# Department of Mathematics 

Syllabus UG (2017-18)

## B. Sc. (Semester I)

## (M-1) Algebra and Trigonometry

## Unit I

Definition of a group with examples and properties, Subgroups, Cosets, Langrange's theorem, Permutation groups, Even and odd permutations.
Application of groups to higher mathematics, rotation symmetry etc.
Unit II
Relation between the roots and coefficients of general polynomial equation in one variable, Transformation of equations, Reciprocal equations, Descartes rules of signs, Introduction to Numerical Methods for solution of algebraic and transcendental equations:
Iteration, bisection and Newton Raphson methods.
Unit III
Rank of matrix, Normal form, and Linear equation, Application of matrix for Solution of non- homogeneous and homogeneous linear equations.
Eigen values, Eigen vectors, Cayley-Hamilton theorem (without proof), Application of Cayley-Hamilton theorem to find Inverse of a matrix.
Representation of Matrix in computer (Concept, Project based activity, use of MS-excel, 'C' language, (no theory questions expected)

## Unit IV

De Moivre's theorem \& its applications ,circular and hyperbolic functions, Inverse circular and hyperbolic functions, Logarithm of a complex quantity, Expansion of trigonometrical functions

## (M-2) Calculus

## Unit I

Limit of the function of one variable, Theorems on limits, Continuityof function of one variable, discontinuity and classification of discontinuities, Differentiation, Indeterminate forms and L'Hospital's rule.

## Unit II

Successive differentiation, Lebinitz's theorem. Rolle's theorem, Lagrange's Mean Value theorem, Cauchy's Mean Value theorem Maclaurin and Taylor series expansions, Unit III
Partial differentiation, Differential and Chain rules (Theorems without Proof), Euler's theorem on homogeneous functions and its applications, Jacobian Unit IV
Integrations of irrational algebraic functions, Reduction formulae, Walli's formula.Definite integrals,Examples on properties of definite integral.

## B. Sc. (Semester II)

## (M-3)Differential, DifferenceEquations and Solid Geometry

## Unit I

First order exact differential equation, Integrating factor, First order linear differential equation and Bernoulli's differential equation, First order higher degree equations (solvable for $x, y, p$ ), Clairaut's form.
Applications of first order differential equationto simple electrical circuits.
Unit II
Higher order linear differential equation with constant coefficients, Operator method to find particular integral, Euler's equidimensional equation, Method of variation of parameters.
Applications of second order differential equation to simple harmonic motion.

## Unit III

Difference equation, Formation of difference equation, Order of difference equation, Linear difference equation, Homogeneous linear equation with constant coefficients, Non-homogeneous linear equation, Particular integrals.

## Unit IV

Sphere, Plane section of sphere ,Intersection of two spheres,Sphere through a given circle,Tangent line,Tangent plane, Right circular cone, Right circular cylinder.

## (M-4)Vector Calculus and Improper Integrals

## Unit I

Vector differentiation, Directional derivative, Gradient, Divergence and Curl, Solenoidal and Irrotational vector fields, their relevance to physical problems.Line integral, Workdone.

## Unit II

Double integration and its evaluation, Area by double integration, Change of order of integration, Transformation of double integral in polar form, Evaluation of triple Integral. Unit III
Green's theorem in a plane, Volume integral, Surface integral, Stroke's theorem (statement only), Gauss divergence theorem (statement only)
Unit IV
Improper integrals and their convergence, Comparison tests, Beta and Gamma functions.
B. Sc. (Semester III)
(M-5) Advanced Calculus, Sequence and Series
Unit I :Mean value theorems, Limit and Continuity of function of two variables, Taylor's theorem for function of two variables.
Unit II: Envelopes, Maxima, Minima and Saddle Points of functions of two variables, Langrange's Multiplier Method.

Unit III: Sequences and theorems on limit of sequence, Bounded and Monotonic sequences, Cauchy's sequence, Cauchy's Convergence Criterion.
Unit IV: Series of non-negative terms ,Comparision test ,Cauchy's integral test ,Ratio test , Root test, Alternating series, Absolute and Conditional convergence.

## (M-6) Differential Equations \& Group Homomorphism

Unit I : Bessel's and Legendre's equations, Bessel's and Legendre's functions with their properties, Recurrence relations and generating functions, Orthogonality of functions.
Unit II: Laplace transform of some elementary functions, Linearity of Laplace transform, Laplace transforms of derivatives and integrals, Shifting theorem, Differentiation and integral of transform, Convolution theorem.
Unit III: Solutions of Ordinary differential equations with constant and variable coefficients, Solutions of simultaneous ordinary and partial differential equations, Fourier transform, Sine and Cosine transforms.
Unit IV: Normal subgroup ,Quotient Group ,Cyclic Group ,Group Homomorphism and Isomorphism, The fundamental theorem of homomorphism.

## B. Sc. (Semester IV)

## (M-7) Partial Differential Equations \& Calculus of Variation

Unit I: Simultaneous differential equations of the first order and the first degree in three variables, Pfaffian differential equation, Solution of Pfaffian differential equation in three variables, Partial differential equations and origins of first order partial differential equation, Formation of partial differential equations by eliminating arbitrary function and arbitrary constants.
Unit II: Lagrange's equation, Integral surface passing through given curve, Compatible system of first order equation, Charpit's method, Jacobi's method.
Unit III: Partial differential equation of second and higher order, Linear partial differential equation of second order with constant coefficients, Homogeneous and Nonhomogeneous linear partial diffrential equations with constant coefficients, Partial differential equations reducible to equations with constant coefficients.
Unit IV: Functional, Continuity of functional, Linear functional, Extremum of a functional, Euler's differential equation and applications, Invariance of Euler's equations.

## (M-8) Mechanics

Unit I: Analytical condition of equilibrium of coplanar forces, Virtual work, Catenary.
Unit II: Velocities and Accelerations along radial and transverse directions, and along tangential and normal directions, Simple harmonic motion.

Unit III: Mechanics of a particle and a system of particles, Constraints, D'Alembert's Principle and Lagrange's equations, Velocity-dependant potential and the Dissipation function, Applications of Lagrangian.
Unit IV: Reduction to the equivalent one-body problem, Equations of motion and First integrals, Virial theorem, Central orbits.

## B. Sc. (Semester V)

## M-9 Analysis

Unit I Fourier series, Even \& Odd functions, Dirichlet's condition, Half Range Fourier Sine and Cosine series.
Unit II The Riemann-Stieltjes integral, Existence and Properties of the integral, The Fundamental theorem of calculus.
Unit III Differentiability of complex function, Analytic function, Cauchy- Reimann equations, Harmonic functions, Constructions of analytic functions.
Unit IV Elementary function, Mapping of elementary function, Mobius transformation, Cross ratio, Fixed points, Inverse points and Critical points of mappings, Conformal mapping.

## M-10 Metric Space, Complex integration \& Algebra

Unit I Countable and uncountable sets, Definition and examples of metric space, Neighbourhood, Limit points, Interior points, Open and closed sets, closure and interior. Unit II Completeness, Compactness, Connectedness
Unit III Ring, Integral domain, Ideals, Fields, Quotient ring, Ring-Homomorphism.
Unit IV Complex integration: Cauchy's integral theorem and formula, Singularity, Residue theorem, Evaluation of integrals.

## B. Sc. (Semester VI)

## M-11 Abstract Algebra

Unit I Group Automorphisms, Inner Automorphisms, Cayley's theorem, Conjugacy relation, Normalizer.
Unit II Definition and examples of Vector Spaces, Subspaces, Sum and direct sum of subspaces, Linear span, Linear Dependence and independence, Basis, Dimensions.
Unit III Algebra of linear transformation, Range, Rank, Kernel, Nullity of a linear map, Inverse of linear transformation, Composition of linear maps.
Unit IV Matrix associated with a linear map, Linear map associated with a matrix, Rank and nullity of a matrix, Inner product space, Gram-Schmidt orthogonalisation process, Orthogonal and unitary matrices.

## M-12 Discrete Mathematics and Elementary Number Theory (Optional Paper)

Unit I Binary Relations, Equivalence Relation, Partitions, Partial Order Relation, Lattices, Duality, Distributive and Complemented Lattices, Boolean Algebra, Graph, Multigraph, Weighted Graphs, Isomorphisms of Graphs, Node
Unit II Divisibility, Division Algorithm, G.C.D., Euclidean Algorithm L.C.M., Primes, Properties of Congruences, Theorems of Fermat, Euler \& Wilson, Conguence of degree 1, Chinese Remainder Theorem, The Function $\varphi(\mathrm{n})$.
Unit III Quadratic Residues and Reciprocity, The Jacobi's symbol, Greatest integer function, Arithmetic functions, Moebius inversion formula.
Unit IV The Diophantine equations,, Positive solutions, Other linear equations, The equations \& , Farrey sequences.

## M-12 Differential Geometry (Optional Paper)

Unit I Parametric representation and definition of curve in space, Special Curves and their representation, length of arc, Tangent at a given point to a curve, Oscillating plane, Normal Plane, Principal normal and binormal , Rectifying plane, Fundamental planes, Curvature of curve, Torsion of curve, Serret-Frenet Formulae, Helices, Locus of the centre of curvature, Oscillating sphere (Sphere of Curvature), Locus of centre of spherical curvature.
Unit II Involute \& Evolute , The curvature and torsion of the evolute, Bertrand curves, Fundamental theorem for space curves, Envelopes and characteristics relating to one parameter family of surfaces and planes, Developable surfaces, Ruled surfaces.
Unit III Curves on a surface, Parametric Curves, Two fundamental forms, Positive definiteness, Fundamental magnitudes for some important surfaces, Direction coefficients, Orthrogonal trajectories of given curves . The formulas of Gauss , Meusnier's theorem, Lines of curvature as parametric curves, Euler's theorem on normal curvature, Rodrigues' formula, Third fundamental form.
Unit IV Definition and the differential equations of Geodesic, Canonical equations for Geodesics, Geodesics on a surface of revolution, Normal property of Geodesics, Tortion of Geodesic, Curvature of Geodesic, Bonnet's Theorem, Geodesic parallels, Geodesic polar coordinates, Theorems on geodesic parallels, Geodesic ellipse and hyperbolas, GaussBonnet Theorem, Gaussian Curvature.

## M-12 Special Theory of Relativity (Optional Paper)

Unit I Newtonian Relativity, Galilean Transformations, The theory of Ether, Michelson - Morley experiment, Lorentz transformation equations, Geometrical interpretation of Lorentz transformations, Group properties of Lorentz transformations.
Unit II Event and Particle, Simultaneity, Relativistic formulae for composition of velocities (Transformation of particle velocities), Relativistic addition law for velocities ,Relativistic formulae for composition of accelerations of a particle, Transformation of Lorentz contraction factor , length contraction , time dilation.
Unit III Tensors, Riemannian metric, metric tensor or fundamental tensor, Minkowski space, Space and Timelike intervals, Light cone or null cone, world points and world lines, Events occurring at the same point and the same time, four vector, four tensors

Unit IV Equivalence of mass and energy i. e. $\mathrm{E}=\mathrm{mc}$, Transformation formula for mass, Transformation formula for momentum and energy ,Energy momentum four vector, fourvelocity, four- acceleration ,Relativistic equations of motins, The energy momentum tensor Tij, Maxwell's equations of electromagnetic theory in vacuo, Propagation of electric and magnetic field strengths, four potential , Transformations of electromagnetic four potential vector

## Syllabus UG (2018-19)

## B. Sc. (Semester I)

## (M-1) Algebra and Trigonometry

## Unit I

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Rank of matrix, Normal form, and Linear equation, Application of matrix for Solution of non- homogeneous and homogeneous linear equations.
Eigen values, Eigen vectors, Cayley-Hamilton theorem (without proof), Application of Cayley-Hamilton theorem to find Inverse of a matrix.
Representation of Matrix in computer (Concept, Project based activity, use of MS-excel, 'C' language, (no theory questions expected)

## Unit IV

De Moivre's theorem \& its applications ,circular and hyperbolic functions, Inverse circular and hyperbolic functions, Logarithm of a complex quantity, Expansion of trigonometrical functions

## (M-2) Calculus

## Unit I

Limit of the function of one variable, Theorems on limits,
Continuityof function of one variable, discontinuity and classification of discontinuities, Differentiation, Indeterminate forms and L'Hospital's rule.
Unit II

Successive differentiation, Lebinitz's theorem. Rolle's theorem, Lagrange's Mean Value theorem, Cauchy's Mean Value theorem Maclaurin and Taylor series expansions, Unit III
Partial differentiation, Differential and Chain rules (Theorems without Proof), Euler's theorem on homogeneous functions and its applications, Jacobian
Unit IV
Integrations of irrational algebraic functions, Reduction formulae, Walli's formula.Definite integrals,Examples on properties of definite integral.

## B. Sc. (Semester II)

## (M-3)Differential, DifferenceEquations and Solid Geometry

## Unit I

First order exact differential equation, Integrating factor, First order linear differential equation and Bernoulli's differential equation, First order higher degree equations (solvable for $x, y, p$ ), Clairaut's form.
Applications of first order differential equationto simple electrical circuits.
Unit II
Higher order linear differential equation with constant coefficients, Operator method to find particular integral, Euler's equidimensional equation, Method of variation of parameters.
Applications of second order differential equation to simple harmonic motion.

## Unit III

Difference equation, Formation of difference equation, Order of difference equation, Linear difference equation, Homogeneous linear equation with constant coefficients, Non-homogeneous linear equation, Particular integrals.

## Unit IV

Sphere, Plane section of sphere ,Intersection of two spheres,Sphere through a given circle,Tangent line,Tangent plane, Right circular cone, Right circular cylinder.

## (M-4)Vector Calculus and Improper Integrals

## Unit I

Vector differentiation, Directional derivative, Gradient, Divergence and Curl, Solenoidal and Irrotational vector fields, their relevance to physical problems.Line integral, Workdone.

## Unit II

Double integration and its evaluation, Area by double integration, Change of order of integration, Transformation of double integral in polar form, Evaluation of triple Integral. Unit III
Green's theorem in a plane, Volume integral, Surface integral, Stroke's theorem (statement only), Gauss divergence theorem (statement only)

## Unit IV

Improper integrals and their convergence, Comparison tests, Beta and Gamma functions.

## B. Sc. (Semester III)

## (M-5) Advanced Calculus \& Graph theory

## Unit I

Limit and Continuity of function of two variables, Taylor's theorem for function of two variables.
Maxima, Minima and Saddle Points of functions of two variables, Langrange's Multiplier
Method. Application of Maxima and minima
Unit II
Sequences, limit of a sequence, Convergent, divergent and oscillatory sequences, theorems and problems, Bounded and Monotonic sequences, Cauchy's sequence examples and theorems on Cauchy sequences

## Unit III

Series of non-negative terms, Comparison test, Ratio test, Root test, Cauchy's integral test, Alternating series, Geometric series, Absolute and Conditional convergence of series.

## Unit IV

Basic concepts of Graph theory: multigraph, weighted graph, isomorphism of graphs. Paths, reachability and connectedness, matrix representation of graphs. Trees, PERT and related techniques.

## (M-6) Mathematical Methods

## Unit I

Bessel's and Legendre's equations, Bessel's and Legendre's functions with their properties, recurrence relations and generating functions, orthogonality of functions.

## Unit II

Laplace transform: Laplace transform of some elementary functions, properties of Laplace transform, shifting theorems, Laplace transform of derivatives and integrals, derivative and integration of Laplace transform , evaluation of integrals, Inverse Laplace transform, properties of inverse Laplace transform, convolution theorem.

## Unit III

Applications of Laplace Transforms:
Solutions of ordinary differential equations with constant and variable coefficients, solutions of simultaneous ordinary differential equations, solutions of partial differential equations, solutions of integral equations, application to electrical circuits.

## Unit IV

Fourier transform: Finite Fourier sine and cosine transforms, inverse finite Fourier sine and cosine transforms, Infinite Fourier transform, infinite Fourier sine and cosine transforms, properties of Fourier transforms, Fourier transform of derivatives, application of Fourier transform to partial differential equations.

## B. Sc. (Semester IV)

## (M-7) Partial Differential Equations \& Calculus of Variation

## Unit I

Origin of first order partial differential equation, formation of partial differential equations by eliminating arbitrary function and arbitrary constants. Lagrange's linear equation of order one, Integral surface passing through given curve, Nonlinear partial differential equation of order one, Charpit's method, special types of nonlinear partial differential equations, Jacobi's method.

## Unit II

Linear partial differential equation of second order with constant coefficients, solution of homogeneous and non-homogeneous linear partial differential equations with constant coefficients, Partial differential equations reducible to equations with constant coefficients.

## Unit III

Partial differential equation of order two with variable coefficients, Classification of second order partial differential equations, characteristics of equations, Reduction to canonical form.

## Unit IV

Functional, Continuity of functional, Linear functional, Extremum of a functional, Euler's differential equation and applications, Invariance of Euler's equations.

## (M-8) Mechanics

## Unit I

Analytical condition of equilibrium of coplanar forces, Virtual work, Catenary.

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Unit IV The Diophantine equations, , Positive solutions, Other linear equations, The equations \& , Farrey sequences.

## M-12 Differential Geometry (Optional Paper)

Unit I Parametric representation and definition of curve in space, Special Curves and their representation, length of arc, Tangent at a given point to a curve, Oscillating plane, Normal Plane, Principal normal and binormal, Rectifying plane, Fundamental planes, Curvature of curve, Torsion of curve, Serret-Frenet Formulae, Helices, Locus of the centre of curvature, Oscillating sphere (Sphere of Curvature), Locus of centre of spherical curvature.
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Unit I Newtonian Relativity, Galilean Transformations, The theory of Ether, Michelson - Morley experiment, Lorentz transformation equations, Geometrical interpretation of Lorentz transformations, Group properties of Lorentz transformations.
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Unit III Tensors, Riemannian metric, metric tensor or fundamental tensor, Minkowski space, Space and Timelike intervals, Light cone or null cone, world points and world lines, Events occurring at the same point and the same time, four vector, four tensors

Unit IV Equivalence of mass and energy i. e. $\mathrm{E}=\mathrm{mc} 2$, Transformation formula for mass, Transformation formula for momentum and energy ,Energy momentum four vector, fourvelocity, four- acceleration ,Relativistic equations of motins, The energy momentum tensor Tij, Maxwell's equations of electromagnetic theory in vacuo , Propagation of electric and magnetic field strengths, four potential, Transformations of electromagnetic four potential vector

## Syllabus UG (2019-20)

B. Sc. (Semester I)

## (M-1) Algebra and Trigonometry

## Unit I

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Eigen values, Eigen vectors, Cayley-Hamilton theorem (without proof), Application of Cayley-Hamilton theorem to find Inverse of a matrix.
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## Unit IV

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## (M-2) Calculus

## Unit I

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Continuityof function of one variable, discontinuity and classification of discontinuities, Differentiation, Indeterminate forms and L'Hospital's rule.

## Unit II

Successive differentiation, Lebinitz's theorem. Rolle's theorem, Lagrange's Mean Value theorem, Cauchy's Mean Value theorem Maclaurin and Taylor series expansions, Unit III
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## (M-3)Differential, DifferenceEquations and Solid Geometry

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Applications of first order differential equationto simple electrical circuits.

## Unit II

Higher order linear differential equation with constant coefficients, Operator method to find particular integral, Euler's equidimensional equation, Method of variation of parameters.

## Applications of second order differential equation to simple harmonic motion.

## Unit III

Difference equation, Formation of difference equation, Order of difference equation, Linear difference equation, Homogeneous linear equation with constant coefficients, Non-homogeneous linear equation, Particular integrals.

## Unit IV

Sphere, Plane section of sphere ,Intersection of two spheres,Sphere through a given circle,Tangent line,Tangent plane, Right circular cone, Right circular cylinder.

## (M-4)Vector Calculus and Improper Integrals

## Unit I

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## Unit II

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## Unit III

Green's theorem in a plane, Volume integral, Surface integral, Stroke's theorem (statement only), Gauss divergence theorem (statement only)
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Improper integrals and their convergence, Comparison tests, Beta and Gamma functions.

## B. Sc. (Semester III)

## (M-5) Advanced Calculus \& Graph theory

## Unit I

Limit and Continuity of function of two variables, Taylor's theorem for function of two variables.
Maxima, Minima and Saddle Points of functions of two variables, Langrange's Multiplier
Method. Application of Maxima and minima
Unit II
Sequences, limit of a sequence, Convergent, divergent and oscillatory sequences, theorems and problems, Bounded and Monotonic sequences, Cauchy's sequence examples and theorems on Cauchy sequences

## Unit III

Series of non-negative terms, Comparison test, Ratio test, Root test, Cauchy's integral test, Alternating series, Geometric series, Absolute and Conditional convergence of series.

## Unit IV

Basic concepts of Graph theory: multigraph, weighted graph, isomorphism of graphs. Paths, reachability and connectedness, matrix representation of graphs. Trees, PERT and related techniques.

## (M-6) Mathematical Methods

## Unit I

Bessel's and Legendre's equations, Bessel's and Legendre's functions with their properties, recurrence relations and generating functions, orthogonality of functions.

## Unit II

Laplace transform: Laplace transform of some elementary functions, properties of Laplace transform, shifting theorems, Laplace transform of derivatives and integrals, derivative and integration of Laplace transform, evaluation of integrals, Inverse Laplace transform, properties of inverse Laplace transform, convolution theorem.

## Unit III

Applications of Laplace Transforms:
Solutions of ordinary differential equations with constant and variable coefficients, solutions of simultaneous ordinary differential equations, solutions of partial differential equations, solutions of integral equations, application to electrical circuits.

## Unit IV

Fourier transform: Finite Fourier sine and cosine transforms, inverse finite Fourier sine and cosine transforms, Infinite Fourier transform, infinite Fourier sine and cosine transforms, properties of Fourier transforms, Fourier transform of derivatives, application of Fourier transform to partial differential equations.

## B. Sc. (Semester IV)

## (M-7) Partial Differential Equations \& Calculus of Variation

## Unit I

Origin of first order partial differential equation, formation of partial differential equations by eliminating arbitrary function and arbitrary constants. Lagrange's linear equation of order one, Integral surface passing through given curve, Nonlinear partial differential equation of order one, Charpit's method, special types of nonlinear partial differential equations, Jacobi's method.

## Unit II

Linear partial differential equation of second order with constant coefficients, solution of homogeneous and non-homogeneous linear partial differential equations with constant coefficients, Partial differential equations reducible to equations with constant coefficients.

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Partial differential equation of order two with variable coefficients, Classification of second order partial differential equations, characteristics of equations, Reduction to canonical form.

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Functional, Continuity of functional, Linear functional, Extremum of a functional, Euler's differential equation and applications, Invariance of Euler's equations.

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Analytical condition of equilibrium of coplanar forces, Virtual work, Catenary.

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## Unit IV

Reduction to the equivalent one-body problem, Equations of motion and First integrals, Virial theorem, Central orbits.

## B. Sc. (Semester V)

## (M-9) Real Analysis

Unit I
Fourier series, Even \& Odd functions, Dirichlet's condition, Half Range Fourier Sine and Cosine series.
Unit II

The Riemann-Stieltjes integral, Existence and Properties of the integral, The Fundamental theorem of calculus.

## Unit III

Countable and uncountable sets, Definition and examples of metric space, Neighborhood, Limit points, Interior points, Open and closed sets, closure and interior.

## Unit IV

Sequence in metric space, Cauchy sequence and their properties, Completeness, Compactness, Connectedness.

## (M-10) Complex Analysis

## Unit I

Differentiability of complex function, Analytic function, Cauchy- Reimann equations, Harmonic functions, Constructions of analytic functions.

## Unit II

Elementary function, Mapping of elementary function, Mobius transformation, Cross ratio, Fixed points, Inverse points and Critical points of mappings, Conformal mapping.

## Unit III

Complex integration: Complex line integral, Cauchy's integral theorem, Extension of Cauchy's theorem, Cauchy's integral formula and its generalized form, Cauchy's inequality, Liouville's theorem, Taylor's and Laurent's theorem.

## Unit IV

Zero of a function, Singular point, types of singularities, Residue at a pole, Residue at infinity Cauchy's residue theorem, Evaluation of integrals of the type integration around unit circle and $\int_{-\infty}^{\infty} f(z) d z$, where $f(z)$ has no poles on the real line.

## B. Sc. (Semester V)

(M-11) Abstract Algebra

## Unit I

Group Automorphisms, Inner Automorphisms, Cayley's theorem, Conjugacy relation, Normalizer.

## Unit II

Rings: Definition and properties of a ring, Integral domain, Fields, Subring, Ideals, Quotient ring, Ring-homomorphism.

## Unit III

Definition and examples of Vector Spaces, Subspaces, Sum and direct sum of subspaces, Linear span, Linear Dependence and independence, Basis, Dimensions.

## Unit IV

Algebra of linear transformation, Range, Rank, Kernel, Nullity of a linear map, Matrix associated with a linear map, Linear map associated with a matrix, Rank and nullity of a matrix.

## (M-12) Special Theory of Relativity

## Unit I

Newtonian Relativity, Galilean Transformations , The theory of Ether, Michelson Morley experiment, Lorentz transformation equations, Geometrical interpretation of Lorentz transformations, Group properties of Lorentz transformations.

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Event and Particle, Simultaneity, Relativistic formulae for composition of velocities (Transformation of particle velocities), Relativistic addition law for velocities ,Relativistic formulae for composition of accelerations of a particle, Transformation of Lorentz contraction factor, length contraction , time dilation.

## Unit III

Tensors, Riemannian metric, metric tensor or fundamental tensor, Minkowski space , Space and Timelike intervals, Light cone or null cone, world points and world lines, Events occurring at the same point and the same time, four vector, four tensors .

## Unit IV

Equivalence of mass and energy i. e. $\mathrm{E}=\mathrm{mc}^{2}$, Transformation formula for mass, Transformation formula for momentum and energy ,Energy momentum four vector, fourvelocity, four- acceleration ,Relativistic equations of motion, The energy momentum tensor $\mathrm{T}_{\mathrm{ij}}$, Maxwell's equations of electromagnetic theory in vacuum, Propagation of electric and magnetic field strengths, four potential , Transformations of electromagnetic four potential vector.

## (M-12) Discrete Mathematics and Elementary Number Theory

## Unit I

Binary Relations, Equivalence Relation, Partitions, Partial Order Relation, Lattices, Duality, Distributive and Complemented Lattices, Boolean Algebra, Graph, Multigraph, Weighted Graphs, Isomorphisms of Graphs, Node

## Unit II

Divisibility, Division Algorithm, G.C.D., Euclidean Algorithm L.C.M., Primes, Properties of Congruences, Theorems of Fermat, Euler \& Wilson, Conguence of degree 1, Chinese Remainder Theorem, The Function $\varphi(n)$.

## Unit III

Quadratic Residues and Reciprocity, The Jacobi's symbol, Greatest integer function, Arithmetic functions, Moebius inversion formula.

## Unit IV

The Diophantine equations, Positive solutions, Other linear equations, The equations $x^{2}+y^{2}=z^{2}$ and $x^{4}+y^{4}=z^{4} \quad \&$ Farrey sequences.

## (M-12) Differential Geometry

## Unit I

Parametric representation and definition of curve in space, Special Curves and their representation, length of arc, Tangent at a given point to a curve, Oscillating plane, Normal Plane , Principal normal and binormal , Rectifying plane, Fundamental planes, Curvature of curve, Torsion of curve, Serret-Frenet Formulae, Helices, Locus of the centre of curvature, Oscillating sphere (Sphere of Curvature), Locus of centre of spherical curvature.

## Unit II

Involute \& Evolute , The curvature and torsion of the evolute, Bertrand curves, Fundamental theorem for space curves, Envelopes and characteristics relating to one parameter family of surfaces and planes, Developable surfaces, Ruled surfaces.

## Unit III

Curves on a surface, Parametric Curves, Two fundamental forms, Positive definiteness, Fundamental magnitudes for some important surfaces, Direction coefficients, Orthrogonal trajectories of given curves , The formulas of Gauss , Meusnier's theorem , Lines of curvature as parametric curves , Euler's theorem on normal curvature, Rodrigues' formula, Third fundamental form.

## Unit IV

Definition and the differential equations of Geodesic, Canonical equations for Geodesics, Geodesics on a surface of revolution, Normal property of Geodesics, Tortion of Geodesic, Curvature of Geodesic, Bonnet's Theorem, Geodesic parallels, Geodesic polar coordinates, Theorems on geodesic parallels, Geodesic ellipse and hyperbolas, Gauss-Bonnet Theorem, Gaussian Curvature.

## Syllabus UG (2020-21)

B. Sc. (Semester I)

## (M-1) Algebra and Trigonometry

## Unit I

Definition of a group with examples and properties, Subgroups, Cosets, Langrange's theorem, Permutation groups, Even and odd permutations.
Application of groups to higher mathematics, rotation symmetry etc.
Unit II
Relation between the roots and coefficients of general polynomial equation in one variable, Transformation of equations, Reciprocal equations, Descartes rules of signs, Introduction to Numerical Methods for solution of algebraic and transcendental equations:
Iteration, bisection and Newton Raphson methods.
Unit III
Rank of matrix, Normal form, and Linear equation, Application of matrix for Solution of non- homogeneous and homogeneous linear equations.
Eigen values, Eigen vectors, Cayley-Hamilton theorem (without proof), Application of Cayley-Hamilton theorem to find Inverse of a matrix.
Representation of Matrix in computer (Concept, Project based activity, use of MS-excel, 'C' language, (no theory questions expected)

## Unit IV

De Moivre's theorem \& its applications ,circular and hyperbolic functions, Inverse circular and hyperbolic functions, Logarithm of a complex quantity, Expansion of trigonometrical functions

## (M-2) Calculus

## Unit I

Limit of the function of one variable, Theorems on limits,
Continuityof function of one variable, discontinuity and classification of discontinuities, Differentiation, Indeterminate forms and L'Hospital's rule.
Unit II
Successive differentiation, Lebinitz's theorem. Rolle's theorem, Lagrange's Mean Value theorem, Cauchy's Mean Value theorem Maclaurin and Taylor series expansions, Unit III
Partial differentiation, Differential and Chain rules (Theorems without Proof), Euler's theorem on homogeneous functions and its applications, Jacobian
Unit IV
Integrations of irrational algebraic functions, Reduction formulae, Walli's formula.Definite integrals,Examples on properties of definite integral.

## B. Sc. (Semester II)

## (M-3)Differential, DifferenceEquations and Solid Geometry

## Unit I

First order exact differential equation, Integrating factor, First order linear differential equation and Bernoulli's differential equation, First order higher degree equations (solvable for $x, y, p$ ), Clairaut's form.
Applications of first order differential equationto simple electrical circuits.
Unit II
Higher order linear differential equation with constant coefficients, Operator method to find particular integral, Euler's equidimensional equation, Method of variation of parameters.
Applications of second order differential equation to simple harmonic motion.

## Unit III

Difference equation, Formation of difference equation, Order of difference equation, Linear difference equation, Homogeneous linear equation with constant coefficients, Non-homogeneous linear equation, Particular integrals.

## Unit IV

Sphere, Plane section of sphere ,Intersection of two spheres,Sphere through a given circle,Tangent line,Tangent plane, Right circular cone, Right circular cylinder.

## (M-4)Vector Calculus and Improper Integrals

## Unit I

Vector differentiation, Directional derivative, Gradient, Divergence and Curl, Solenoidal and Irrotational vector fields, their relevance to physical problems.Line integral, Workdone.

## Unit II

Double integration and its evaluation, Area by double integration, Change of order of integration, Transformation of double integral in polar form, Evaluation of triple Integral. Unit III
Green's theorem in a plane, Volume integral, Surface integral, Stroke's theorem (statement only), Gauss divergence theorem (statement only)
Unit IV
Improper integrals and their convergence, Comparison tests, Beta and Gamma functions.
B. Sc. (Semester III)
(M-5) Advanced Calculus , Sequence and Series
Unit I :Mean value theorems, Limit and Continuity of function of two variables, Taylor's theorem for function of two variables.
Unit II: Envelopes, Maxima, Minima and Saddle Points of functions of two variables, Langrange's Multiplier Method.

Unit III: Sequences and theorems on limit of sequence, Bounded and Monotonic sequences, Cauchy's sequence, Cauchy's Convergence Criterion.
Unit IV: Series of non-negative terms ,Comparision test ,Cauchy's integral test ,Ratio test , Root test, Alternating series ,Absolute and Conditional convergence.

## (M-6) Differential Equations \& Group Homomorphism

Unit I : Bessel's and Legendre's equations, Bessel's and Legendre's functions with their properties, Recurrence relations and generating functions, Orthogonality of functions.
Unit II: Laplace transform of some elementary functions, Linearity of Laplace transform, Laplace transforms of derivatives and integrals, Shifting theorem, Differentiation and integral of transform, Convolution theorem.
Unit III: Solutions of Ordinary differential equations with constant and variable coefficients, Solutions of simultaneous ordinary and partial differential equations, Fourier transform, Sine and Cosine transforms.
Unit IV: Normal subgroup ,Quotient Group ,Cyclic Group ,Group Homomorphism and Isomorphism, The fundamental theorem of homomorphism.

## B. Sc. (Semester IV)

## (M-7) Partial Differential Equations \& Calculus of Variation

Unit I: Simultaneous differential equations of the first order and the first degree in three variables, Pfaffian differential equation, Solution of Pfaffian differential equation in three variables, Partial differential equations and origins of first order partial differential equation, Formation of partial differential equations by eliminating arbitrary function and arbitrary constants.
Unit II: Lagrange's equation, Integral surface passing through given curve, Compatible system of first order equation, Charpit's method, Jacobi's method.
Unit III: Partial differential equation of second and higher order, Linear partial differential equation of second order with constant coefficients, Homogeneous and Nonhomogeneous linear partial diffrential equations with constant coefficients, Partial differential equations reducible to equations with constant coefficients.
Unit IV: Functional, Continuity of functional, Linear functional, Extremum of a functional, Euler's differential equation and applications, Invariance of Euler's equations.

## (M-8) Mechanics

Unit I: Analytical condition of equilibrium of coplanar forces, Virtual work, Catenary.
Unit II: Velocities and Accelerations along radial and transverse directions, and along tangential and normal directions, Simple harmonic motion.
Unit III: Mechanics of a particle and a system of particles, Constraints, D'Alembert's Principle and Lagrange's equations, Velocity-dependant potential and the Dissipation function, Applications of Lagrangian.

Unit IV: Reduction to the equivalent one-body problem, Equations of motion and First integrals, Virial theorem, Central orbits.

## B. Sc. (Semester V)

## M-9 Analysis

Unit I Fourier series, Even \& Odd functions, Dirichlet's condition, Half Range Fourier Sine and Cosine series.
Unit II The Riemann-Stieltjes integral, Existence and Properties of the integral, The Fundamental theorem of calculus.
Unit III Differentiability of complex function, Analytic function, Cauchy- Reimann equations, Harmonic functions, Constructions of analytic functions.
Unit IV Elementary function, Mapping of elementary function, Mobius transformation, Cross ratio, Fixed points, Inverse points and Critical points of mappings, Conformal mapping.

## M-10 Metric Space, Complex integration \& Algebra

Unit I Countable and uncountable sets, Definition and examples of metric space, Neighbourhood, Limit points, Interior points, Open and closed sets, closure and interior. Unit II Completeness, Compactness, Connectedness
Unit III Ring, Integral domain, Ideals, Fields, Quotient ring, Ring-Homomorphism.
Unit IV Complex integration: Cauchy's integral theorem and formula, Singularity, Residue theorem, Evaluation of integrals.

## B. Sc. (Semester VI)

## M-11 Abstract Algebra

Unit I Group Automorphisms, Inner Automorphisms, Cayley's theorem, Conjugacy relation, Normalizer.
Unit II Definition and examples of Vector Spaces, Subspaces, Sum and direct sum of subspaces, Linear span, Linear Dependence and independence, Basis, Dimensions.
Unit III Algebra of linear transformation, Range, Rank, Kernel, Nullity of a linear map, Inverse of linear transformation, Composition of linear maps.
Unit IV Matrix associated with a linear map, Linear map associated with a matrix, Rank and nullity of a matrix, Inner product space, Gram-Schmidt orthogonalisation process, Orthogonal and unitary matrices.

## M-12 Discrete Mathematics and Elementary Number Theory (Optional Paper)

Unit I Binary Relations, Equivalence Relation, Partitions, Partial Order Relation, Lattices, Duality, Distributive and Complemented Lattices, Boolean Algebra, Graph, Multigraph, Weighted Graphs, Isomorphisms of Graphs, Node

Unit II Divisibility, Division Algorithm, G.C.D., Euclidean Algorithm L.C.M., Primes, Properties of Congruences, Theorems of Fermat, Euler \& Wilson, Conguence of degree 1, Chinese Remainder Theorem, The Function $\varphi(\mathrm{n})$.
Unit III Quadratic Residues and Reciprocity, The Jacobi's symbol, Greatest integer function, Arithmetic functions, Moebius inversion formula.
Unit IV The Diophantine equations,, Positive solutions, Other linear equations, The equations \& , Farrey sequences.

## M-12 Differential Geometry (Optional Paper)

Unit I Parametric representation and definition of curve in space, Special Curves and their representation, length of arc, Tangent at a given point to a curve, Oscillating plane, Normal Plane, Principal normal and binormal , Rectifying plane, Fundamental planes, Curvature of curve, Torsion of curve, Serret-Frenet Formulae, Helices, Locus of the centre of curvature, Oscillating sphere (Sphere of Curvature), Locus of centre of spherical curvature.
Unit II Involute \& Evolute, The curvature and torsion of the evolute, Bertrand curves, Fundamental theorem for space curves, Envelopes and characteristics relating to one parameter family of surfaces and planes, Developable surfaces, Ruled surfaces.
Unit III Curves on a surface, Parametric Curves, Two fundamental forms, Positive definiteness, Fundamental magnitudes for some important surfaces, Direction coefficients, Orthrogonal trajectories of given curves , The formulas of Gauss , Meusnier's theorem, Lines of curvature as parametric curves, Euler's theorem on normal curvature, Rodrigues' formula, Third fundamental form.
Unit IV Definition and the differential equations of Geodesic, Canonical equations for Geodesics, Geodesics on a surface of revolution, Normal property of Geodesics, Tortion of Geodesic, Curvature of Geodesic, Bonnet's Theorem, Geodesic parallels, Geodesic polar coordinates, Theorems on geodesic parallels, Geodesic ellipse and hyperbolas, GaussBonnet Theorem, Gaussian Curvature.

## M-12 Special Theory of Relativity (Optional Paper)

Unit I Newtonian Relativity, Galilean Transformations, The theory of Ether, Michelson - Morley experiment, Lorentz transformation equations, Geometrical interpretation of Lorentz transformations, Group properties of Lorentz transformations.
Unit II Event and Particle , Simultaneity, Relativistic formulae for composition of velocities (Transformation of particle velocities), Relativistic addition law for velocities ,Relativistic formulae for composition of accelerations of a particle, Transformation of Lorentz contraction factor , length contraction , time dilation.
Unit III Tensors, Riemannian metric, metric tensor or fundamental tensor, Minkowski space, Space and Timelike intervals, Light cone or null cone, world points and world lines, Events occurring at the same point and the same time, four vector, four tensors

Unit IV Equivalence of mass and energy i. e. $\mathrm{E}=\mathrm{mc} 2$, Transformation formula for mass, Transformation formula for momentum and energy ,Energy momentum four vector, fourvelocity, four- acceleration ,Relativistic equations of motins, The energy
momentum tensor Tij, Maxwell's equations of electromagnetic theory in vacuo , Propagation of electric and magnetic field strengths, four potential , Transformations of electromagnetic four potential vector

## Syllabus UG (2021-22)

## B. Sc. (Semester I)

## M-1: Elementary Mathematics

Unit I Complex Numbers: De Moivre's Theorem and its application. Roots of complex number, Euler's formula, Polynomial equations, The $\mathrm{n}^{\text {th }}$ roots of unity, The elementary functions.
Unit II Matrices: Rank of a matrix. Equivalent matrices, Row canonical form, Normal form, Elementary matrices and rank of a matrix, System of homogeneous and nonhomogeneous equations, Characteristic equation and roots, Cayley-Hamilton Theorem (without proof)
Representation of Matrix in computer (Concept, Project based activity, use of MS-excel, 'C' language, (no theory questions expected)
Unit III Theory of Equations: Theorems on roots of equation, Relation between the roots and the coefficients, Formation and solutions with surd and complex roots, Descartes' rule of signs, Calculation of $f(x+h)$ by Horner's process, Transformation of equations. Introduction to Numerical Methods for solution of algebraic and transcendental equations:
Iteration, bisection and Newton Raphson methods.
Unit IV Elementary Number Theory: Division Algorithm, Greatest Common Divisor, Euclidean Algorithm. The Diophantine equation $\mathrm{ax}+\mathrm{by}=\mathrm{c}$, The Fundamental Theorem of Arithmetic (without proof), Basic Properties of Congruence, Linear Congruence and the Chinese Remainder Theorem

## M-2: Differential and Integral Calculus

Unit I Successive differentiation, Leibnitz's theorem, MaClaurin's and Taylor's theorems, Indeterminate forms.

Unit II Functions of two variables and its geometrical representation, Limit and continuity of functions of two variables, Partial derivatives, Homogeneous functions, Theorems on total differentials, composite functions, differentiation of composite functions (without proof), Equality of mixed partial derivatives, Asymptotes. Envelopes

Unit III Jacobians and its properties, Taylor's series of two variables, Maxima and Minima of function of two variables, Lagrange's method of multiplier

Unit IV Reduction formulae, Integration of algebraic rational functions, Integration of trigonometric functions, Integration of irrational functions

## B. Sc. (Semester II)

## M-3: Geometry, Differential \& Difference Equations

Unit I Equation of a sphere, General equation of a sphere, The sphere through four given points, Plane section of a sphere, Intersection of two spheres, A sphere with a given diameter, A sphere through a given circle, Intersection of a sphere and a line, Plane of contact, Condition for the orthogonality of two spheres, The right circular cone, The right circular cylinder
Unit II Families of curves, Orthogonal trajectories, Exact equations, integrating factors, linear and Bernoulli's equations, reduction of order.

Application of first order differential equation to electrical circuits.
Unit III Second order linear differential equations: Introduction. The general solution of the homogeneous equation, The use of a known solution to find another, The homogeneous equation with constant coefficients, non homogeneous linear equation, The method of undermined coefficients, The method of variation of parameters

Unit IV Difference Equations: Definition, solution of simple difference equations, Homogeneous linear equations, General solutions of higher order homogeneous linear equations with variable coefficients, Non-homogeneous equation reducible to homogeneous equation, Method of evaluating $\frac{1}{f(E\}} \phi(x)$, First order Non-homogeneous linear equations, Higher order nonhomogeneous linear equations with constant coefficients, First order linear equation with variable coefficients, Equation homogeneous in $u(x)$, Equations reducible to linear equations with constant coefficients

## M-4: Vector Analysis

Unit I Vector differentiation, Differential Geometry, Gradient, Divergence and Curl, Solenoidal and Irrotational vector fields, their relevance to physical problems.

Unit II Double integration, evaluation of double integrals, change of order of integration, Application of double integrals, Area in polar coordinates, Triple integration, Gamma function, Transformation of Gamma function, Beta function, evaluation of Beta function, Symmetric property of Beta function, Transformation of Beta function, Relation between Beta and Gamma functions

Unit III Ordinary integral of vectors, line integral, Surface integral, Volume integral

Unit IV Green's Theorems in the plane and its application, Gauss divergence Theorem, Stokes' Theorem.

## B. Sc. (Semester III)

## (M-5) Advanced Calculus \& Graph theory

## Unit I

Limit and Continuity of function of two variables, Taylor's theorem for function of two variables.
Maxima, Minima and Saddle Points of functions of two variables, Langrange's Multiplier Method. Application of Maxima and minima

## Unit II

Sequences, limit of a sequence, Convergent, divergent and oscillatory sequences, theorems and problems, Bounded and Monotonic sequences, Cauchy's sequence examples and theorems on Cauchy sequences

## Unit III

Series of non-negative terms, Comparison test, Ratio test, Root test, Cauchy's integral test, Alternating series, Geometric series, Absolute and Conditional convergence of series.

## Unit IV

Basic concepts of Graph theory: multigraph, weighted graph, isomorphism of graphs. Paths, reachability and connectedness, matrix representation of graphs. Trees, PERT and related techniques.

## (M-6) Mathematical Methods

## Unit I

Bessel's and Legendre's equations, Bessel's and Legendre's functions with their properties, recurrence relations and generating functions, orthogonality of functions.

## Unit II

Laplace transform: Laplace transform of some elementary functions, properties of Laplace transform, shifting theorems, Laplace transform of derivatives and integrals, derivative and integration of Laplace transform, evaluation of integrals, Inverse Laplace transform, properties of inverse Laplace transform, convolution theorem.

## Unit III

Applications of Laplace Transforms:
Solutions of ordinary differential equations with constant and variable coefficients, solutions of simultaneous ordinary differential equations, solutions of partial differential equations, solutions of integral equations, application to electrical circuits.

## Unit IV

Fourier transform: Finite Fourier sine and cosine transforms, inverse finite Fourier sine and cosine transforms, Infinite Fourier transform, infinite Fourier sine and cosine transforms, properties of Fourier transforms, Fourier transform of derivatives, application of Fourier transform to partial differential equations.

## B. Sc. (Semester IV)

## (M-7) Partial Differential Equations \& Calculus of Variation

## Unit I

Origin of first order partial differential equation, formation of partial differential equations by eliminating arbitrary function and arbitrary constants. Lagrange's linear equation of order one, Integral surface passing through given curve, Nonlinear partial differential equation of order one, Charpit's method, special types of nonlinear partial differential equations, Jacobi's method.

## Unit II

Linear partial differential equation of second order with constant coefficients, solution of homogeneous and non-homogeneous linear partial differential equations with constant coefficients, Partial differential equations reducible to equations with constant coefficients.

## Unit III

Partial differential equation of order two with variable coefficients, Classification of second order partial differential equations, characteristics of equations, Reduction to canonical form.
Unit IV
Functional, Continuity of functional, Linear functional, Extremum of a functional, Euler's differential equation and applications, Invariance of Euler's equations.

## (M-8) Mechanics

## Unit I

Analytical condition of equilibrium of coplanar forces, Virtual work, Catenary.

## Unit II

Velocities and Accelerations along radial and transverse directions, and along tangential and normal directions, Simple harmonic motion.

## Unit III

Mechanics of a particle and a system of particles, Constraints, D'Alembert's Principle and Lagrange's equations ,Velocity-dependant potential and the Dissipation function, Applications of Lagrangian.

## Unit IV

Reduction to the equivalent one-body problem, Equations of motion and First integrals, Virial theorem, Central orbits.

## B. Sc. (Semester V)

## M-9 Analysis

Unit I Fourier series, Even \& Odd functions, Dirichlet's condition, Half Range Fourier Sine and Cosine series.
Unit II The Riemann-Stieltjes integral, Existence and Properties of the integral, The Fundamental theorem of calculus.

Unit III Differentiability of complex function, Analytic function, Cauchy- Reimann equations, Harmonic functions, Constructions of analytic functions.
Unit IV Elementary function, Mapping of elementary function, Mobius transformation, Cross ratio, Fixed points, Inverse points and Critical points of mappings, Conformal mapping.

## M-10 Metric Space, Complex integration \& Algebra

Unit I Countable and uncountable sets, Definition and examples of metric space, Neighbourhood, Limit points, Interior points, Open and closed sets, closure and interior.
Unit II Completeness, Compactness, Connectedness
Unit III Ring, Integral domain, Ideals, Fields, Quotient ring, Ring-Homomorphism.
Unit IV Complex integration: Cauchy's integral theorem and formula, Singularity, Residue theorem, Evaluation of integrals.

## B. Sc. (Semester VI)

## M-11 Abstract Algebra

Unit I Group Automorphisms, Inner Automorphisms, Cayley's theorem, Conjugacy relation, Normalizer.
Unit II Definition and examples of Vector Spaces, Subspaces, Sum and direct sum of subspaces, Linear span, Linear Dependence and independence, Basis, Dimensions.
Unit III Algebra of linear transformation, Range, Rank, Kernel, Nullity of a linear map, Inverse of linear transformation, Composition of linear maps.
Unit IV Matrix associated with a linear map, Linear map associated with a matrix, Rank and nullity of a matrix, Inner product space, Gram-Schmidt orthogonalisation process, Orthogonal and unitary matrices.

## M-12 Discrete Mathematics and Elementary Number Theory (Optional Paper)

Unit I Binary Relations, Equivalence Relation, Partitions, Partial Order Relation, Lattices, Duality, Distributive and Complemented Lattices, Boolean Algebra, Graph, Multigraph, Weighted Graphs, Isomorphisms of Graphs, Node
Unit II Divisibility, Division Algorithm, G.C.D., Euclidean Algorithm L.C.M., Primes, Properties of Congruences, Theorems of Fermat, Euler \& Wilson, Conguence of degree 1, Chinese Remainder Theorem, The Function $\varphi(n)$.
Unit III Quadratic Residues and Reciprocity, The Jacobi's symbol, Greatest integer function, Arithmetic functions, Moebius inversion formula.
Unit IV The Diophantine equations, , Positive solutions, Other linear equations, The equations \& , Farrey sequences.

## M-12 Differential Geometry (Optional Paper)

Unit I Parametric representation and definition of curve in space, Special Curves and their representation, length of arc, Tangent at a given point to a curve, Oscillating plane, Normal Plane, Principal normal and binormal, Rectifying plane, Fundamental planes, Curvature of curve, Torsion of curve, Serret-Frenet Formulae, Helices, Locus of the centre of curvature, Oscillating sphere (Sphere of Curvature), Locus of centre of spherical curvature.
Unit II Involute \& Evolute, The curvature and torsion of the evolute, Bertrand curves, Fundamental theorem for space curves, Envelopes and characteristics relating to one parameter family of surfaces and planes, Developable surfaces, Ruled surfaces.
Unit III Curves on a surface, Parametric Curves, Two fundamental forms, Positive definiteness, Fundamental magnitudes for some important surfaces, Direction coefficients, Orthrogonal trajectories of given curves , The formulas of Gauss , Meusnier's theorem, Lines of curvature as parametric curves, Euler's theorem on normal curvature, Rodrigues' formula, Third fundamental form.
Unit IV Definition and the differential equations of Geodesic, Canonical equations for Geodesics, Geodesics on a surface of revolution, Normal property of Geodesics, Tortion of Geodesic, Curvature of Geodesic, Bonnet's Theorem, Geodesic parallels, Geodesic polar coordinates, Theorems on geodesic parallels, Geodesic ellipse and hyperbolas, GaussBonnet Theorem, Gaussian Curvature.

## M-12 Special Theory of Relativity (Optional Paper)

Unit I Newtonian Relativity, Galilean Transformations, The theory of Ether, Michelson - Morley experiment, Lorentz transformation equations, Geometrical interpretation of Lorentz transformations, Group properties of Lorentz transformations.
Unit II Event and Particle , Simultaneity, Relativistic formulae for composition of velocities (Transformation of particle velocities), Relativistic addition law for velocities ,Relativistic formulae for composition of accelerations of a particle, Transformation of Lorentz contraction factor , length contraction , time dilation.
Unit III Tensors, Riemannian metric, metric tensor or fundamental tensor, Minkowski space, Space and Timelike intervals, Light cone or null cone, world points and world lines, Events occurring at the same point and the same time, four vector, four tensors

Unit IV Equivalence of mass and energy i. e. $\mathrm{E}=\mathrm{mc} 2$, Transformation formula for mass, Transformation formula for momentum and energy ,Energy momentum four vector, fourvelocity, four- acceleration ,Relativistic equations of motins, The energy momentum tensor Tij, Maxwell's equations of electromagnetic theory in vacuo, Propagation of electric and magnetic field strengths, four potential, Transformations of electromagnetic four potential vector.

