

DETAILS OF ENTRANCE TEST – 2021-2022

Name of the Faculty: **Faculty of Natural Sciences**
 Department/Centre: **Mathematics**
 Name of the Program: **M.Sc. Mathematics with Computer Science**

About Program's Prospects: The students have been placed in reputed industries as well as in good academic institute.

Summary of Entrance Test

S.No	Test-Component	Test Duration (minutes)	Max. Marks	Passing Marks	Negative Marking (Yes/No)
1.	Multiple Choice Questions	90	100	15 %	Yes -0.25 marks/

Any other information about the entrance test:

Important instruction for test:

Permissible Material/equipment for Entrance Test (as required):

- Black/Blue Ball Pen
- Calculator
- Pencil

Detailed Entrance Test Syllabus is attached:

Calculus and Differential Equations

ϵ - δ definition of the limit of a function. Algebra of limits. Continuous functions and classification of discontinuous functions. Differentiability. Successive differentiation. Leibnitz theorem. Rolle's theorem. Mean Value theorems. Taylor's theorem with Lagrange's and Cauchy's form of remainder. Taylor's and Maclaurin's series of elementary functions.

Indeterminate forms. Curvature. Cartesian, polar and parametric formulae for radius of curvature. Partial derivatives. Euler's theorem on homogeneous functions.

Asymptotes. Test for concavity and convexity. Points of inflexion. Multiple points. Tracing of curves in Cartesian and polar coordinates.

Reduction formulae. Quadrature. Rectification. Intrinsic equation. Volumes and surfaces of solids of revolution.

Order and degree of a differential equation. Equations of first order and first degree. Equations in which the variables are separable. Homogeneous equation. Linear equations and equations reducible to linear form. Exact differential equations. Clairaut's form and singular solutions. Linear differential equations with constant coefficients. Homogeneous linear differential equations. Second order linear differential equations (exact. Normal and variation of parameters). Systems of linear differential equations.

Geometry of Two and Three Dimensions

Conic sections. General equation of second degree. Pair of lines. Lines Joining the origin to the points of intersection of a curve and a line. Equation of parabola in standard and parametric form. Tangent. Normal pole and polar and their properties.

Equations of ellipse and hyperbola in standard and parametric forms. Tangent Normal. Pole and polar and their elementary properties. Conjugate diameters. Asymptotes. Conjugate hyperbola and rectangular hyperbola.

Polar Equation of a conic. Polar equation of tangent, normal, polar and asymptotes. Tracing of parabola, ellipse and hyperbola.

Equation of plane. Pair of planes. Equations of a line. Line and plane. Shortest distance. Equation of sphere. Tangent plane, plane of contact and polar plane. Intersection of two spheres. Radical plane. Coaxial spheres. Conjugate systems. Equation of cone. Intersection of Cone with plane and a line. Enveloping cone. Right circular cone.

Equation cylinder. Enveloping and right circular cylinders. Equations of central conicoids. Tangent plane. Normal. Plane of contact and polar plane. Enveloping cone and enveloping cylinder. Conjugate diameters and diameters planes. Equations of paraboloids and its simple properties.

Functions of Several Variables and Complex Trigonometry

Functions of several variables. Domains and Range. Functional notation, Level curves and level surfaces. Limits and continuity. Partial derivatives. Total differential. Fundamental lemmas. Differential of functions of n variables and of vector functions. The Jacobian matrix. Derivatives and differentials of composite functions, the general chain rule.

Implicit functions. Inverse functions. Curvilinear co-ordinates. Geometrical Applications. The directional derivatives. Partial derivatives of higher order. Higher derivatives of composite functions. The Laplacian in polar, cylindrical and spherical co-ordinates. Higher derivatives of implicit functions. Maxima and minima of functions of several variables.

Introduction. Vector fields and scalar fields. The gradient field. The divergence of a vector field. The curl of a vector field. Combined operations. Irrotational fields and Solenoidal fields. Double integrals, triple integrals and multiple integrals in general. Change of variables in integrals. Arc length and surface area.

Line integrals in the plane. Integrals with respect to arc length, Basic properties of line integrals. Line integrals as integrals of vectors. Green's Theorem. Independence of path, Simply connected domains, Extension of results to multiply connected domains. Line Integrals in space. Surfaces in space, orientability. Surface integrals. The divergence theorem. Stokes's theorem. Integrals independent of path.

Curves in space, parametric representation. Arc length and natural parameter. Contact of curves. Tangent to a curve. Osculating plane. Principal normal. Binomial. Expression for t , n and b in generalized parameter. Curvature and torsion. Serret Frenet Formulae. Helices. Fundamental theorem for space curves.

De Moivre's theorem and its applications. Expansion of $\sin n\theta$, $\cos n\theta$ and $\tan n\theta$. Separation into real and imaginary parts. Summation of series based on $C+iS$ method.

Abstract Algebra

Sets. Relations. Functions. Binary operations. Groups and its elementary properties. Subgroups and its properties. Cyclic groups. Cosets. Lagrange's theorem. Normal subgroups and factor groups.

Group homomorphism. Isomorphism. The isomorphism theorems. Permutation groups. Even and odd permutations. Alternating group. Cayley's theorem.

Automorphism. Inner Automorphism. Normaliser. Centre of a group. Conjugate classes. Class equation of a finite group and its applications. Sylows theorem and its applications. Rings and its elementary properties. Integral domains. Fields. Field of quotients. Subrings. Ideals. Quotient rings.

Homomorphism of rings and its properties. The isomorphism theorems. Rings of Polynomials. Some properties of $R[X]$. The division Algorithm. Roots of polynomials. Euclidean domain. Principal ideal domain. Unique factorization domain.

Real Analysis

Elements of Point-Set Theory

Introduction (addition, multiplication, and order in the set of real numbers and their properties). Bounded and unbounded sets. Infimum and supremum of a set and their properties. Countable and uncountable sets. Order completeness in $\mathbb{R}$. Open set. Neighborhood. Interior of a set. Limit point of a set. Closed set. Bolzano-Weirstrass theorem.

Real Sequences

Sequence of real numbers, convergent and non-convergent sequences. Cauchy's general principle of convergence. Algebra of sequences. Theorems on limits of sequences. Monotone sequences.

Infinite Series

Infinite series and its convergence. Test for convergence of positive term series. Comparison Test. Ratio Test. Cauchy's Root Test. Raabe's Test. Logarithmic Test, Integral Test. Alternating series. Absolute and conditional convergence. Product of two absolutely convergent series. Cauchy's product of two series one of which is absolutely convergent.

Riemann Integration

Definition, existence and properties of Riemann integral of a bounded function. Darboux's Theorem. Condition of integrability. The integral as the limit of the sums. Properties of Riemann Integral. The fundamental theorem of calculus. Mean-value theorem of integral calculus. Integration by parts. Change of variables. Second mean-value theorem.

Uniform Convergence

Definition of pointwise and uniform convergence of sequences and series of functions. The Cauchy's criterion for uniform convergence. Weirstrass M-test. Uniform convergence and continuity. Uniform convergence and Riemann integration. Uniform convergence and differentiation.

Improper Integrals

Definition of improper integrals. Convergence of improper integrals. Comparison test. Cauchy's test for convergence. Absolute convergence. Beta and Gamma functions and their properties.

Linear Algebra

Linear Systems and Gaussian Elimination

Linear systems. Matrix representation of linear systems. Gaussian-Jordan elimination. Homogeneous linear systems. Row echelon form and the General solution. Row rank of a matrix and solution sets of homogeneous linear systems and general linear systems. Elementary matrices.

Vector Spaces

Definition, examples and basic properties. Subspaces. Linear independence. Linear combinations and span. Basis and dimension. Sum and intersection of subspaces. Direct sum of subspaces.

Linear Transformations

Definition and examples. Properties of linear transformations. Rank and kernel. The rank and nullity of a matrix. The matrix representation of a linear transformation. Change of basis. Isomorphism.

V. Orthogonality in Vector Spaces

Scalar products in R^n and C^n . Complex matrices and orthogonality in C^n . Inner product spaces. Orthogonality in inner product spaces. Normed linear spaces. Inner product on complex vector spaces. Orthogonal complements. Orthogonal sets and the Gram-Schmidt process. Unitary matrices.

Eigenvalues and Eigenvectors

Eigenvalues and eigenvectors. Characteristic equation and polynomial. Eigenvectors and eigenvalues of linear transformations. Similar matrices and diagonalization. Triangolizable matrices. Eigenvalues and eigenvectors of symmetric and Hermitian matrices.

Canonical Forms

Quadratic forms and conic sections. Quadrics. Bilinear forms. Minimal polynomials. The Cayley-Hamilton theorem.

Mechanics

Basic Concept of Mechanics:- Fundamental laws of Newtonian mechanics. Inertial frame of reference. Particle, mass, rigid body, rest and motion and force. External and internal forces. Forces acting at a point. Triangle law of forces and polygon law of forces. Lami's theorem. Equilibrium of a system of particles. Necessary conditions for equilibrium forces.

Moments, parallel forces, couples, moment of a force about a point and a line. Theorem of varignon. Necessary conditions for equilibrium (moment). Equilibrium of two couples. Reduction of a general plane force system, parallel force system in two and three dimensions. Friction.

Work and Energy: Conservative field and potential energy. Principle of conservation of energy for a particle and principle of virtual work for a system of particles. Catenary (cartesian, intrinsic forms). Geometrical properties of catenary. Centre of gravity and centre of parallel forces. Centre of gravity of some simple bodies: rod, triangle, arc, plane area, surface of revolution, sum of difference of two bodies, segment of a sphere and some simple curves.

Components of velocity and acceleration (cartesian, radial and transverse, tangential and normal). Uniformly accelerated motion. Simple harmonic motion. Resisted motion. Harmonic oscillators. Damped and forced vibration. Elastic strings. Hooke's law. Vertical and horizontal vibrations of a particle attached to an elastic string.

Projectile and motion in a non-resisting medium. Constrained motion on a smooth vertical circle. Simple pendulum. Collisions (direct).

Motion of a Particle under a central force. Differential equation of a central orbit in both reciprocal polar and pedal coordinates, Newton's law of gravitation and planetary orbits. Kepler's laws of motion deduced from Newton's laws of gravitation and vice-versa. Motion of the mass centre and motion relative to mass centre. Principle of linear momentum. Angular momentum and energy for a particle and for a system of particles. D'Alembert's principle. General theory of plane impulse.

Metric Spaces, Complex Analysis and Differential Equations

Definition and examples of metric spaces. Open spheres and closed spheres. Neighbourhoods. Open sets. Interior points. Limit points. Closed sets and closure of a set. Boundary points. Diameter of a set. Subspace of a metric space. Convergent and Cauchy

sequences. Complete metric space. Dense subsets and separable spaces. Nowhere dense sets.

Definition and examples of continuous functions. Characterizations of continuous functions. Uniform continuity. Isometry and homeomorphism. Compact spaces. Sequential compactness and Bolzano Weierstrass property. Continuous functions on compact sets. Connectedness. Components. Continuous functions on connected sets.

Complex numbers as ordered pairs. Geometrical representation of complex numbers. Stereographic projection. Continuity and differentiability of complex functions. Analytic functions. Cauchy Riemann equations. Harmonic functions. Elementary functions.

Mapping by elementary functions. Mobius transformations. Fixed points. Cross ratio. Inverse points and critical mappings. Conformal mappings.

Partial differential equations of first order. Lagrange's solution. Some special types of equations which can be solved by methods other than the general method. Charpit's general method of solution.

Partial differential equations of second and higher orders. Classification of linear partial differential equations of second order. Homogeneous and non-homogeneous equations with constant coefficients. Partial differential equations reducible to equations with constant coefficients. Monge's method.

Mathematical Statistics and Operational Research

Mathematical Statistics

Classical, relative frequency and axiomatic approaches. Basic laws of total probability and compound probability. Random variable (discrete and continuous). Mathematical expectation.

Binomial, Poisson, normal, multi-normal, lognormal, rectangular and Cauchy distributions. Bivariate populations. Regression and correlation. Rank correlation. Least square method of fitting regression lines.

Sampling. Random sampling. Random number. Large sample tests of means and proportion. Distributions of t , χ^2 and F (without derivation) and tests of significance based on them.

Operational Research

Different types of models, their distribution and general methods of solutions. Elementary inventory and replacement models. Sequencing theory.

Linear Programming

Simplex method, duality, transportation and assignment problems.

Theory of Games

Rectangular games. Saddle points. Mixed strategies. Relation of dominance. Various methods for solving rectangular games. Inter - relation between the theory of games and linear programming.

Programming in C and Numerical Analysis.

Introduction to Computer

Number system Booting Process. Computer Language Introduction to operating system. Types of programming languages. Compilers and interpreters. Programmer's model of a computer. Algorithms. Flow charts. Data types. Storage Classes.

C Programming

Operators and Expressions. Arithmetic input/output instructions. Structure of C programs. Decision control structure. Decision statements. Loop. Case control. Structures and unions. Functions. Recursions. Preprocessors arrays. Puppeting of strings. Structures and unions. Pointers. File formatting.

Algebraic and Transcendental Equations

Bisection method. Regula Falsi method. Iteration method. Newton-Raphson method. Rate of convergence of Newton Raphson formula. Chebyshev method. Write a program in C for the above methods.

Systems of Linear and Nonlinear Equations

Solution of system of linear equations: by direct methods. Gauss elimination method, Gauss-Jordan method and by indirect method, Jacobi's and Gauss-Seidel iteration methods. Solution of system of nonlinear equations by method of iteration and Newton Raphson method. Write algorithm and program in C for Gauss elimination method, Gauss-Jordan method, Gauss Jacobi's and Gauss-Seidel iterative method.

Interpolation

Finite difference operators. Polynomial interpolation formulae based on equidistant points. Newton forward and backward formulae. Gauss forward & backward formulae. Sterling formula. Bessel's and Everest formula. Polynomial interpolation formulae based on arbitrary points. Lagranges formula and Newton's divided formula. Write a program in C for Newton forward and backward formula.

Numerical Differentiation, Numerical Integration and Ordinary Differential Equations

Numerical differentiation. Numerical integration:-trapezoidal and Simpson's rule, Romberg integration & their algorithm as well as program in C. Numerical solution of ordinary differential equations by Taylor's series, Picards method, Euler's method, second and fourth order Runge Kutta method.