Office Copy

Copy Right Reserved

UNIVERSITY OF DELHI

SCHEME OF EXAMINATION

AND

COURSES OF READING

FOR

B.A./B.Sc. (HONOURS) EXAMINATION IN MATHEMATICS

Part I Examination, 1992

Part II Examination, 1993

Part III Examination, 1994

AUTHENTICATED CO[PY]

Officer-on-Special Duty
Publication Division,
University of Delhi

Syllabus applicable for the students seeking admission to the B.A./B.Sc. (Hons.) Mathematics Course in the academic year 1991-92.

Price :

COMPLIMENTARY COPY

App. 'B'

B.A./B.Sc. (HONOURS) MATHEMATICS 1991-92.

COMPULSORY—16 UNITS OPTIONAL—2 UNITS.

Distribution of Units

1st Year

Unit 1	:	Vector Calculus and Geometry
Unit 2	:	Algebra-I
Unit 3	:	Analysis-I
Unit 4	:	Analysis-II

2nd Year

Unit 5.	:	Algebra-II
Unit 6	:	Differential Equations-I
Unit 7	:	Mechanics-I
Unit 8	:	Numerical Analysis & Computer Programming
Unit 9	:	Analysis-III
Unit 10	:	Probability & Mathematical Statistics

3rd Year

Unit 11	:	Differential Equations-II
Unit 12	:	Algebra-III
Unit 13	:	Algebra-IV
Unit 14	:	Mechanics-II
Unit 15	:	Analysis-IV
Unit 16	:	Analysis-V

Units 17 & 18 (Optionals)

To be prescribed latter.

Scheme of Examinations :

(i) Each unit will be of 50 marks and will have two hours examination.

(ii) Each unit will be divided into 4 sections and the candidate will have to answer only one Question from each section with a provision for internal choice in each section.

(iii) There will be examination at the end of Ist Year, 2nd Year and 3rd Year

Teaching Schedule :

(i) 3 periods per week will be the teaching norm to cover each unit.

(ii) Adequate number of tutorials will be provided as per the University norms. Two periods per week will be provided for practicals.

(iii) Subsidiary subjects and other requirements of the languages will be the same as approved by the University for the Honours subjects.

(The other Conditions will remain the Same).

Unit 1. Vector Calculus and Geometry

Section 1

Differentiation and partial differentiation of a vector function. Derivative of Sum, Dot Product and Cross Product of two vectors. Gradient, Devergence and Curl.

Section 2

System of circles, Standard equations and properties of Parabola, Ellipse and Hyperbola.

Section 3

General equation of second degree in two variables. Tracing of a conic.

Section 4

Sphers, Cone, Cylinder, tangent lines and tangent planes.

Unit 2. Algebra-I

Section I

De'Moivre's Theorem (both integral and rational index). Summation of Series, Expression for Cos nQ, sin nQ in terms of

powers of sin Q, Cos Q and cos nQ, sin nQ in terms of Cosine and Sine multiples of Q, solution of equations using trignometry.

Section II

Symmetric, skew symmetric, Hermition, Skew Hermition matrices. Elementry operations on matrices. Inverse of a matrix. Linear independence of row and column matrices, Row rank, Column rank and Rank of a matrix, equivalance of Column and Row rank. Characteristic equation of a matrix, Cayley Hamilton Theorem.

Section III

Applications of Matrices to a system of linear (both homogeneous and non-homogeneous) equations Theorems on consistency of a system of linear equations.

Relations between the roots and coefficients of polynomials. Symmetric functions of the roots of an equation, transform of equations.

Section IV

Permutations, Cycles, permutation as a product of disjoint cycles, transposition, even and odd permutation.

Number system, well ordering principle, Divisibility and basic properties of congruence.

Unit 3. Analysis-I

Section I

The real number system as a complete ordered field Neighbourhoods, open and closed sets, Limit points of sets, Bolzano Weierstrass theorem.

Section II

Sequences, convergent sequences, Cauchy sequences Monometric sequences, Subsequences, Limit superior and limit inferior of a sequence.

Section III

Infinite series, convergence of infinite series. Positive term series, Comparison test, Cauchy's nth root test, D'Alemberts's ratio test, Raabe's test, Cauchy's integral test, alternating series, Leibnitz test. Absolute and conditional convergenece.

Section IV

Successive Differentiation. Leibnitz Theorem, Partial differentiation, curvature, asymptotes, singular points concavity, convexity, Points of inflexion, tracing of curves in cartesion and polar coordinates.

Note : The emphasis of Calculas portion should be on curve tracing.

Unit 4. Analysis-II

Section I

Limits, continuity, sequential continuity, algebra of continuous functions, continuity of composite functions, continuity on (a, b) implying boundedness, Intermediate Value Theorem, Inverse Function Theorem, Uniform continuity.

Section II

Differentiation, Algebra of derivatives, Differentiability and continuity, chain rule, Inverse function theorem, Darboux theorem, Rolle's theorem, Mean Value theorems, Taylor's theorem.

Section III

Taylor's series, Maclaurin's series, Expensions of Sin x, Cos x, e^x, log $(1+x)$, $(1+x)^m$, Applications of Mean Value theorems to Monotone functions and inequalities, Maxima and Minima, Indeterminate forms.

Section IV

Integration of irrational functions, reduction formulae, Rectification, Quadrature, Volumes and Surfaces of revolution

Unit 5. Algebra-II

Section I

Groups, subgroups, Lagrange's Theorem, Normal subgroups, quotient groups.

Section II

Homomorphism, Isomorphism, First and second theorem of Homomorphism, Permutation groups, Cayley's Theorem.

Section III

Automorphisms, Counting principle, class equation, Cauchy's Theorem.

Section IV

Sylow's Theorems, Direct product of groups, Fundamental theorem of finite abelian groups (Only statement with illustrations), Survey of groups upto order 8.

Unit 6. Differential Erential Equations I

Nature and origin of differential equations

1. *First Order Differential Equations*

   Linear equations. Homogeneous and non-homogeneous equations. Separable equations. Exact equations. First Order higher degree equations solvable for x, y, p. Applications to the cooling law, population growth and radioactive decay.

2. *Second Order Differential Equations*

   Statement of existence and uniqueness of solution under given initial conditions. Algebraic properties of solutions. Wronskian. Its properties and applications. Linear homogeneous equations with constant coefficients. Linear non-homogeneous equations. The method of variation of parameters. The method of undetermined coefficients. Euler's equation.

3. Power series solutions. Ordinary points, singular points The method of Frobenius. Bessel's equation. Legendre's equation.

4. The method of elimination for two simultaneous first order equations. Picard's existence theorem. Pffafian differential equations.

Unit. 7. Mechanics—I

I. *Coplaner Force Systems.*

   Necessary and sufficient condition for equilibrium of a particle. Triangle law of forces, polygon law of forces, Lami's theorem.

Moment of a force about a line. Varignon's Theorem for concurrent force systems Necessary condition for a system of patricles to be in equilibrium.

Equipollent force systems. Couples and their moments, Equipollence of two couples. Reduction of a general plane force system. Parallal force systems.

Work and Potential Energy. Principle of Virtual Work for a system of particles.

Infinitesimal displacement of a plane lamina. Necessary and sufficient conditions for the equilibrium of a rigid body movable parallel to a fixed plane.

II. Centre of Gravity. Formulae, Methods of sysmetry and decomposition, Theorm of Pappus.

Friction : Laws of Static and Kinetic Friction, Problems of equilibrium under forces including friction (excluding indeterminate cases.)

Catenary.

Stable Equilibrium. Energy test of stability (problems involving one variable only.)

III. General Force Systems. Total force, total moment relative to a base point, total moment under a change of base point. Necessary and sufficient conditions for a system to be equipollent to zero. Reduction of force systems. To a force and couple and to a wrench Invariants of a system.

General displacements of a rigid body. Composition of infinitesimal displacements.

Generalized co-ordinates; Definition; any infinitesimal displacements of a system in terms of generalized co-ordinates, Generized Forces, Work done and Potential Energy in terms of generalized co-ordinates; Principle of Virtual Work for a rigid body.

IV. Hydrostatics; Pressure at a point; Resultant pressure on a plane surface; Centre of Pressure.

Unit. 8. Numerical Analysis and Computer Programming.

I. Fortran 77. Organization of digital computer Algorithm and flowchart. Constants; Variables, Type declaration, Arithmetic expression, Assignment statements. Input/Output statements. Control statments if, block if, go to ands. Arrays; Arithmetic statement function, function and subroutine subprograms.

II. Solution of algebraic and transcedental equations. Bisection method; Iteration methods based on first degree equation, Secant method and Newton-Raphson method, Rate of convergence of iterative methods. Development of FORTRAN programs of these methods.

III. System of linear algebraic equations.

Direct methods. Gauss elimination (without pivoting for programs); Gauss-Jordan elimination and error analysis. Iterative methods. Gauss-Jacobi and Gauss-Seidel iterative methods and their convergence. Development of FORTRAN programs for above methods.

IV. Interpolation and Approximation.

Lagrange and Newton interpolation. Linear and higher order, Finite difference operators; Interpolating polynomials using finite differences, Hermite interpolation. Approximation by least square method. Development of FORTRAN programs for the above theory.

Notes :

1. Theory paper in the university examination will be of 2 hours duration and will carry 40 marks. Apart from this, 10 marks are reserved for internal assessment based on the practical work done during the year.

II. For theory paper 3 periods and for practicals 2 periods per week per student are to be allotted.

III. Use of scientific calculator by the students is allowed in the theory examination.

Unit 9. Analysis III

Section I

Definition and examples of metric spaces. Neighbourhoods, Limit points, open and closed sets, Sequences and continuous functions on metric spaces, Uniform continuity.

Section II

Compactness, Connectedness.

Section III

Completeness, Cantor's intersection theorem, contraction Principal, Construction of real numbers as the completion of the incomplete metric space of rationals, real numbers as a complete ordered field.

Section IV

Functions from $R^2 \to R$, Schwarz and Young's theorem Implicit function theorem, Taylor's theorem, Maxima and Minima, Lagrange's method of undetermined multipliers.

Unit 10. Probability and Mathematical Statistics

Section I

Probability Classical, Relative and Axiomatic. Conditional probability and independence. Random Variables, Distribution Function, Mathematical expectation and generating functions.

Section II

Discrete Distribution Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric and Multinomial, Continous Distribution Uniform, Exponential, Gamma, Beta, Cauchy, Laplace and their interrelation.

Section III

Joint and conditional distribution, Conditional expectations. Correlation and linear regression for two variables. Joint moment generating function and moments. Bivariate normal distributions.

Section IV

Normal distributions, Characterstic function. Weak law of large numbers. Central limit Theorem for independent and identically distributed random Variables.

Unit—11 : Differential Equations—II

I. First Order Partial Differential Equations.

Definition of partial differential equations, its order and degree. Classification of partial differential equations into linear, semilinear quasilinear and nonlinear.

Linear partial differential equations of first order. Charpit's Method, solution of standard forms, compatible system of first order equations Jacobi's method.

Classification of solutions of first order equations and their geometrical interpretation.

II. Second Order Partial Differential Equations-I

Classification of second order equations into elliptic. parabolic and hyperbolic, Reduction to canonical forms

Cauchy Problem and Notion of Characteristics. Solution of Linear Hyperbolic Equation.

III. Seoond Order Partial Differential Equations-II

Separation of Variables. Product Solutions for Laplace's Equation, Heat Equation ond Wave Equation in cartesian, cylinderical and spherical polar co-ordinates.

IV. Second and Higher Order Partial Differential Equations.

Linear partial differential equations with constant co-efficients; Homogeneous linear partial differential equations with variable co-efficients.

Non-linear partial differential equations of second order, Monge's method of solving equations of the form $Rr+Ss+Tt=V$.

Unit-12. Algebra-III

Section I

Rings, Subrings, Integral Domain, Field, charActerstic, Ideals and Quotient Rings.

Section II

Embedding of Rings, Prime and Maximal Ideals, The field of Quotients of Integral Domain, Principal Ideal Domain.

Section III

Eucledean Ring, Gaussian Ring of Integers, Polynomial Rings over a rational field, Polynomial Rings over Commutative Rings, Unique Factorization Domains.

Section IV

Extension Field, Finite and Algebraic Extensions, Roots of polynomials, Definition and examples of splitting field, construction by straight edge and compass.

Unit 13 : Algebra IV

Section I

Vector space, Subspace, linearly independence, basis dimension, direct sums.

Section II

Linear Transformation, Hom (V, W) Matrix of a linear transformation, change of basis, Rank and Nullity of linear transformation.

Section III

Inner product space, Cauchy-Schwartz Inequality, Bessel's Inequality, Gram Schimdt orthogonalization process, Dual spaces, Applications to system of linear equations.

Section IV

Eigen volue, Eigen vector, characteristic and minimal polynomial, Cayley Hamilton Theorem, Diagonalisation of a linear trausformation. Invariant subspaces, direct sum decomposition, Invariant direct sum, Primary Decomposition Theorem.

Unit 14 : Mechanics-II

I. *Kinematics*

Basic concepts of mechanics. Position Vector, Velocity, Acceleration, Velocity and Acceleration of a particle along a curve. Radial and Transverse Components (Plane curves); Tangential

and Normal components (space curves) Angular Velocity and Angular Acceleration. Principles of linear momentum, angular momentum and energy for a particle and system of particles, use of centroids, De'Alembert's principle. Conservation field and potential energy. Principle of Conservation of Energy.

II. *Particle Dyuamics I*

Rectilinear motion. Uniformly accelerated motion, resisted motion; Harmonic Oscilator, Damped and forced vibrations. Elastic springs and strings. Hooke's law. Projectile Motion. Under gravity and in resisted medium.

III. *Particle Dynamics II*

Constrained particle motion. In a horizontal circle and on a smooth vertical circle.

Orbital Motion; Motion of a particle under a central force, use of reciprocal co-ordinates and padel co-ordinates, Newton's law of gravitation and planetary orbits. Kepler's laws of motion deduced from Newton's law of gravitation and vice-versa.

IV. *Rigid Body Dynamics*

Moments of Inertia. Definition and standard results; Momental ellipsoid, Theorems of parallel axes and perpendicular axes, Principal axes and their determination, Equi-momental systems. Rigid body motion in 2-D. Flywheels, Compound Pendulum; Cylinder Rolling down and Inclined Plane.

Angular momentum and Kinetic Energy of a rigid body. Rotating about a Fixed Point and in a General Motion. Principles of linear momentum, angular momentum and energy for a rigid body.

Unit 15 : Analysis IV

Section I

Riemann Integral, Integrability of continuous and monotic functions. The Fundamental theorem of Integral Calculus, Riemann—Stieltjes Integral Definition and examples only.

Section II

Improper integrals and their convergences, comparison tests, Abel's and Dirichlet's tests, Beta and Gamma functions and their properties.

Section III

Differentiation under integral sign, Integration in R^2, Green's theorem.

Section IV

Integration in R^3, Gauss and Stroke's theorems.

Units 16 : Analysis V

Section I

Series of arbitrary terms, Abel's and Dirichlet's test convergence, divergence and oscillation, Rearrangement of series, Multiplication of series, Double series.

Section II

Sequences and series of functions, Pointwise and uniform convergence. Weiestrass M test. Uniform convergence and continuity, differentiation and integration. Weierstrass Approximation Theorem.

Section III

Fourier series, Fourier expansion of piecewise monotonic functions.

Section IV

Power series and their convergences, Absolute and uniform convergence of a power series. Use of power series for defining logrithmic, exponential and trigonometric functions.

D.U.P. 611—9-91—600+50.