B.A./B.Sc. Part I (effective from session 2019-2020)

There shall be FOUR compulsory papers. In each paper, there are nine questions in all. Question No. 1 is compulsory with five parts from whole syllabus and rest of the questions are divided into two sections namely Section A and Section B, each of which contains four questions. Students has to answer two questions from each section.

Paper I: Algebra and Trigonometry

Section-A

Group Theory
Algebraic Structure, Definition of Group with examples and simple properties.Order of a group. Subgroups and its properties. Transformation, Permutation, Symmetric Set, Permutation Group, Cyclic Permutation, Transposition, Even and odd permutations, The alternating group A_n, Cyclic Group and Order of an element of a group, Torsion free group, Torsion group or periodic group, Mixed group. Homomorphism, Isomorphism,Transference of group structure theorem. Cayley's theorem. Kernel of Homomorphism, Cosets, Lagrange's theorem, Deduction of Lagrange's theorem.Normal subgroups, Simple Group, Quotient groups.The fundamental theorem of homomorphism.
(3 questions)

Algebraic Equations
Transformation of equations.Descarte's rule of signs.Solution of cubic equations by Cardan's method.Solution of biquadratic equations by Descarte's Rule.
(1 question)

Section-B

Properties of Integers
Divisor, Division algorithm.Greatest Common Divisor, Euclidean algorithm, Fundamental theorem of arithmemetic.Congurences and residue classes. Euler Øfunction. Euler's, Fermat's and Wilson's theorem.
(1 question)

Trigonometry
De Moivre's theorem, Applications of De Moivre's theorem. Expansion of trigononetrical functions. Exponential, circular, logarithmic, inverse circular, hyperbolic and inverse hyperbolic functions of a complex variable. Summation of trigonometrical series by C+ iS and Difference method, Sum of Series of Hyperbolic Function.
(3 questions)

Paper II: Advanced Calculus

Section A

Limit and Continuity of Functions of Two variables. Partial Differentiation, Euler's Theorem on Homogeneous Functions, Total Derivative, Change of Variables, Expansions of Functions of Two Variables, Taylor's Theorem and Maclaurin's Theorem, Jacobian, Envelopes and Evolutes, Maxima and Minima of Functions of Two Variables. **(4 questions)**

Section B

Beta and Gamma Functions, Multiple Integrals, Change of Order of Integration in Double Integral, Area and Volume by Double Integration. Triple Integral, Dirichlet's Integral, Liouville's Theorem. **(4 questions)**

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Paper III: Differential Equations and Laplace Transform

Section A

Differential Equations

Differential Equations of first order and higher degree, Differential equations solvable for p, y and x. Differential Equation of Clairaut's form, Differential Equations reducible to Clairaut's form, Singular solutions. Geometrical meaning of a differential equation of first order, Differential equation of orthogonal trajectories, Linear differential equations with constant coefficients. Homogeneous linear differential equations, Differential equations reducible to the homogeneous linear form, Simultaneous differential equations. **(4 questions)**

Section B

Linear differential equations of second order with variable coefficients, Transformations of differential equations by changing the dependent and independent variables. Method of variation of parameters. Total differential equations. **(2 questions)**

Laplace Transform

Existence theorem for Laplace transforms. Properties of Laplace transforms, Laplace transforms of derivatives and integrals, Laplace transforms of unit step and Dirac Delta functions, Inverse Laplace transform, Properties of Inverse Laplace transforms, Inverse Laplace transforms of derivatives and integrals, Convolution Theorem, Solutions of ordinary differential equations using Laplace transform, Solutions of simultaneous differential equations using Laplace transform.

(2 questions)

Paper IV: Analytical Geometry and Vector Calculus

Section A

Analytical Geometry

Co-ordinates, Geometry of Three Dimensions Projections, Direction Cosines, Plane, Straight line, Sphere, Cone, Cylinder, Conicoids, Paraboloid. **(4 questions)**

Section B

Vector Calculus

Vector Differentiation. Differential Operators : Gradient, Divergence, Curl, Laplacian Operator, Vector Integration, Gauss Divergence Theorem, Stokes Theorem, Green's Theorem in the Plane.

(4 questions)

B.A./B.Sc. Part II (effective from session 2020-2021)

There shall be FOUR compulsory papers. In each paper, there are nine questions in all. Question No.1 is compulsory with five parts from whole syllabus and rest of the questions are divided into two sections namely Section A and Section B, each of which contains four questions. Students have to answer two questions from each section.

Paper I: AbstractAlgebra

Section-A

Rings and Fields

Introduction to rings, integral domains and fields. Characteristic of a ring. Ring homomorphism. Ideals and quotient rings. Field of quotients of an integral domain. Euclidean rings. Polynomial rings. Polynomials over the rational field. Eisenstein's criteria. Unique factorization domain.

(3 questions)

Definition and examples of vector spaces.Subspaces.Sum and direct sum of subspaces. Linear span. Linear dependence and independence and their basic properties.

(1 question)

Section-B

Vector spaces

Basis. Dimension. Existence of complementary subspace of a subspace of a finite dimensional vector space.Dimensions of sums of subspaces. Quotient space and its dimension.

(1 question)

Linear transformations and their representations as matrices. The algebra of linear transformations. Rank of matrices, Echelon and Normal form of matrices, The rank – nullity theorem. Change of basis.Dualspace. Bidual space and natural isomorphism.

Application of matrices to a system of linear(both homogeneous and non-homogeneous) equations. Theorems on consistency of a system of linear equations.The characteristic equation of a matrix. Eigen values and eigen vectors. Cayley- Hamilton theorem and its use in finding inverse of a matrix. Diagonalisation of square matrices with distinct eigen values.

(3 questions)

Paper II: Real Analysis

Section A

Lower and upper bounds. Axiom of completeness.Supremum and infimum of the subsets of R. Completeness of R. Density theorem, Archimedean principle.

Definition of a sequence.Theorems on limits of sequences. Bounded and monotonic sequences. Convergence of a sequence. Cauchy's convergence criteria.Bolzano Weierstrass criteria. Limit superior and limit inferior. Convergence of a series.Series of non-negative terms. The number " e `` as an irrational number. Comparison test. Cauchy's n^{th} root test. Ratio test. Raabe's test. Logarithmic, De Morgan and Bertrand's tests. Alternating series. Leibnitz test. Absolute and conditional convergences.

(4 questions)

Section B

Continuous functions and their properties. Classification of discontinuities.Sequential continuity and limits. Uniform convergence. Differentiability. Chain rule of differentiability. Rolle's theorem. Lagrange's and Cauchy's mean value theorems. Darboux theorem.

(2 questions)

Riemann integral. Integrability of continuous and monotonic functions. The fundamental theorem of Integral Calculus. Mean Value theorems of Integral calculus. Convergence of Improper integrals.

(2 questions)

Paper III: Linear Programming and Game Theory

Section A

Problem Solving and Decision Making, Quantitative Analysis and Decision Making, Developing Mathematical Models, Mathematical Programming, Linear Programming, Convex Sets, Convex and Concave Functions, Theorems on Convexity.Linear Programming Problem (LPP), Simple and General LPP. Solutions of Simple LPP by Graphical Method. Analytical Solution of General LPP, Canonical and Standard forms of LPP.Slack and Surplus Variables.Solution of General LPP by Simplex Method.

(2 questions)

Use of Artificial Variables in Simplex Method, Big-M Method and Two-Phase Method.

(1 question)

Concept of Duality in Linear Programming, Theorems on Duality, Dual Simplex Method.

(1 question)

Section B

Transportation Problem, Balanced and Unbalanced Transportation Problems. Solution of Transportation Problem.Methods for finding Initial Basic Feasible Solution of Transportation Problem, Optimal Solution of Transportation Problem by Modified Distribution (MODI) Method. Degeneracy in Transportation Problem. Maximization Transportation Problem.

(1 question)

Assignment Problem.Balanced and Unbalanced Assignment Problems. Solution of Assignment Problem.Hungarian Method. Maximization Assignment Problem. Travelling Salesman Problem.

(1 question)

Game Theory

Competitive Game, Two-Person Zero-Sum (Retangular) Game. Minimax-Maximin Criteria, Saddle Points.Solution of Rectangular Game with and without Saddle Points. Huge Rectangular Games, Dominance Rules. Solution of Huge Rectangular Games using Rules of Dominance, Graphical Method for 2xn and mx2 Games without Saddle Points. **(2 questions)**

Paper IV: Statics and Dynamics

Section A

Statics

Force, Components of force, Parallel forces, Resultant of two forces in a plane, Moment, Couple, Resultant of two couples, Law of parallelogram of forces, Law of triangle of forces, Lami's theorem,Analytical conditions of equilibrium of coplanar forces, Virtual work, Stable and unstable equilibrium, Catenary.

(4 questions)

Section-B

Dynamics

Motion in a straight line: velocity and acceleration, Elastic and inelastic collisions between two objects, The coefficient of restitution, Motion in a plane: velocity and acceleration along radial and transverse direction, velocity and acceleration along tangential and normal directions, Elastic strings, Motion in resisting medium, Projectile motion in resisting medium, Uniform circular motion, Motion on a smooth curve in a vertical plane, Motion in a vertical circle, Simple harmonic motion, Simple pendulum, Cycloidal pendulum. **(4 questions)**

B.A./B.Sc. Part III (effective from session 2021-2022)

There shall be FOUR compulsory papers, ONE optional paper and a Viva – Voce and Project work based on all the papers read in B.A./B.Sc. Part III .In each paper there are nine questions in all in which question one is compulsory with five parts from whole syllabus and rest of the questions are divided into two sections each of which contains four questions, students has to answer two from each sections.

Compulsory Paper

Paper I : Metric Spaces 50 marks

Paper II : Complex Analysis and Calculus of Variations 50 marks

Paper III : Tensors and Differential Geometry 50 marks

Paper IV : Mechanics 50 marks

Optional Paper (any one of the following)

Paper V (a) : Programming in C 50Marks = 30 Marks (Theory)+20 marks(Practical)

Paper V (b) : Discrete Mathematics 50 Marks

Paper V (c) : Numerical Methods 50 Marks

Viva-voce and Project Work 50 Marks

There shall be a Viva-voce and a Project work based on the all papers of B.A./B.Sc.Part III (Mathematics). Under the project, the candidate shall present a dissertation. The dissertation will consist of at least two theorems/ articles with proof or two problems with solution, relevant definitions with examples and / or counter examples, wherever necessary, from each paper of Mathematics studied in B.A. / B.Sc. III.

The dissertation will be of 20 marks and the viva-voce will be of 30 marks. For viva-voce and evaluation of project work there shall be a Co-coordinator, an external examiner and an internal examiner. The dissertation will be forwarded by the Head of department at the University centre and by the Principal of the college at the college centre.

Paper I Metric Spaces

Section A

Definition of a Metric Space, Examples of Metric Space, Bounded and Unbounded Metric Space, Pseudo-metric, Examples of Pseudo-metric, Subspace of a Metric Space Examples of Subspace of a Metric Space, Diameter of a Subset of a Metric Space, Distance of a Point from a Non-empty set, Distance between two Non-empty Subsets of a Metric Space, Illustrative Examples. **2Questions**

Open and Closed Spheres, Neighbourhood of a point, Interior Point and Interior of a Set, Open sets, Equivalent Metrics, Exterior Point and Exterior of a Set, Frontier Points and Boundary Points of a Set, Frontier and Boundary of a Set, Limit Point and Isolated Point, Derived Set, Closed Set, Closure of a Set ,Dense Sets and Separable Spaces, Open and Closed Sets in a Subspace of a Metric Space, Examples. (**2Questions)**

Section B

Sequence in a Metric Space, Convergence in a Metric Space Cauchy Sequence, Complete Metric Space, Isometry and Isometric Space, Completion of a Metric Space, Function, Continuous Function, Algebra of Real/Complex Valued Continuous Function, Uniform Continuity, Examples. (**1Question)**

Separated Sets, Disconnected Space and Disconnected Sets, Connected Space and Connected Sets, Components ,Totally Disconnected Space, Connectedness in the real line, Continuity and Connectedness, Examples. (**1Question)**

Cover, Lindelof Space, Compact Sets and compact Space, Finite Intersection Property and Compactness, Continuity and Compactness, Sequentially Compactness, Compactness and Total Boundedness, Examples. (**2Questions)**

Paper II Complex Analysis and Calculus of Variation

Section A

Complex Analysis

Analytic function. Cauchy-Riemann equations.Harmonic functions**.**Complex integration.Cauchy's theorem.Cauchy's integral formula.Derivatives.Taylor's series.Laurent's series.Liouville's theorem.Morera's theorem.Zeros and singularities. Poles and residues .Cauchy's residue theorem. Contour integration.

(4 questions)

Section B

Expansion of simple functions in Fourier series. Fourier transform and its simpleproperties.

(2questions)

Calculus of variations

Functionals. Variation of a functional .Euler's equation. Case of several variables. Natural boundary conditions. Variational derivative. Invariance of Eular's equation under transformation of coordinates. fixed end point problem for n unknown functions. Variational problem with subsidiary conditions. Isoperimetric problem. Finite subsidiary conditions.

(2 questions)

Paper III TENSORS AND DIFFERENTIAL GEOMETRY

Section A

Tensors: Transformation of coordinates, Contravariant and covariant vectors, Scalar invariants, Scalar product of two vectors, Tensors of any order. Symmetric and skew-symmetric tensors, Addition and multiplication of tensors, Contraction, composition and quotient law, Reciprocal symmetric tensors of second order.

Fundamental tensors, Associated covariant and contravariant vectors, Inclination of two vectors and orthogonal vectors.

The Christoffel symbols, Law of transformation of Christoffel symbols, Covariant derivatives of covariant and contravariant vectors, Covariant differentiation of tensors.

Curvature tensor and its Identities, Flat Space, Ricci tensor, Einstein space, Einstein tensor .

(3 questions)

Differential Geometry: (Vector Approach)

What is a curve?, Arc length, Reparametrization, Level Curves vs. Parametrized Curves Tangent and Osculating Plane, Principal Normal and Binormal.

(1 question)

Section B

Curvature and Torsion, Behaviour of a curve near one of its points, Curvature and Torsion of a curve as the intersection of two surfaces, Contact between curves and surfaces,Osculating circle and Sphere, Locus of centres of spherical curvature, Plane Curves, Space Curves, Fundamental existence theorem for space curve. **(1 question)**

What is Surface?, Smooth Surfaces, Tangents, Normals and Orientability, Examples of Surfaces, Quadric Surfaces.

First fundamental form , Length of Curves on Surfaces, Isometries of Surfaces, Conformal of surfaces, Surface Area.

The second Fundamental Form, The Curvature of Curves on a surfaces, The normal and Principal Curvatures, Geometric Interpretation of Principal Curvatures. **(2 question)**

The Gaussian and Mean Curvatures, The Pseudosphere, Flat Surfaces, Surfaces of Constant Mean Curvature, Gaussian Curvature of Compact Surfaces, The Gauss map.

Definition and Basic Properties of Geodesics, Geodesic Equations. **(1question)**

Paper IV Mechanics

Section A

Statics: Forces in three dimensions. Poinsot's central axis. Wrenches.Null lines and null planes. Conjugate lines and conjugate forces. **(2 questions)**

Particle Dynamics: Central orbits. Apses and apsidal distances.Kepler's laws of planetary motion. **(1 question)**

Motion of a particle in three dimensions.Accelerations in terms of different coordinate systems. Motion on a smooth surface. **(1 question)**

Section B

Rigid Dynamics: Moments and products of inertia. The momental ellipsoid.Equimomental systems. Principle axes. **(2 questions)**

D' Alembert's principle.The general equation of motion of a rigid body.Motion of the centre of inertia and motion relative to the centre of inertia.Impulsive foreces. **(1 question)**

Motion about a fixed axis.The compound pendulum. Centre of percussion. **(1 question)**

Paper V(a) Programming in C

Section A

Introduction to operating system & programming languages, Characteristics of Good program, Procedure for problem solving, Algorithm (Algorithm development, Advantages of Algorithms), Flow Chart (symbols used in Flow-Charts), Logical Structures (Sequential Logic, Selection Logic, Iterative Logic).

C & Its Fundamentals : Introductions, History of C, Features of C, Structure of a C program, The First Program in C (Compilation and Execution of C Program), The C-Character Set, Data types in C (Basic data types), Identifiers, Variables, Constants / Literals, Reserve Words / Keywords, Library Function , Preprocessor Directives (#include, #define).

Operators and Expressions: Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Conditional Operator or Ternary Operators (? :), Increment & Decrement Operator, Bitwise Operator, Comma Operator, Size of Operator .

Control Statements in C: Decision Making statements (if statements, if-else statements, Nested if –else Statements), Selection Statements, Iteration Statements (while Statement, do-while Statement, for Statements), Jumping Statements (The goto Statement, The return Statement, The break Statement, The continue Statement).

(4 questions)

Section B

Arrays in C: Declaration of an Array, Initialization of Array (At Compile Time Initialization, At Run Time Initialization), Types of Array (Single Dimension Arrays, Multi Dimensional Arrays).

Functions in C: Types of Function, Scope of the User Defined Function, Differences between Functions and Procedures, Advanced Featured of Functions (Function Prototypes, Actual and Formal Parameters or Arguments, Local and Global Variable, Calling Functions by Value or by reference, Recursion), Passing Arrays to a Function (Passing One-Dimensional Array in Function, Passing an Entire One – Dimensional Array to a Function, Passing Multi-Dimensional Array To a Function).

Pointers in C: Definition & Declaration, Null Pointer, Pointer Operators, Passing Pointers to the Functions, Return Pointer from Functions, Array of Pointers (Pointer to Single Dimensional Array, Pointer to Multidimensional Array).

(4 questions)

Paper V(b) Discrete Mathematics

Section A

Sets and Propositions: Cardinality. Mathematical Induction. Principle of inclusion and exclusion.

Computability and Formal Languages: Ordered sets. Languages. Phrase Structure Grammars. Types of Grammars and Languages. Permutations. Combinations and Discrete Probability.

Relations and Functions: Binary Relations. Equivalence Relations and Partitions.Partial Order Relations and Lattices. Chains and Anti chains . Pigeon Hole Principle.

Graphs and Planar Graphs: Basic Terminology. Multigraphs.Weighted Graphs.Paths and Circuits.Shortest Paths.Eulerian Paths and Circuits.Traveling Salesman Problem.Planar Graphs.Trees. **(4 questions)**

Section B

Finite State Machines: Equivalent Machines. Finite State Machines as Language Recognizers.

Analysis of Algorithms: Time Complexity, Complexity of Problems. Discrete Numeric Functions and Generating Functions.

Recurrence Relations and Recursive Algorithms: Linear Recurrence Relations with constant coefficients. Homogeneous Solutions. Particular Solution.Total Solution.Solution by the Method of Generating Functions.Brief review of Groups and Rings.

Boolean Algebra: Lattices and Algebraic Structures. Duality.Distributive and Complemented Lattices.Boolean Lattices and Boolean Algebras.Boolean Functions and Expressions.Propositional Calculus.Design and Implementation of Digital Networks.Switching Circuits.

(4 questions)

Paper V(C) Numerical Methods

Section A

Errors in Numerical Calculations. Calculus of finite differences: Delta (Λ),E, inverted delta (V) and D operators. Forward, Backward and Central differences, The fundamental theorem of finite differences.

Curve Fitting: Fitting of a straight line, Nonlinear Curve Fitting. **(2 questions)**

Interpolation: Newton's formulae for interpolation (forward and backward) for equal intervals. Central difference interpolation formulae: Gauss Central difference formulae, Stirling formulae, Bessel formulae and Everett formulae. Interpolation with unequal intervals: Lagrange's interpolation formulae, Newton's divided difference interpolation formulae.

(2 questions)

Section B

Solutions of Algebraic and Transcendental Equations: Bisection, Iteration, Regula- Falsi and Newton- Raphson methods, Ramanujan's Method, The Secant method, Solution of system of Non-linear equations. Numerical differentiation, Errors in Numerical differentiation

(2 questions)

Numerical Integration: Trapezoidal, Simpson's one-third, Simpson's three- eighth and Weddle's rules. Gauss- Legendre quadrature formula.

Numerical Solution of ordinary differential equations

Taylor's series method, Picard's method, Euler's method, Euler's modified method, Milne's method and Runge- Kutta method. Initial and Boundary-value problems

(2 questions)