SYLLABUS OF MATHEMATICS

B.A./B.SC. PART-I
Effective from session 2009-2010

Syllabus- Mathematics
B.A./B.Sc. Part I (effective from session 2009-2010)

The examination shall consist of FOUR theory papers as follows:

Paper I	:	Algebra and Trigonometry	50 marks
Paper II	:	Calculus	50 marks
Paper III	:	Differential Equations	50 marks
Paper IV	:	Analytical Geometry	50 marks

Paper I : Algebra and Trigonometry

Section-A
Properties of Integers
Division algorithm. Euclidean algorithm. Fundamental theorem of arithmemetic . Congurences and residue classes. Fermat's and Wilson's theorem.
(1 question)

Algebraic Equations
Relations between the roots and coefficients of general polynomial equation in one variable. Transformation of equations. Descarte's rule of signs. Solution of cubic equations (Cardon's method). Solution of biquadratic equations.
(1question)

Groups
Definition of a group with examples and simple properties. Subgroups. Cyclic groups. Coset decomposition. Lagrange's theorem and its consequences. Fermat's and Euler's theorems. Homomorphism and Isomorphism. Normal subgroups. Quotient groups. The fundamental theorem of homomorphism. Permutation groups. Even and odd permutations. The alternating group A_n. Cayley's theorem.
(3 questions)

Section-B
Trigonometry
Applications of De Moivre's theorem. Expansion of trigononetrical functions. Exponential, circular, logarithmic, inverse circular, hyperbolic and inverse hyperbolic functions of a complex variable. Gregory's series. Summation of trigonometrical series.
(3 questions)

Paper II : Calculus
Section A
Differential Culculus
Successive differentiation. Leibnitz theorem. Maclaurin and Taylor series expansions. Tangents and normals. Asymptotes. Curvature.Tests for concavity and convexity. Points of inflexion. Multiple points.

Tracing of curves in Cartesian and polar coordinates. Partial and total differentiation. Change of variables. Euler's theorem on homogeneous functions. Envelopes and evolutes.

(4 questions)

Section B
Integral Calculus

Integration of irrational algebraic functions and transcendental functions. Reduction formulae. Definite integrals. Quadrature. Rectification. Volumes and surfaces of solids of revolution. Beta and Gamma functions. Double and triple integrals. Differentiation under the sign of integration. Dirichlet's integral. Change of order of integration in double integrals.

(4 questions)

Paper III : Differential Equations

Section A
Ordinary Differential Equations

Degree and order of a differential equation. Differential equations of first order and first degree. Differential equations in which the variables are separable. Homogeneous equations. Linear equations and equations reducible to the linear form. Exact differential equations. First order higher degree equations solvable for x,y,p. Clairaut's form and singular solutions. Geometrical meaning of a differential equation. Orthogonal trajectories. Linear differential equations with constant coefficients. Homogeneous linear differential equations and equations reducible to the homogeneous linear form.

(4 questions)

Section B

Linear differential equations of second order. Transformation of the equation by changing the dependent variable / the independent variable. Method of variation of parameters.

Simultaneous and total differential equations.

(2 questions)

Laplace Transform

Linearity of the Laplace transform. Existence theorem for Laplace transforms. Laplace transforms of derivatives and integrals. Shifting theorems. Differentiation and integration of transforms. Convolution theorem. Solution of integral equations and systems of differential equations using the Laplace transform.

(2 questions)

Paper IV : Analytical Geometry
Section A

Confocal conics.Double contact of conics. Conics treated by polar coordinates.

Coordinates of a point in space. Direction cosines of a line . Plane. Straight line. Sphere. Cone. Cylinder.

(4 questions)

Section B

Central conicoids. Paraboloids. Plane sections of conicoids Generating lines. Confocal conicoids.

(4 questions)

B.A/B.sc.Part II(effective from session 2010- 2011)

The examination shall consist of FOUR theory papers as follows :

Paper I :	Abstract Algebra	50 marks
Paper II :	Real Analysis	50 marks
Paper III :	Advanced Calculus and Numerical Analysis	50 marks
Paper IV :	Statics and Dynamics	50 marks

Paper I : **Abstract Algebra**

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)

Section-B

Vector spaces

Definition and examples of vector spaces. Subspaces.Sum and direct sum of subspaces.Linear span.Linear dependence, independence and their basic properties. 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. (2 questions)

Linear transformations and their representations as matrices. The algebra of linear transformations.The rank – nullity theorem. Change of basis .Dual space. 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

Dedekind's definition of real numbers. Addition, subtraction and multiplication of real numbers. Section of sets of real numbers. Lower and upper bounds. Supremum and infimum of the subsets of R. Completeness of R.

(2 questions)

Definition of a sequence.Theorems on limits of sequences. Bounded and monotonic sequences. Convergence of a sequence. Cauchy's convergence criteria. Completeness of R. 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.

(2 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. Indeterminate forms.
(2 questions)

Riemann integral. Integrability of continuous and monotonic functions. The fundamental theorem of Integral Calculus.Mean Value theorems of Integral calculus. Riemann- Stiltjes integration.

Improper integrals and their convergence Comparison tests.

(2 questions)

Paper III : **Advanced Calculus and Numerical Analysis**

Section A

Advanced Calculus

Limit and continuity of functions of two variables .Taylor's theorem for functions of two variables. Jacobians. Maxima, minima and saddle points of functions of two variables. Lagrange's multiplier method.

(2 questions)

Vector Calculus

Vector differentiation. Gradient , divergence and curl. Vector integrations. Theorems of Gauss, Green & Stokes and problems based on these theorems.

(2 questions)

Section B

Numerical Analysis

Delta (Λ),E, inverted delta (Λ) and D operators. The fundamental theorem of finite differences. Method of separation of symbols. Gregory- Newton forward and backward interpolation formulae for equal intervals. Newton's divided difference and Lagrange's interpolation formulae for unequal intervals. Central difference formulae due to Gauss (forward and backward), Stirling, Bessel and Laplace- Everett.

(2 questions)

Solution of equations : Bisection, Iteration, Regula- Falsi and Newton- Raphson methods.

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

Solution of ordinary differential equations of first order by Taylor, Picard, Euler, Euler modified, Milne and Runga- Kutta methods.

(2 questions)

Paper IV : **Statics and Dynamics**

Section A

Statics

Analytical conditions of equilibrium of coplanar forces. Virtual work. Catenary. Stable and unstable equilibrium.

(4 questions)

Section B

Dynamics

Velocities and accelerations along radial and transverse directions, and along tangential and normal directions. Simple harmonic motion. Elastic strings. Motion in resisting medium. Motion on smooth and rough plane curves.

(4 questions)

B.A./B.Sc. Part III (effective from session 2011-2012)

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 .

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 :	Machanics	50 marks

Optional Paper (any one of the following) 50 marks

Paper V (a) : Spherical Trigonometry & Spherical Astronomy

Paper V (b) : Discrete Mathematics

Paper V (c) : Hydrostatics

Paper V (d) : Special theory of Relativity

Paper V (e) : Theory of Numbers

Paper V (f) : Probability theory

Paper V (g) : Linear Programming and Games Theory

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 distance and metric spaces. Examples of Euclidean metric space, sequence spaces and function spaces. Open spheres. Open sets and their properties. Interior of a set and its properties. Closed set and its properties. Closure of a set and its properties. Boundary of a set. Dense set.

(2 questions)

Base and axioms of countability. Separable space. Subspace. Product space.

(1 question)

Sequences and subsequences and their convergence in a metric space. Cauchy sequence. Complete metric space and its examples. Cantor's theorem. Baire's category theorem.

(1 question)

Section B

Definition and properties of a compact set. Compact sets in R. Finite intersection property. Bolzano-Weierstrass property and its equivalence. Sequential compactness and total boundedness.

(2 questions)

Definition of continuous mapping in a metric space. Limit of a function in a metric space. Relationship between continuity and limit. Continuity in terms of open sets and closed sets. Continuity of constant and identity mappings. Continuity and compactness. Connectedness in a metric space. Interval as a connected subspace.

(2 questions)

Paper II : Complex Analysis and Calculus of Variations

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. Rouche's theorem. Hurwitz theorem. Jensen's theorem.

(4 questions)

Section B

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

(2 questions)

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 vactors. 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, Ricci tensor, Curvature tensor identities.

(3 questions)

Section B
Differential Geometry
Curves in space

Regular curves. Tangent, Principal normal and binormal. Curvature and torsion. Serret- Frenet's formulae, Contact between curves and surfaces, Osculating plane. Normal plane. Rectifying plane.Osculating sphere. Helices, Involutes and evolutes. (2 questions)

Theory of surfaces

Parametric patches on surfaces. Curves on a surface. First fundamental from and arc length. Orthogonal trajectories. Second fundamental from . Gauss's formulae, Weingarten's formulae Curvature, of a curve on a surface, Normal curvature, Meunier's theorem. Principal curvature. Gaussian curvature. Mean curvature. Lines of curvature. Euler's theorem, Conjugate directions. Asymptotic lines. Null lines, Beltrami and Enneper's theorem.Gauss characteristic equations, Mainardi Codazzi equation. Geodesic Geodesic coordinates, Geodesic curvature.

(3 questions)

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) : Spherical Trigonometry & Spherical Astronomy

Section A

Spherical trigonometry

Simple relations between trigonometrical functions of the sides and angles of a spherical triangle, Solution of triangles. Area of a spherical triangle, Spherical excess.

(4 questions)

Section B

Spherical Astronomy

System of coordinates and their determination, Diurnal and annual motion of the earth. Twilight. Astronomical Instruments. Kepler's laws. Time. Equation of time.

(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) : Hydrostatics

Section A

Centre of pressure. Thrust on plane surfaces. Thrust on the Curved surface. The Equilibrium of floating body. (4 questions)

Section B

Stability of Equilibrium of floating body. Meta Centre. Position of Equilibrium. Surface of Buoyancy, Surface of buoyancy in General.
(2 questions)
Gas laws.Mixture of gases. Internal energy. Adiabatic expansion.Work done in compressing a gas. Isothermal atmosphere. Connective equilibrium
(2 questions)

Paper V (d) : Special theory of Relativity

Section A
Review of Newtonian Mechanics

Inertial frames. Speed of Light and Galilean relativity. Michelson-Morley experiment. Lorentz-Fitzgerald contraction hypothesis. Relative character of space and time. Postulates of special theory of Relativity. Lorentz transformation equations and its geometrical interpretation. Group properties of Lorentz transformations.

Relativistic Kinematics

Composition of parallel velocities. Length contraction. Time dilation. Transformation equations for components of velocity and acceleration of a particle and Lorentz contraction factor.

Geometrical representation of space-time

Four dimensional Minkowskian space-time of special relativity. Time-like , light-like and space-like intervals. Null cone. Proper time, Word line of a particle. Four vectors and tensors in Minskowskian space-time. (4 questions)

Section B
Relativistic Mechanics

Variation of mass with velocity. Equivalence of mass and energy. Transformation equations for mass momentum and energy. Energy-momentum four vector. Relativistic force and Transformation equations for its components. Relativistic Lagrangian and Hamiltonian. Relativistic equations of motion of a particle. Energy momentum tensor of a continuous material distribution.

Electromagnetism

Maxwell's equations of vacuo. Transformation equations for the densities of electric charge and current .Propagation of electric and magnetic field strengths. Transformation equations for electromagnetic four potential vector. Transformation equations for electric and magnetic field strengths. Gauge transformation. Lorentz invariance of Maxwell's equations. Maxwell's equations in tensor form. Lorentz force on a charged particle. Energy momentum tensor of an electromagnetic field.
(4 questions)

Paper V (e) : Theory of Numbers

Section A

Permutation and combination. Fermat's Little theorem. Wilson's theorem. Generating functions.

Chinese remainder theorem. Polynomial congruence, Combinatorial study of d(n). Formulae for d(n) and (n). Multiplicative Arithmetic functions. The Mobius inversion formula. (n) Properties of reduced residue system. Primitive roots modulo p.
(4 questions)

Section B

Elementry properties of (x) . Tchebychev's theorem. Some unsolved problems about primes.

Euler's criterion. The Legend – symbol . The quadratic reciprocity law. Application of quadratic reciprocity law. Consecutive residues and non-residues. Consecutive triples of quadratic residues. Sum of two squares. Sum of four squares. (4 questions)

Paper V (f) : Probability Theory (*not to be offered by those who read Statistics as a subject*)

Section A

Concept of sample space. Events. The algebra of probability axioms. Independent and dependent event . Exclusive events, Conditional probability, Baye's theorem . Stochastic independence.
(2 questions)

Random Variables: The general definition of random variables as a function of the sample space. Discrete and continuous random variables, The probability function , Distribution Density function . Joint distribution . Marginal and conditional distribution.
(2 questions)

Section B

Mathematical expectation . Moments. Conditional expectation. Moment generating function. Cumulant.
(2 questions)

Function of random variables. Chebycheff's inequality . Convergence of probability, Bernoulli's theorem. The week low of large numbers. Komogrov's inequality , Strong low of large numbers.
(2 questions)

Paper V (f) : Linear Programming and Game Theory

Section A

Linear Programming : Convex sets and functions. Linear programming problem(LPP).Two-variable LPP. Procedure of solving two-variable LPP by graphical method. Some important definitions related to general LPP. Canonical and standard forms of LPP. Slack and surplus variables. Basic solutions of LPP. Solution of general LPP. Simplex method. Big-M method. Two phase method, Exceptional cases, Degeneracy in simplex method. (2 questions)

Duality : Principle of duality in linear programming problem. Fundamental duality theorem. Symmetric dual problem. Unsymmetric dual problem. The dual of a mixed system. (1question)

Integer Programming: Integer programming problem (IPP). Pure and mixed IPP. Methods of solution. Gomory's cutting plane method. Branch and bound method. Zero-one integer programming and its applications. (1question)

Section B

Transportation and Assignment Problems: Mathematical formulation of transportation problem. Balanced and unbalanced transportation problems. Solution of transportation problem. Transportation table. Initial basic feasible solution. Methods for finding initial basic feasible solution. Optimality Test. Modified distribution (MODI) method. Degeneracy in transportation problems. Maximization transportation problem. Trans-shipment problem.

Mathematical formulation of assignment problem. Difference between transportation problem. Balanced and unbalanced assignment problems. Solution of assignment problem. Hungarian method. Maximization assignment problem. Travelling salesman problem. (2questions)

Game Theory : Characteristics of a game. Basic definitions . Competitive games, Zero-sum and non-zero-sum games. Two-person zero-sum games. Minimax-Maximin Criteria. Saddle point. Solution of rectangular games with and without saddle points. Mixed strategies dominance property. Graphical method for 2xn and mx2 games without saddle point. Applications and limitations of game theory. Equivalence of rectangular game and linear programming: Fundamental theorem of game theory. (2questions)

Viva-voce and Project Work 100 marks

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The dissertation will be of 40 marks and the viva-voce will be of 60 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.

Differential Geometry

Curves in space

Regular curves. Tangent, Principal normal and binormal. Curvature and torsion. Serret- Frenet's formulae, Contact between curves and surfaces, Osculating plane. Normal plane. Rectifying plane.Osculating sphere. Helices, Involutes and evolutes. (2 questions)

Theory of surfaces

Parametric patches on surfaces. Curves on a surface. First fundamental from and arc length. Orthogonal trajectories. Second fundamental from . Gauss's formulae, Weingarten's formulae Curvature, of a curve on a surface, Normal curvature, Meunier's theorem. Principal curvature. Gaussian curvature. Mean curvature. Lines of curvature. Euler's theorem, Conjugate directions. Asymptotic lines. Null lines, Beltrami and Enneper's theorem.Gauss characteristic equations, Mainardi Codazzi equation. Geodesic Geodesic coordinates, Geodesic curvature.