Topic	Content
Fundamentals of Analytic Geometry	1. *Vectors (basic definitions).* *Linear dependence/ independence of vectors.* *Basis and affine coordinates.* *Projection of a vector onto an axis.* *Cartesian and Polar coordinates.* *The Scalar (Dot) product of two vectors (definition, properties, applications).* *The Vector (Cross) product of two vectors (definition, properties, applications).* *The Triple Scalar product of three vectors (definition, properties, applications).* *Transformation of the Cartesian coordinate system on a plane and in space.* 2. *Equations of a straight line in 2 Dimensions: normal vector form, parametric and Cartesian Forms, two-point form, slope-intercept form, intercept Form.* *Relationship between lines.* *The angle between two lines.* *Shortest distance from a point to a line.* *Bundle of lines.* 3. *Conics and quadratic equations. Reducing the general equation of a quadric (second-degree) curve to its canonical form.* *Ellipse (definition, properties, shape).* *Hyperbola (definition, properties, shape).* *Parabola (definition, properties, shape).* *Conics in polar coordinates.* 4. *Equations of a plane: normal vector form, Cartesian equation, three-point form, intercept form.* *Straight line in 3 Dimensions.* *Relationship between a plane and a line in 3-D.* *Relationship between lines in 3-D.* *Planes and lines in 3-D (Practice problems).* 5. *Classification of quadric surfaces.*

Elements of Linear Algebra	1. *Matrices (basic definitions).* *Determinant of a matrix (definition, properties).* *Minor and cofactor to the element of a matrix.* 2. *Linear simultaneous equations.* *Cramer's rule.* *The rank of a matrix. Theorem about principal (basic) minor.* *Consistency criterion for linear simultaneous equations* *(Kroneker – Capelli's theorem).* *Homogeneous linear simultaneous equations (conditions* *for the existence of a non-trivial solution, the fundamental* *set of solutions, the structure of the general solution).* 3. *Linear vector space.* *Linear dependence of vectors.* *Basis and dimension of the space.* *Subspace and linear spans.* *Intersection and union of subspaces.* *Solution (null) space to a homogeneous linear system.* *Linear operators and their matrix representations.* 4. *Linear operators and matrices.* *Composition of linear operators and matrix multiplication.* *Inverse operator and inverse matrix.* *Image and kernel of a linear operator.* *Eigenvalues and eigenvectors of linear operators.* *Change of basis for linear transformations.*
Fundamentals of Discrete Mathematics	1. *Sets and operations with them.* 2. *Cardinality of sets. Comparing cardinalities.* *Finite and infinite sets (definition, examples).* *Countable (countably infinite) and uncountable sets* *(examples, properties).* *Sets of cardinality continuum.* *Cantor's diagonalization method.*

	3. *Foundations of combinatorics:* *permutations, arrangements, combinations.* *Permutations with repetition. arrangements with repetition, combinations with repetition.* **4.** *Power Series and Dirichlet Series.* *Generating Functions.* *Recurrent sequences.* *Stirling Numbers, Fibonacci Numbers, Catalan Numbers, Bernoulli Numbers and Polynomials.*
Fundamentals of Mathematical Analyses	**1**. *Sequences.* *Limit of a sequence.* *Basic properties of convergent sequences.* *Limit of a monotone bounded sequence. The number e.* **2**. *Functions (definition, basic characteristics of behavior of functions).* *Limit of a function at infinity. Limit of a function at a point.* *Basic properties.* **3.** *Derivative of a function: definition, geometric interpretation.* *Tangent line and normal to a curve.* *Derivatives of elementary functions (a table of basic derivatives).* *Rules of differentiation, including chain rule and inverse function differentiation.* **4.** *Antiderivative (primitive) and indefinite integral.* *Basic properties of indefinite integral.* *Main methods of integration (integration by substitution, integration by parts).*
Fundamentals of Calculus of Complex Functions	**1**. *Complex Numbers.* *Cartesian Form of a complex number (definition, complex conjugates, basic operations).* *Geometric representation of a complex number.* *Polar form of a complex numbers (definition, operations,* de *Moivre's formula).*

	Exponential form of a complex number (Euler's formula). 2. *Differentiability of a function of a complex variable.* *Geometric interpretation of the derivative of a function of a complex variable.* *Cauchy-Riemann equations.* *Conformal mapping (definition).* 3. *Complex power series.* *Abel's theorem and the radius of convergence.* *Basic properties of complex power series within its disk of convergence.* 4. *Taylor series for analytic functions.* *Taylor series expansions of elementary functions (examples).*
Basic Concepts of Number Theory and Cryptography	1. *Divisibility theory of natural numbers; modular multiplicative inverse (an inverse of a number (mod n)); multiplicative ciphers.* 2. *Euler's phi-function (Euler's totient function), Euler's theorem; linear ciphers.* 3. *Modular square root (square root mod m); exponential ciphers.* 4. *Primality tests; RSA algorithm.*
Basic Concepts of Probability Theory	1. *Classical definition of probability (classical probability concept).* *Probability of union, intersection, complement, symmetric difference of random events.* 2. *Independent events.* *Conditional probability.* *Law of total probability.* *Bayes' Theorem.* 3. *Classical distributions: Uniform, Bernoulli, Binomial, Hypergeometric, Poisson, Gaussian.* 4. *Mathematical expectation, variance and moments of random variable.* 5. *Bernoulli's law of large numbers.* *Poisson Theorem.* *De Moivre-Laplace theorem.*