

SYLLABUS

COURSE: B.Sc/B.A. MATHEMATICS

CBCS:(Honours and General)

SEMESTER	PAPER	UNITS	TAUGHT BY		
I	MAT-HC-1016 CALCULUS	<p>Unit I(a) Higher order derivatives, Leibnitz rule and its applications to problems of type $e^{ax+b} \sin x$, $e^{ax+b} \cos x$, $(ax+b)^n \sin x$, $(ax+b)^n \cos x$,</p> <p>(b) Concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L-Hopital's rule, applications in business, economics and life sciences.</p> <p>[1] Chapter 4 (Sections 4.3-4.5,4.7) (for part (b)) [2] Chapter 10 (Section 10.1-10.6) (for part (b)). [3] Chapter 5 (only for part (a))</p>	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes	
		<p>Unit 2 (a) Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x \, dx$, $\int \cos^n x \, dx$, $\int \tan^m x \, dx$, $\int \sec^n x \, dx$, $\int (\log x)^n \, dx$, $\int \sin^m x \cos^n x \, dx$.</p> <p>(b) Volumes by slicing, disks and washers' methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.</p> <p>[1] Chapter 6 (Section 6.2,6.4), Chapter 9 (Section 9.4) (for part (b)) [2] Chapter 6 (Section 6.1-6.5), (for part (b)) [4] Chapter 4 (4.1-4.6) (only for part (a))</p>		DR. BIBHASH DEKA	Lecture, notes, powerpoint
		<p>Unit 3 Triple product, introduction to</p>			

		vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, modelling ballistics and planetary motion, Kepler's second law. [1] Chapter 9 (Section 9.3), Chapter 10 [2] Chapter 11 (11.3, 11.4) Chapter 12		
MAT-HC-1026 ALGEBRA	Unit 1 Polar representation of complex numbers, n th roots of unity, De Moivre's theorem for rational indices and its applications. [1] : Chapter 2	MR. PRAJNAN KUMAR BHAGAWATI		Lecture, notes
	Unit 2 Statements and logic, statements with quantifier, compound statements, implications, proofs in Mathematics; Sets, operations on sets, family of sets, power sets, Cartesian product; Functions, one-one, onto functions and bijections, Composition of functions, Inverse of a function, Image and Inverse image of subsets [2] Chapters 1– 3			
	Unit 3 Relation, Equivalence relations, Equivalence classes and partitions of a set, congruence modulo n in integers; Induction Principles, the well-ordering principle, greatest common divisor of integers. [3] Chapters 4– 5. Unit 4 Systems of Linear Equations, row reduction and echelon forms, vector equations, the matrix equation $Ax = b$, solution sets of linear systems, linear independence, introduction to linear transformations, the matrix of a linear transformation; Matrix operations, inverse of a matrix, characterizations of invertible matrices; Determinants, Cramer's rule	DR. NARAYAN NAYAK	Lecture, notes, practical and laboratory work	

		[4] : Chapter1(Sections1.1–1.9); Chapter2(Sections,2.1–1.3); Chapter3(Sections3.1–3.3)		
	MAT-HG/RC-1016 CALCULUS	Unit 1 Graphs of simple concrete functions such as polynomial, Trigonometric, Inverse trigonometric, Exponential and logarithmic functions [1] Chapter 1 (Sections 1.1 to 1.3), and Chapter 7 (Sections 7.2, 7.3, and 7.6)	DR. NARAYAN NAYAK	
		Unit 2 Limits and continuity of a function including approach, Properties of continuous functions including Intermediate value theorem. [2] Chapter 1		
		Unit 3 Differentiability, Successive differentiation, Leibnitz theorem, Recursion formulae for higher derivatives. [3] Chapter 5.	DR. BIBHASH DEKA	Lecture, notes
		Unit 4 Rolle's theorem, Lagrange's mean value theorem with geometrical interpretations and simple applications, Taylor's theorem, Taylor's series and Maclaurin's series, Maclaurin's series expansion of functions such as their use in polynomial approximation and error estimation. [1] Chapter 4 (Sections 4.2, and 4.3), [2] Chapter 9 (Sections 9.8, and 9.9)		
		Unit 5 Functions of two or more variables, Graphs and level curves of functions of two variables, Partial differentiation up to second order. [2] Chapter 13 (Sections 13.1, and 13.3)		
II	MAT-HC-2016 REAL ANALYSIS	Unit 1 Algebraic and order properties of \mathbb{R} , absolute value and real line, bounded sets, supremum and infimum, completeness	DR. NARAYAN NAYAK	Lecture, notes, powerpoint, video

		<p>property of \mathbb{R}, the Archimedean property, the density theorem, intervals, nested interval theorem. [1] Chapter2</p>		
		<p>Unit 2 Real sequences, limit of a sequence, convergent sequence, bounded sequence, limit theorems, monotone sequences, monotone convergence theorem, subsequences, monotone subsequence theorem, Bolzano Weierstrass theorem for sequences, Cauchy sequences, Cauchy's convergence criterion, properly divergence sequences. [1] Chapter3</p>		
		<p>Unit 3 Infinite series, convergence and divergence of infinite series, Cauchy criterion, Tests for convergence: comparison test, limit comparison test, ratio test, root test, integral test, Absolute convergence, rearrangement theorem, alternating series, Leibniz test, conditional (non-absolute) convergence. [1] Chapter9Sections9.1-3.</p>		
	MAT-HC-2026 DIFFERENTIAL EQUATIONS	<p>Unit 1 Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.</p>	DR. BIBHASH DEKA	Lecture, notes
		<p>Unit 2 Introduction to compartmental model, exponential decay model, exponential growth of population, limited growth of population, limited growth with harvesting.</p>		
		<p>Unit 3 General solution of</p>		

		<p>homogeneous equation of second order, principle of superposition for</p> <p>homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.</p>		
	MAT-HG/RC-2016 ALGEBRA	<p>Unit 1</p> <p>General properties of equations, Theorems related to real roots of equations, Existence of a root in the general equation, Imaginary roots, Equal roots, Theorems determining the number of roots of an equation. Relation between roots and coefficients of nth degree equation, Solutions of cubic and biquadratic equations, when some conditions on roots of the equation are given, Depression of an equation when a relation exists between two of its roots, Symmetric functions of the roots for cubic and biquadratic. De Moivre's theorem (both integral and rational index), Roots of complex numbers, Solutions of equations using trigonometry and De Moivre's theorem.</p>	DR. NARAYAN NAYAK	Lecture, notes, practical and laboratory work
		<p>Unit 2</p> <p>Matrix Algebra, Addition, Transposition, Symmetry, Multiplication of matrices and their properties, Matrix inversion and properties, Row Echelon form and Rank of a matrix, Reduced</p> <p>row Echelon form, Consistency of linear systems, Solutions of system of homogeneous and non-homogeneous linear equations with number of equations and unknowns up to four.</p>	DR. BIBHASH DEKA	Lecture, notes

		Invariance of rank under elementary transformations, Reduction to normal form.		
		Unit 3 Permutations. Congruence of Integers. Groups, Properties of group elements. Subgroups. Cyclic groups, Permutation groups, Cosets of a subgroup. Definition of Ring, Subring, Ring with unity, Commutative Ring (Up to definition 5.5)	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes, quiz
III	MAT-HC-3016 THEORY OF REAL FUNCTIONS	Unit 1 Cluster point or limit point of a set, limits of a function (ϵ - δ approach), sequential criterion for limits, divergence criteria, limit theorems, one sided limits, infinite limits and limits at infinity.	DR. NARAYAN NAYAK	Lecture, notes, practical and laboratory work
		Unit 2 Continuous functions, sequential criterion for continuity and discontinuity, algebra of continuous functions, continuous functions on intervals, maximum-minimum theorem, intermediate value theorem, location of roots theorem, preservation of intervals theorem, uniform continuity, uniform continuity theorem.		
		Unit 3 Differentiability of a function at a point and in an interval, Caratheodory's theorem, chain rule, derivative of inverse function, Rolle's theorem, mean value theorem, Darboux's theorem, Cauchy mean value 21 theorem, Taylor's theorem and applications to inequalities, Taylor's series expansions of exponential and trigonometric functions, $\ln(1+x)$, $1/(ax+b)$ and $(1+x)^n$		
	MAT-HC-3026 GROUP THEORY -	Unit 1 Symmetries of a square,	MR. PRAJNAN	Lecture, notes, test

	I	Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups. Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups.	KUMAR BHAGAWATI	
		Unit 2 Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem. External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.		
		Unit 3 Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.		
	MAT-HC-3036 ANALYTICAL GEOMETRY	Unit 1 Transformation of coordinates, pair of straight lines. Parabola, parametric coordinates, tangent and normal, ellipse and its conjugate diameters with properties, hyperbola and its asymptotes, general conics: tangent, condition of tangency, pole and polar, center of a conic, equation of pair of tangents, reduction to standard forms, central conics, equation of the axes, and length of the axes, polar equation of a conic, tangent and normal and properties.	DR. BIBHASH DEKA	Lecture, notes,assignment,
		Unit 2 Plane, straight lines and shortest distance. Sphere, cone and cylinder, central conicoid, ellipsoid, hyperboloid of one and two		

		sheets, diametral planes, tangent lines, director sphere, polar plane, section with a given center.		
	MAT-SE-3014 COMPUTER ALGEBRA SYSTEMS AND RELATED SOFTWARE	Unit 1 Introduction to CAS and Applications: Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, plotting functions of two variables using Plot 3 D and Contour Plot, plotting parametric curves surfaces, customizing plots, animating plots, producing tables of values, working with piecewise defined functions, Combining graphics.	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes
		Unit 2 Simple programming in a CAS, working with matrices, Performing Gauss elimination, operations (transpose, determinant, inverse), Minors and cofactors, working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigenvalue, eigen vector and diagonalization.		
	MAT-HG/RC-3016 DIFFERENTIAL EQUATIONS	Unit 1 First order exact differential equations, integrating factors, Rules to find an integrating factor	DR. BIBHASH DEKA	Lecture, notes powerpoint
		Unit 2 Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation; Simultaneous differential equations.		
IV	MAT-HC-4016 MULTIVARIATE CALCULUS	Unit 1 Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Higher order partial derivative, Tangent planes, Total differential and differentiability, Chain rule, Directional derivatives, The gradient, Maximal and normal property of the gradient, Tangent planes and normal	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes

		lines.		
		Unit 2 Extrema of functions of two variables, Method of Lagrange multipliers, Constrained optimization problems; Definition of vector field, Divergence and curl.		
		Unit 3 Double integration over rectangular and nonrectangular regions, Double integrals in polar coordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals, triple integration in cylindrical and spherical coordinates, Change of variables in double and triple integrals.		
		Unit 4 Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral; Surface integrals, Stokes' theorem, The Gauss divergence theorem.		
	MAT-HC-4026 NUMERICAL METHODS	Unit 1 Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition.	DR. BIBHASH DEKA	Lecture, notes,video
		Unit 2 Lagrange and Newton interpolation: linear and higher order, finite difference operators.		
		Unit 3 Numerical differentiation: forward difference, backward difference and central difference. Integration: trapezoidal rule, Simpson's rule, Euler's method.		
	MAT-HC-4036 RING THEORY	Unit 1 Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideals, ideal generated by a subset of a ring, factor rings,	DR. NARAYAN NAYAK	Lecture, notes

		operations on ideals, prime and maximal ideals. Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.		
		Unit 2 Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in $\mathbb{Z}[x]$. Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.		
	MAT-SE-4024 LATEX AND HTML	Unit 1 Elements of LaTeX; Hands-on-training of LaTeX; graphics in LaTeX; PS Tricks; Beamer presentation	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes, test
		Unit 2 HTML, creating simple web pages, images and links, design of web pages.		
	MAT-RC-4016 REAL ANALYSIS	Unit 1: Algebraic and order properties of Real numbers, Order completeness of Real numbers, Open and closed sets, Limit of functions, Sequential criterion for limits, Algebra of limits, Properties of continuous functions, Uniform continuity. Uniform Continuity theorem excluding continuous extension and approximation) Unit 2: Sequences, Convergent and Cauchy sequences, Sub sequences, Limit superior and limit inferior of a bounded sequence, Monotonically increasing and decreasing sequences, Infinite series and their convergences, Positive term series, Absolute convergence, Comparison tests, Cauchy's nth root test, D'Alembert's ratio test, Raabe's test.	DR. NARAYAN NAYAK	Lecture, notes, practical and laboratory work
	MAT-HG-4026 NUMERICAL ANALYSIS	Unit 1 Gaussian elimination method (with row pivoting), Gauss-	DR. BIBHASH DEKA	

		<p>Jordan method; Iterative methods: Jacobi method, Gauss-Seidel method; Interpolation: Lagrange form, Newton form, Finite difference operators, Gregory-Newton forward and backward difference interpolations, Piecewise polynomial interpolation (Linear and Quadratic).</p>		
		<p>Unit 2 Numerical differentiation: First and second order derivatives; Numerical integration: Trapezoid rule, Simpson's rule; Extrapolation methods: Richardson extrapolation, Romberg integration; Ordinary differential equation: Euler's method, Modified Euler's methods (Heun and Mid-point).</p>		Lecture, notes, assignment
	MAT-SE-4014 R PROGRAMMING	<p>Unit 1: Getting Started with R - The Statistical Programming Language Introducing R, using R as a calculator; Explore data and relationships in R; Reading and getting data into R: combine and scan commands, viewing named objects and removing objects from R, Types and structures of data items with their properties, Working with history commands, Saving work in R; Manipulating vectors, Data frames, Matrices and lists; Viewing objects within objects, Constructing data objects and their conversions. Unit 2: Descriptive Statistics and Tabulation Summary commands: Summary statistics for vectors, Data frames, Matrices and lists; Summary tables. Unit 3: Distribution of Data Stem and leaf plot, Histograms, Density function and its plotting, The Shapiro-Wilk test for normality, The Kolmogorov-Smirnov test.</p>	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes, practical and laboratory work

		Unit 4: Graphical Analysis with R Plotting in R: Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts, Bar charts; Copy and save graphics to other applications.		
V	MAT-HC-5016 COMPLEX ANALYSIS	Unit 1 Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Limits, Limits involving the point at infinity, continuity.	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes, video,
		Unit 2 Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions.	DR. NARAYAN NAYAK	Lecture, notes
		Unit 3 Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals Unit 4 Antiderivatives, proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula. Liouville's theorem and the fundamental theorem of algebra..		
	MAT-HC-5026 LINEAR ALGEBRA	Unit 1 Vector spaces and subspaces, null space and column space of a matrix, linear transformations, kernel and range, linearly independent sets, bases, coordinate systems, dimension of a vector space, rank, change of basis.	DR. NARAYAN NAYAK	Lecture, notes, assignment
		Unit 2 Eigenvectors and eigenvalues of a matrix, the characteristic equation, diagonalization, eigenvectors of a linear transformation, complex		

		eigenvalues, Unit 3 Inner product, length, and orthogonality, orthogonal sets, orthogonal projections, the Gram–Schmidt process, inner product spaces; Diagonalization of symmetric matrices, the Spectral Theorem.		
	MAT-HE-5026 MECHANICS	Unit 1 Composition and resolution of forces, Parallelogram of forces, Triangle of forces, Converse of triangle of forces, Lami’s Theorem, Parallel forces, Moment of a force about a point and an axis. Couple, Resultant of a system of forces. Equilibrium of coplanar forces. Friction, C.G of an arc, plane area, surface of revolution, solid of revolution.	DR. BIBHASH DEKA	Lecture, notes powerpoint,
		Unit 2 Velocities and acceleration along radial and transverse directions and along tangential and normal directions, motion in a straight line under variable acceleration, simple harmonic motion and elastic string. Newton’s law of motion. Work, Energy and momentum, Conservative forces-Potential energy, Impulsive forces, Motion in resisting medium.		
	MAT-HE-5066 PROGRAMMING IN C	Unit 1 Variables, constants, reserved words, variable declaration, initialization, basic data types, operators and expression (arithmetic, relational, logical, assignment, conditional, increment and decrement), hierarchy of operations for arithmetic operators, size of and comma operator, mixed mode operation and automatic (implicit) conversion, cast (explicit) conversion, library functions, structure of a C program, input/output functions and statements.	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes, practical and laboratory work
		Unit 2		

		Control Statements: if-else statement (including nested if-else statement), switch statement. Loop control Structures (for and nested for, while and do-while). Break, continue, go to statements, exit function.		
		Unit 3 Arrays and subscripted variables: One and Two-dimensional array declaration, accessing values in an array, initializing values in an array, sorting of numbers in an array, addition and multiplication of matrices with the help of array. Functions: function declaration, actual and formal arguments, function prototype, calling a function by value, recursive function.		
	MAT-SE-5014 COMBINATORICS AND GRAPH THEORY	1, 2	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes, powerpoint
	MAT-RE-5016 NUMBER THEORY	1, 2	DR. NARAYAN NAYAK	Lecture, notes powerpoint
VI	MAT-HC-6016 RIEMANN INTEGRATION AND METRIC SPACES	Unit 1 Riemann integration: upper and lower sums; Darboux integrability, properties of integral, Fundamental theorem of calculus, mean value theorems for integrals, Riemann sum and Riemann integrability, Riemann integrability of monotone and continuous functions on intervals, sum of infinite series as Riemann integrals, logarithm and exponential functions through Riemann integrals, improper integrals, Gamma functions.	DR. NARAYAN NAYAK	
		Unit 2 Metric spaces: definition and examples, sequences in metric spaces, Cauchy sequences, complete metric spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's		Lecture, notes

		theorem. Subspaces, dense sets, separable spaces.		
		Unit 3 Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach contraction mapping principle. Connectedness, connected subsets of \mathbb{R} , connectedness and continuous mappings.		
	MAT-HC-6026 PARTIAL DIFFERENTIAL EQUATIONS	Unit 1 Introduction, Classification, Construction of first order partial differential equations (PDE). Cauchy's problem for first order equations, linear equations of the first order, Integral surfaces passing through a given curve, Nonlinear partial differential equations of the first order, Cauchy's method of characteristics, Charpit's method. Solutions satisfying given conditions, Jacobi's method.	MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes, powerpoint
		Unit 2 Canonical form of first order PDE, Method of separation of variables for first order PDE.		
		Unit 3 Reduction to canonical forms, Equations with constant coefficients, General solution.		
	PROJECT		DR. NARAYAN NAYAK DR. BIBHASH DEKA MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes
	MAT-HE-6056 RIGID DYNAMICS	Unit 1 Moments and products of inertia, parallel axes theorem, theorem of six constants, the momental ellipsoid, equipmental systems, principle axes.	DR. BIBHASH DEKA	Lecture, notes, powerpoint
		Unit 2 D'Alembert's principle, the		

		<p>general equation of motion of a rigid body, motion of the centre of inertia and motion relative to the center of inertia.</p> <p>Unit 3 Motion about a fixed axis, the compound pendulum, centre of percussion. Motion of a body in two dimension under finite and impulsive forces.</p> <p>Unit 4 Conservation of momentum and energy, generalized coordinates, Lagrange's equations, initial motions.</p>		
	MAT-SE-6014 LATEX AND HTML		MR. PRAJNAN KUMAR BHAGAWATI	Lecture, notes, assignment
	MAT-RE-6016 NUMERICAL ANALYSIS		DR. BIBHASH DEKA	Lecture, notes, project work