between two intersecting planes, parallelism and perpendicularity of two planes.

Straight Line: Equations (symmetric and parametric form), direction ratios and direction cosines, canonical equation of the line of intersection of two intersecting planes, angle between two lines, distance of a point from a line, condition of coplanarity of two lines, equations of skew lines, shortest distance between two skew lines.

Unit II: Analytical Geometry II

Sphere: General equation, circle, sphere through the intersection of two spheres, radical plane, tangent and normal.

Cone: Right circular cone, general homogeneous second degree equation, section of a cone by a plane as a conic and as a pair of lines, condition of three perpendicular generators.

Cylinder: General equation, right circular cylinder, enveloping cylinder paraboloid, hyperboloid, ellipsoid.

Unit II: Vector Calculus

Vector differentiation, gradient, divergence, curl and laplacian operators, vector identities, line integral and basic properties, examples on evaluation of the integrals, definition of a double integral, its conversion to iterated integrals, evaluation of a double integral by change of order of integration and by change of variables, surface areas as double integrals, definition of a triple integral and evaluation, change of variables, volume as a triple integral, line, surface and volume integrals of vector functions.

Unit IV: Integral Theorems

Greens theorem in the plane, direct consequences of the theorem, stokes theorem (statement only), direct consequences of the theorem. Gauss divergence theorem (statement only), direct consequences of the theorem.

Text Books:

1. R. M. Khan, *Analytical Geometry and Vector algebra*, New Central book agency, Kolkata.
2. Ghosh and Maity, *A text Book of Vector analysis*, New Central book agency, Kolkata.

Reference Books:

1. J.G. Chakravorty, *Analytical Geometry & Vector Analysis*, UBS Publishers' Distributors (p) Ltd.
2. P.K.Jain and Khalil Ahmed: *A Text Book of Analytical geometry of three dimension*, Wiley Eastern Limited .

MAT-UG-E301: ALGEBRA

Unit I: Classical Algebra

Complex numbers, De Moivre's theorem and its applications, exponential Sine, Cosine and logarithm of a complex number, Inverse circular and hyperbolic functions, Polynomials, Fundamental Theorem of classical algebra (statements only), polynomials with real coefficients, nth degree polynomial with exactly n roots, nature of roots of an equation, Statements of Descarte's rule of signs and its applications, Rolls theorem and its direct applications, relation between roots and coefficients, symmetric functions of roots, transformation of equations, Cardan's method of solution of a cubic.

Unit II: Matrix Theory

Recapitulation of fundamentals of matrix algebra, symmetric and skew symmetric, Hermitian and skew Hermitian matrices, idempotent, nilpotent, orthogonal, unitary matrices and their properties, rank of a matrix, normal form, finding the inverse of a matrix by elementary transformation, system of linear equations and consistency, characteristic equations, eigen values, eigen vectors

and properties, Cayley Hamilton theorem and its use in finding inverse and powers of a matrix

Unit III: Modern Algebra I

Basic concepts: sets, subsets, operations on sets, union, intersection and complement, verification of the laws of algebra of sets, De Morgan's law, cartesian product of two sets, mappings, composition of mappings, identity and inverse mappings, binary operations in a set, identity element, inverse element.

Unit IV: Modern Algebra II

Introduction of Group theory, definition and examples, elementary properties using definition of Group, Definition and examples of sub-group- statements of necessary and sufficient conditions and its applications.

Definition and examples of Ring, Field, Sub-ring and Sub-field.

Text Books:

1. Burnside and Panton: The Theory of Equations.
2. Ghosh and Chakraborty: Higher Algebra, New Central Book Agency

Reference Books:

1. I.N. Herstein: Topics in Algebra, Wiley Eastern Ltd.

MAT-UG-C401: ABSTRACT ALGEBRA

Unit I: Groups I

Groups, subgroups, cyclic groups, cosets, Lagrange's theorem, normal subgroup, quotient group, homomorphism of groups, fundamental theorem of homomorphism, isomorphism, Cauchy's theorem for abelian groups, permutation groups, symmetric groups, alternating groups.

Unit II: Groups II

Rings, properties, subrings, ideals, principal, prime and maximal ideal in a commutative ring, homomorphism and isomorphism of rings, integral domains, Fields, properties following the definition.

Unit III: Linear Algebra

Vector Space: Definitions, examples, properties, subspaces, span of a set, linear dependence and independence, Dimension and Basis.

Unit IV: Linear transformation

Definition and examples, Range and kernel of a linear map, matrix of the linear transformation, rank and nullity, inverse of a linear transformation, consequences of rank nullity theorem.

Inner product spaces: Cauchy-Schwarz inequality, orthogonality, orthonormality, Gram-Schmidt orthogonalization process.

Text Books:

1. R. M. Khan, Algebra, New Central Book Agency, Calcutta.
2. Sen , Ghosh , Mukhopadhyay, Topics in Abstract Algebra, university Press.

Reference Books:

1. M.Artin: Algebra, Prentice Hall of India
2. I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd.

MAT-UG-C402: DIFFERENTIAL EQUATIONS AND MECHANICS

Unit I: Ordinary Differential Equations

Recapitulation of first order Differential equation, Second and higher order ordinary linear differential equations with constant coefficients, Cauchy-Euler differential equations, simultaneous differential equations (two variables) with constant coefficients, second order linear differential equations with variable coefficients by the variation of parameters, total and simultaneous differential equations.

Unit II: Laplace Transform

Laplace transform of standard functions, Laplace transform of periodic functions, existence theorem for Laplace transform, shifting theorems, inverse Laplace transform, differentiation and integration of transforms, Convolution theorem, solution of ordinary differential equation with constant coefficient using Laplace transform.

Unit III: Partial Differential Equation

Partial Differential Equations of first order, Lagrange's solution, some special type of equations, which can be solved easily by methods other than general method, Charpit's general method of solution, Partial Differential Equations of 2nd and higher orders, classification of linear partial differential equations of 2nd order, homogeneous and non homogeneous equations with constant coefficients, partial differential equations reducible to equations with constant coefficients. Monge's Method and applications in heat and wave equations.

Unit IV: Mechanics

Elementary concept of Statics, fundamental definitions and principles of Dynamics, motion in a straight line, motion in a plane Cartesian and polar coordinates, work, power and energy, moment of inertia, general equations of motion of material system.

Text Books:

1. M.D. Raisinghinia: *Differential equation*, S.Chand& Co.
2. M.D. Raisinghinia: *Advanced differential equation*, S.Chand& Co.
3. S. Ganguly and S. Saha: *Analytical Dynamics of a Particle*, New Central
4. S. A. Mollah: *Dynamics of rigid bodies*, Books and Allied(P) ltd.

Reference Books:

1. B. S. Grewal: *Higher Engineering Mathematics*, Khanna Publishers, New Delhi
2. Jain, Iyengar: *Advanced Engineering Mathematics*, Narosa Publication.

MAT-UG-C501: REAL AND COMPLEX ANALYSIS**Unit I: Real analysis**

Ordered field, upper bounds, lower bounds, maximum element, minimum element, supremum, infimum, order completeness of the real line, the Cauchy-Schwarz inequality, minkowsky's inequality, similar sets, finite and infinite sets, countable and uncountable sets, uncountable collection of countable sets.

Unit II: Metric Spaces

Euclidean space \mathbb{R} , open balls and open sets, closed sets, adherent points, accumulation points, The Bolzano-Wierstrass theorem for \mathbb{R} only, the Hiene-Borel covering theorem, compactness in \mathbb{R} .

Convergent sequences in a Metric space, Cauchy sequences, complete Metric spaces, limit of a function, continuous function, examples of continuous functions, continuity and inverse images of open or closed sets, functions continuous on compact sets, intermediate value theorem for continuous functions, uniform continuity, discontinuities of real valued functions.

Unit III: Complex Analysis I

Definition of Complex number and the algebra of complex number, conjugation, absolute value, inequalities, functions of a complex variable, limit, continuity, uniform continuity, analytic function, Cauchy-Riemann equations.

Unit IV: Complex Analysis II

Sequences, series, uniform convergence, power series, Hadamard's formula for the radius of convergence, elementary functions, rectifiable arcs, contours, complex line integration, Cauchy's integral formula for the derivatives of an analytic function, Cauchy's estimate, Morera's theorem, Liouville's theorem, Fundamental theorem of algebra.

Text Books:

1. S.C. Malik: *Mathematical Analysis*, Wiley Eastern Limited
2. Shanti Narayan: *A course of Mathematical Analysis*, S.Chand and Co., New Delhi.

3. Churchil and Brown: Complex Variables and Applications, McGraw Hill

Reference Books:

1. T. M. Apostol: Mathematical Analysis, Narosa Publishing House.
2. Richard Goldberg: Methods of Real analysis, Oxford, New Delhi.
3. B. Choudhary: The Elements of Complex Analysis, New Age International

MAT-UG-C502: OPERATIONS REASEARCH

Unit I: Linear Programming

Definitions of O.R, Definition of Linear Programming Problem (L.P.P), formulation of L.P.P, graphical solution of L.P.P, Simplex method, big-M method, two phase method, concept of duality, dual and primal techniques, dual simplex method.

Unit II: Linear Programming

Introduction to transportation problem, initial basic feasible solution, balanced and unbalanced transportation problem, optimal solution, and assignment problems.

Unit III: Game Theory

Game and strategies, introduction, two person zero sum games, maximin and minimax principles, games without saddle point, mixed strategies, solution of 2 x 2 rectangular games, graphical method, dominance property, algebraic method for m x n games.

Unit IV: Network Analysis

Network definitions, shortest route problem, minimal spanning tree problem, maximal flow problem, project scheduling by PERT-CPM.

Text Books:

1. Kanti Swarup, Gupta : Operations Research, S.Chand & Co.
2. H.A. Taha: Operations Research, Prentice Hall of India.

Reference Books:

1. C.K. Mustafi: Operation Research: Methods and practices, New age International.
2. C.R. Kothari: An introduction to Operation Research, Vikas Publishing Ltd.

MAT-UG-C601: MATHEMATICAL MODELLING AND GRAPH THEORY

Unit I: Graph Theory I

Definition of graph and examples, subgraphs, incidence and adjacency matrices, isomorphism, complement of a graph. Walks, trails, and paths, connectedness and components, cut points and bridges. Eulerian graphs, Konigsberg bridge problem, Hamiltonian graphs.

Unit II: Graph Theory II

Trees, characteristics of trees planarity, colourability, chromatic number, five colour theorem.

Unit III: Mathematical Modeling

Mathematical modeling through ordinary differential equations, linear and non-linear growth-decay models, compartment model. Mathematical modeling in dynamics through ordinary differential equations of first order, mathematical modeling of geometrical problems, mathematical modeling of population dynamics, modeling of epidemics through systems

Unit IV: Mathematica

Algebraic computations (analytical and symbolic solutions), Numerical computations, mathematical functions, lists and matrices, graphics and programming.

Text Books:

1. J.N. Kapur: Mathematical Modeling, New age International
2. D. B. West: Introduction to Graph Theory, Pearson Education
3. Stephen Wolfram: The Mathematica Book, Wolfram Research Inc.

Reference Books:

1. H. M. Roberts and Thompson: Life Science Models, Springer-Verlag.
2. F. Harary: Graph Theory, Addison Wesley

MAT-UG-C602: COMPUTER ORIENTED NUMERICAL ANALYSIS USING C

Unit I: Numerical Analysis I

Solution of Equations: Bisection method, Regula-falsi method, Newton-Raphson method, roots of polynomial.

Interpolation: Newton's forward and backward interpolation, Lagrange's interpolation, divided differences.

Numerical differentiation: Numerical quadrature formula, Newton-cote formula Gauss-quadrature formula, Chebychev's formula.

Linear equation: direct methods for solving systems of linear equations (Gauss elimination, LU Decomposition, Cholesky decomposition. Iterative methods (Jacobi, Gauss-seidal and Relaxation methods).

Unit II: Numerical Analysis II

The algebraic eigen value problem: Jacobi's method, power method

Ordinary Differential Equations: Euler method, single-step methods, Runge-Kutta's method, multi-step method, Milne's method.

Methods based on integration: Trapezoidal rule, $1/3^{\text{rd}}$ Simpson's rule, Simpson's $3/8^{\text{th}}$ rule.

Unit III: Programming in C

Programmer's model of a computer, algorithms, flow charts, data types, arithmetic and input/output instructions, decisions control structures, decision statements, logical and conditional operators, loop case control structures, functions, recursions, arrays

Unit IV: Practical

1. Gauss elimination method
2. Gauss-seidal method
3. Jacobi's method
4. Power method
5. Lagrange's interpolation
6. Trapezoidal rule
7. Simpsons $1/3^{\text{rd}}$ and $3/8^{\text{th}}$ rule.
8. Bisection method
9. Newton-Raphson's method
10. Runge-Kutta method (first and fourth order)

Text Books:

1. S.S. Sastry, *Introductory methods of Numerical analysis*, Prentice Hall.
2. M.K. Jain, S.R.K Iyengar, R.K. Jain: Numerical Methods, New age International
3. E. Balguruswamy, *ANSI C*, Tata McGraw Hill

Reference Books:

1. C. Balachandra Rao and Shantha, C.K: Numerical Methods, University Press
2. Y. Kanitkar, Let us C, BP Publication